GREEN FOUNDATION

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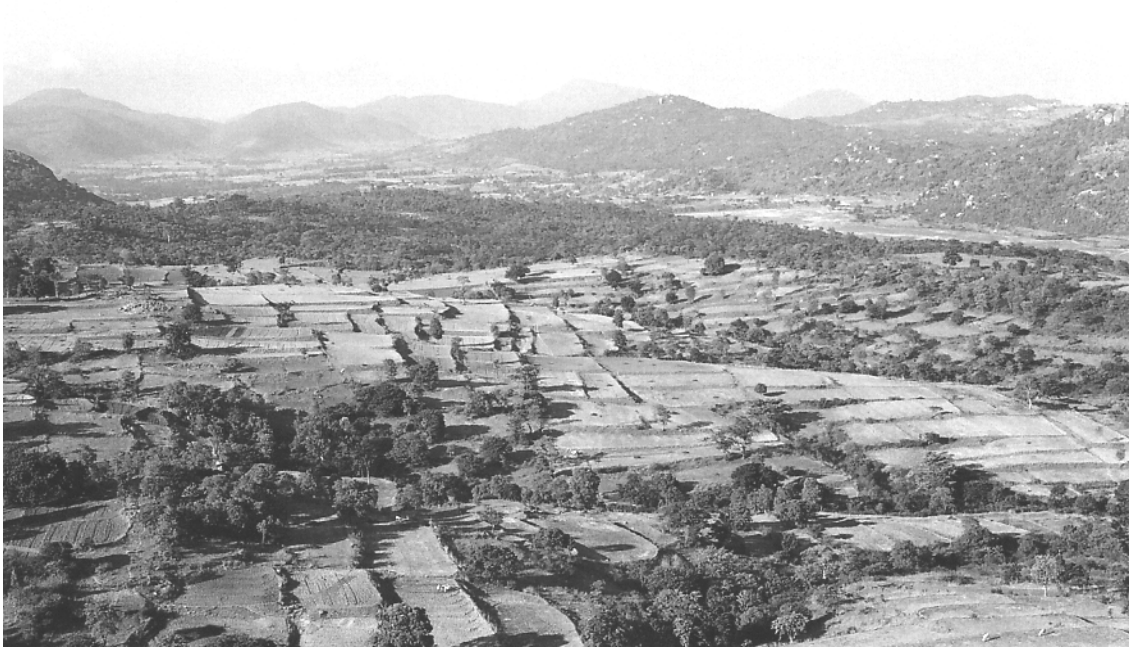
High-risks for the farmers of a semi-arid region of South India:

to what extent can organic farming help the farmers in Veereianadoddi and the surrounding villages in southern Karnataka?



Presented by NANCY LOOSEMORE

In view of obtaining the DIPLÔME D'AGRONOMIE TROPICALE (DAT)
Delivered by the CENTRE NATIONAL D'ÉTUDES EN AGRONOMIE TROPICALE (CNÉARC)

Under the guidance of:

Vanaja Ramprasad (Green Foundation)
Mireille Dosso (Cnearc)

26th October 2006

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Charles Chabot
Mireille Dosso
Didier Meunier

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RÉSUMÉ

Du fait de la Révolution Verte et ses revers en Inde, Green Foundation et d'autres organisations font la promotion de l'agro-biologie et aident les paysans à se défaire des dépendances aux intrants externes et aux fournisseurs. Cette étude de six mois évalue les besoins et possibilités d'agriculture biologique intégrée autour de Veereianadoddi (Bangalore Rural District, Karnataka). Les caractéristiques biophysiques, évolutions historiques et pratiques agricoles de la zone furent déterminées par enquêtes de terrain et entretiens avec des paysans. Une classification des paysans fût élaborée, pour comprendre leurs situations, aspirations et contraintes.

Depuis environ trente ans seulement, les intrants externes sont utilisés dans cette zone semi-aride reculée. Beaucoup de paysans produisent principalement l'alimentation de la famille, grâce au très répandu systèmes de culture associés « éleusine et inter-cultures ». Progressivement, certains ont vu leur situation changer avec l'accès à l'irrigation. Aujourd'hui, d'importantes différences d'accès à la terre, l'eau et d'autres formes de capital reflètent des inégalités précédentes et demeurent liées aux divisions de caste.

Les familles ont des envies et possibilités différentes de suivre les recommandations de Green Foundation, du fait de leur situation économique et du fonctionnement de leur exploitation. La disponibilité à long terme en eau et en sol de qualité requiert la poursuite des projets de Green Foundation. Cependant, d'autres projets sont nécessaires pour soutenir les paysans dépendants de petites surfaces en culture pluviale. Actuellement, ces paysans tirent peu de bénéfices directs des pratiques agro-biologiques, dont les résultats en culture pluviale demeurent incertains. Par ailleurs, les problèmes de nombreuses familles dépassent le cadre d'action de Green Foundation et appellent l'intervention d'autres acteurs du développement rural.

Mots clés

projet de développement rural, agriculture biologique intégrée (agriculture alternative), diagnostic agraire, évaluation de projet, enquête sur exploitations agricoles, Inde – Sud - Karnataka, zone semi-aride, culture pluviale, éleusine, cultures associées, irrigation

ABSTRACT

Due to the Green Revolution's drawbacks in India, organisations like Green Foundation have emerged, promoting agro-ecology and helping farmers escape dependence on external inputs and suppliers. This six-month study assessed the needs and possibilities of integrated organic farming and Green Foundation's projects in and around Veereianadoddi (Bangalore Rural District, Karnataka). The biophysical characteristics, historical evolutions and current farming practices in the area were determined from field investigations and interviews with farmers. A classification of the different farmers was elaborated to understand their current situation, aspirations and constraints.

External inputs have only appeared in the last thirty years, in this cut-off semi-arid area. Many farmers produce principally food for the family, the most widespread cropping system being ragi with intercrops. Progressive irrigation opportunities have changed the situation for some. They use more external inputs and commercialise more produce from irrigated fields. Today significant differences in access to land, water and other capital, reflect past inequalities and remain linked to families' caste.

The differences in the economic situation of the family and the functioning of their farming systems, mean that not all are equally able and willing to follow Green Foundation's suggestions. The long-term availability of water and good quality soil clearly calls for organic farming practices and Green Foundation must pursue their work. However, other projects should be developed to support the small dry-land farmers. They currently benefit little from organic practices, for which the outcome on dry-land remains uncertain in the area. Besides, the problems that many families face go beyond Green Foundation's possibilities and require interventions from other actors of rural development.

Key-words:

rural development project, integrated organic farming, agrarian diagnosis, project evaluation, farmer interviews, Karnataka - South India, semi-arid zone, rainfed farming, finger millet, intercrops, irrigation

FOREWORD

It is my belief that "development" is a very dangerous term. On a philosophical level, it requires constant questioning, as to what it is and what legitimacy outsiders have to interfere in an area that they can leave when they choose. My experiences of interactions with people from very different backgrounds have always been extremely positive and I am not suggesting that outside support or interest should be avoided, only that care is needed.

This report is aimed at people working in the "development field" and hopefully concerned with helping others improving both their physical and moral living conditions. As its author, I apply the same requirement to myself as I expect my numerous colleagues engaged in this field to do, and have outlined below my current ethical and philosophical perspective on "development". It is not theoretical, but an objective to work towards and a guide in checking that the work is not deviating from its purpose.

Without giving a precise definition, I use it to mean the improvement of people's living conditions, via a lessening of the impact of elements out of their control or beyond their knowledge. This must be according to what they decide such improvements might consist of and never according to what might seem best for them, or else, as an outsider, any legitimacy is lost. If it is to be sustainable, then it must be just, in that it should not handicap the possibilities of others achieving the same goal, either at present or in the future, and it must rely on resources guaranteed to the people.

From my experience, this requires working towards a more democratic society: one where human beings are considered and treated as equals; one where knowledge, both practical and theoretical, can be better accessed and shared; one where decisions are made in as just a way as possible. These three elements help individuals to have a better understanding of the world they live in, be less vulnerable to elements out of their control, and avoid some people being victims of what others have decided.

This report attempts to enable a better understanding of the living conditions of farmers within the study area, the resources at their disposal and how they are used. Short and long term problems have been highlighted and proposals made to improve the situation of the farmers and the management of resources. The conclusions drawn here can be extended to some other areas, similar to this one, but care must be taken that the conditions are close to those described here and any important differences noted.

A specific public are the members of Green Foundation, the NGO with and for whom this work was conducted. It is however meant to help all those trying to improve the living conditions of farmers in areas similar to this one.

The description of the technical and economic situation of the farmers is accompanied by elements of the social organisation, not only because these influence technical and economic factors, but also because they are themselves central to any "development". Of course, not all actors can work directly on all aspects and all problems. These must however be kept in mind, to avoid any consequences going in the wrong direction, to maintain the emergence and the sharing of new ideas on the different aspects of "development", and to support any helpful initiatives be it morally or physically.

GLOSSARY

***Alube* :**local cattle-drawn implement, see annexe 3 for a full description

Consumables: used in the context of a crop or livestock system, consumables refers to material inputs necessary for that crop or livestock system, that are used up or transformed in the course of the production

Cropping system (CS): see § 1.3.5

Crops and plants: see annexe 2 for alternative English, local and Latin names

Depreciation: a measure of the loss of value of the equipment necessary for a particular farming system - on average, this is the yearly sum that must be spent to replace equipment that has become to old to fulfil its purpose satisfactorily - evaluated for a farming system

Development, as in rural development, is a term that requires particular care as to its use. A discussion on this term and on the self engagement related to this work is given in ... the foreword.

Farming system (FS): see § 1.3.6

Farmyard manure: animal excrements mixed with some vegetable matter and left in heaps to partially decompose over durations of some 4-12 months

Gross return: see § 1.3.5

Heggunte: local cattle-drawn implement, see annexe 3 for a full description

Hallikars: name of the local breed of zebus in this part of Karnataka and in neighbouring states

Income or farm income: see § 1.3.6

Jeevamrutha: preparation used in organic farming including cow urine, cow dung and jaggery

Kunte: local cattle-drawn implement, see annexe 3 for a full description

Kuurge: local cattle-drawn implement, see annexe 3 for a full description

Labour-day (ld or hd): unit used for measuring a work quantity. One ld corresponds to the quantity of work that can be done by one human being, for a job that in the local context is not gender specific.

Livestock system (LS): see § 1.3.5

Man labour-day (md): unit used for measuring a work quantity. One md corresponds to the quantity of work that can be done by one person, for a job that in the local context is done by men only.

Net added-value: see § 1.3.6

Net return: see § 1.3.5

Production costs: see § 1.3.5

Scrub land has been used to designate land that is not purposefully sown or planted by farmers, but that is not forest land either. It includes: some fields that farmers do not use because they have too much land compared to their current workforce or interest in

agriculture; areas on the edge of the forest, that were usually cleared previously, but have been subsequently abandoned because of poor land conditions and the proximity of the forest, today containing a mixture of bushes and herbaceous species; other small fields or parts of fields that are too stony or have too thin soil to be cultivated; low lying areas that can be under water at some times the year, but that then develop quite a dense covering of herbaceous species; ditches and areas close to small streams on the edges of which sometimes significant areas of spontaneous vegetation develop. This land will contain both herbaceous species and low growing trees or bushes.

Self-help group is a community based organisation. Individuals group together to form an organisation whose objective is often creating low interest credit opportunities for its members. it can however be done to increase support within the community and permit other collaboration to be implemented.

Services: used here in the context of a cropping system or livestock system, services refers to the work that is paid for, but that is carried by qualified professionals or by companies

Vuta :local cattle-drawn implement, see annexe 3 for a full description

Woman labour-day (wd): unit used for measuring a work quantity. One wd corresponds to the quantity of work that can be done by one person, for a job that in the local context is done by women only.

ABBREVIATIONS USED

APMC: Agricultural Produce Marketing Committee

CS: cropping system

d: day

FCI: Food Corporation of India

FS: farming system

h: hour

hd: see ld

ICRISAT: International Crops Research Institue for the Semi-Arid Tropics

ld or hd: labour-day (or human-day)

LS: livestock system

md: man labour-day

MSP: minimum support price

NA: not applicable

NQ: not quantified

PDS: public distribution service

SHG: self-help group

wd: woman labour-day

OVERVIEW

CONTENTS

SHOULD FARMERS BE INTERESTED IN CONVERTING BACK TO ORGANIC FARMING?

The study conducted here is a contribution to the thinking on sustainable rural development, via an investigation into the situation of farmers in and around Veereianadoddi. Veereianadoddi is a small village in Southern Karnataka, where an organic village project has been set up by Green Foundation, a local NGO, in partnership with the Karnatakan state government. In India, a heavily implemented "green revolution" has had numerous negative effects. From this has emerged a wide movement, of which Green Foundation is just one actor, trying to find and implement sustainable forms of agriculture that can improve farmers' situations as well as the quality of their produce.

I have attempted to give the farmers' perspective on these issues within the local context of the chosen study area, in order to help Green Foundation with their work. What support can Green Foundation give the farmers there? In other words:

- what need do farmers have for converting to organic farming?
- are specific categories of farmers concerned?
- what benefits can these farmers expect from organic farming?

To answer these questions about the farmers, it is necessary to look in detail at:

- how they farm and how they live
- the constraints and difficulties that they face
- the changes they introduce when farming organically

The organic farmers in the area have only recently converted to this type of farming. Because of this, the possible benefits to come from organic farming could not be fully evaluated. Some partial conclusions have been drawn, that will require checking. On the other hand, many elements are put forward that should help current and future experiments and projects be conclusive.

As to the farmers' current situation, an in-depth analysis was carried out. It is based on the assumption that farmers have good reasons for proceeding as they do. The study requires understanding the social organisation and the farming practices as a way of seeing what choices are made by farmers. It allows necessary resources for each type of farm to be compared with those currently available to the different categories of farmers. Besides this, farmers' needs and aspirations can be compared with what they can obtain from their farming activities. The natural and social constraints thus identified, difficulties for farmers and pressures on resources become apparent.

From there, necessary changes and possible changes are discussed. The focus is on what Green Foundation can do to support farmers and what need they have for organic farming. But the detailed study of the farmer's current situation also raises issues that go beyond the capacity of a small NGO, however determined and hard-working. Ideas are proposed for Green Foundation to consider in the pursuit of their work, but also for other actors of the rural development field. I hope they will be read, pondered over and the results of this thinking process acted upon by those who have some means of doing so.

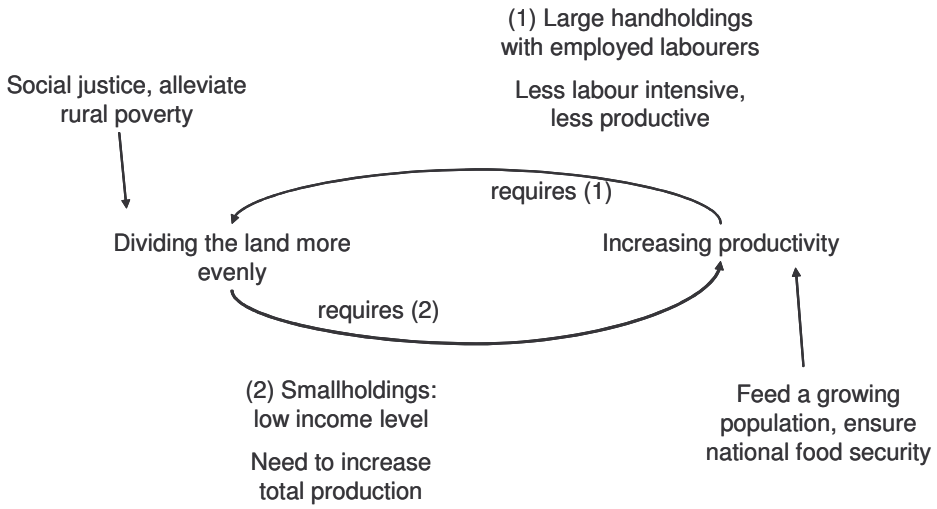
1 A DIFFERENT "GREEN REVOLUTION" IN THE MAKING?

The green revolution has shown its limits. It has increased the total production of agricultural produce, but it has not alleviated rural poverty nor made the future less uncertain for many farmers and consumers. Rather, it has often emphasised inequalities (Landy, 1996) and provoked a deterioration of the quality and availability of natural resources (Chominot and Landy, 1997). In reaction to this, many ideas on different ways of helping farmers tackle some of the problems they face and of practising farming that maintains natural capital are being implemented today. Green Foundation is one organisation working in this field.

1.1 AGRICULTURAL POLICIES IN INDIA

India is a country with a long history of state or government-led agricultural policies. They have been of all kinds: providing irrigation facilities, by the construction of dams for example; re-orientating agriculture towards export crops under British colonial rule; agrarian reforms attempting to redistribute the land; setting up credit cooperatives; subsidising inputs, etc. The initial objectives, after India gained its independence in 1947, were double: increase production levels to feed an ever-growing population; support social changes that will help reduce poverty among the rural population by a redistribution of access to land (Figure 1). In the context of the time, both were considered to be linked (Landy, 1996). Although agrarian reform came back onto the scene in the late 70's, the social objective of agricultural policies has for many years been pushed aside.

Figure 1: Land reform and green revolution: contradictory or complementary?



1.1.1 Increasing production to insure the nation's food security

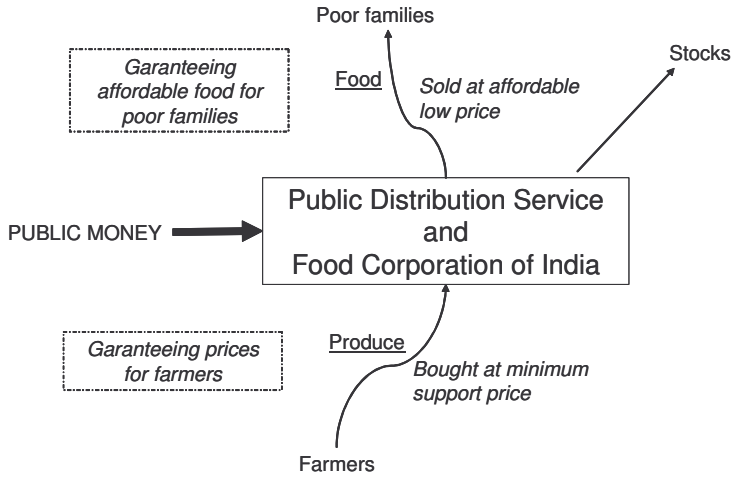
The 2 severe droughts of 1965 and 1967 constituted a real shock and led to urgently implemented policies. India had to increase its grain production fast to prevent future food crises. The green revolution, already in the doing, was stepped-up: the government gave active support to introduce new high-yielding varieties of crops, along with all the elements that such high-yielding varieties need. The increases in yields are obtained with higher levels of inputs: more water, more fertilising material, and more pest and disease control. Credits and subsidies were set up to enable farmers to invest in irrigation facilities and to maintain the prices of inputs reasonable. The focus was on the areas with the highest production potential, which means those already ahead of the others. Production increased heavily, that of rice

doubling and that of wheat tripling between 1960 and 1995 (Landy, 1996), both due to increased surfaces cultivated and higher yields. India was able to constitute grain stocks and start exporting agricultural produce.

1.1.2 Regulating markets and guaranteeing food for all

Another important policy of the central government has been the public distribution service (PDS). This was just one of a group of measures regulating the national agricultural markets: controlling imports and exports and setting-up of the Food Corporation of India (FCI) in 1965. The FCI was created to deal with buying produce, organising transport and storage, and distributing produce (Chominot and Landy, 1997). The FCI has been central in providing minimum procurement prices to farmers: the state buys produce from farmers when market prices dip below a certain level. It has been used to manage a system of grain storage enabling food security at a national level to be guaranteed, even in low production years. Lastly, it has attempted to ensure that poor parts of the population have access to cheap staple food: the PDS redistributes the grain bought from farmers to low-income families via the Fair Price Shops.

Figure 2: Role of the Food Corporation of India - regulating markets and redistributing food to the poor



These "shops" are sale points, where prices are very low and are, in theory, only accessible to poor families detaining a ration card. The system has many faults. It is particularly criticised for the high cost of such a subsidised system. However, an important proportion of the cereal grains produced in the country still transits through the FCI (Landy, 1996). The minimum support price (MSP) and PDS system are still in place and affect the local farmers (§ 2.2.1.4, 2.2.4, 2.5.1, 3.4.2).

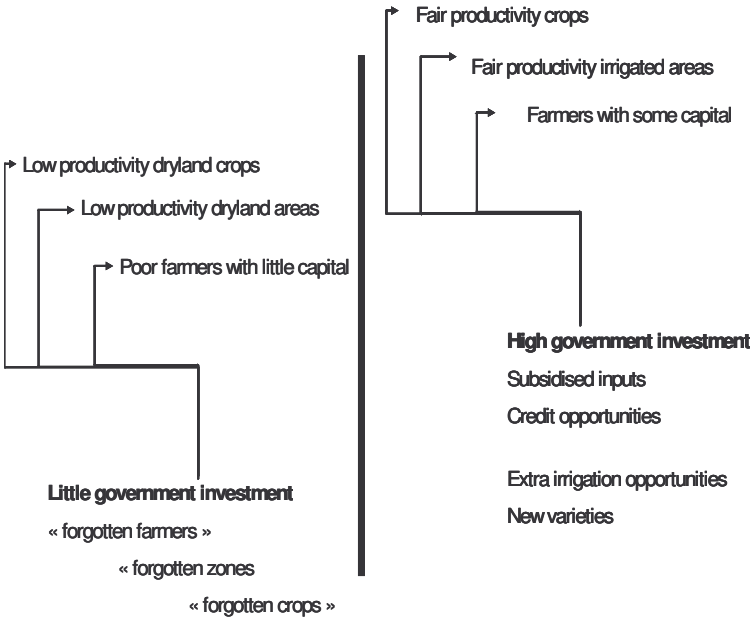
1.1.3 Unequal access to new farming opportunities

At the on-set of the Green Revolution proper, previous agrarian reforms aiming at giving smaller farmers access to land were dropped. The measures destined at increasing production were said to benefit all, as unlike mechanisation, they do not require large land surfaces to make the investments worthwhile. This has not been the case… They might not require large landholdings, but they still require enough surplus cash at the start of the growing season to purchase the inputs. Because of this, numbers of poorer farmers have been excluded. Moreover, the technological package of high-yielding varieties, irrigation facilities and inputs has centred on the main cereal crops and on the areas with good potential for irrigation.

There have been high-yielding varieties developed for other crops, like ragi or sorghum for example. Subsidised inputs have reached even the remotest of areas. Credit opportunities have been proposed by cooperative banks or self-help groups in small villages. Despite this, the imbalance between the initially more productive and the least productive categories has

grown. The scale on which the transformations have taken place has not been the same (Figure 3).

Figure 3: Concentrating on high productivity categories

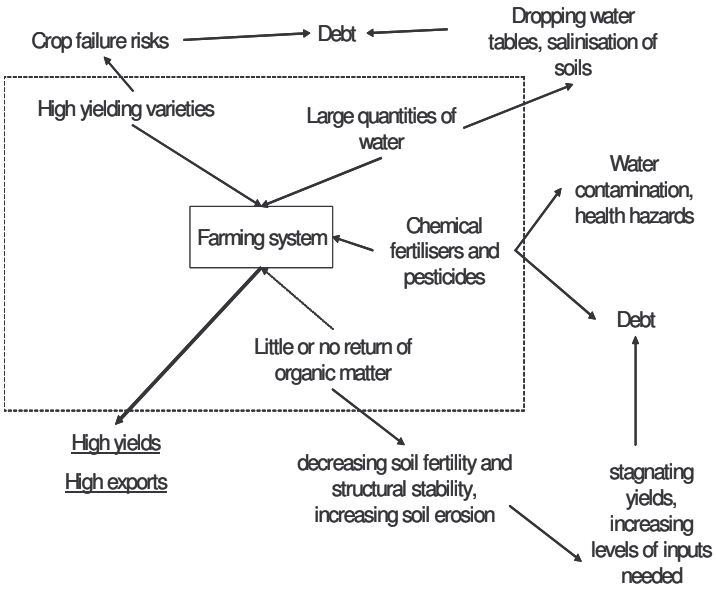


Landy (1994) gives an example of the extensive government inputs that have been received by Mandya, in South Karnataka. It is a zone benefiting very early on from irrigation facilities. The government has provided subsidised inputs, training and technical demonstrations, introduction of new crops, organised marketing… He contrasts it with villages near Nagamangala, further East, where solely rainfed crops are grown. There, the only changes that have been introduced by the government are some new crops and techniques, but that have spread mainly by spontaneous diffusion from farmer to farmer, a few overcrowded primary schools where free lunches are served and the weekly visits of a nurse. This also creates problems for the irrigated zone, where immigration from the dry-land zone has been high. The management of today's large urban population, with an important proportion of poor, is difficult.

1.1.4 Health and environment risks

The problems of the Green Revolution go beyond increasing inequalities. It is commonly admitted today, that in the areas with the highest productivity, yields are stagnating, sometimes declining as figures for Karnataka suggest (Landy, 1996), or at least require more and more inputs to be maintained.

Figure 4: The other outputs of the Green Revolution



Environmental degradation can be serious (Figure 4). For example, studies in the Kaliveli watershed in Tamil Nadu have shown that soil and groundwater salinisation, as well as a drop in the water-table level have occurred since the on-set of bore-well irrigation (Lacarce and Fleutry, 2001); these are common problems in areas where electricity subsidies and other government measures have enabled important increases in production levels to be made. Other natural resource degradations include decreasing

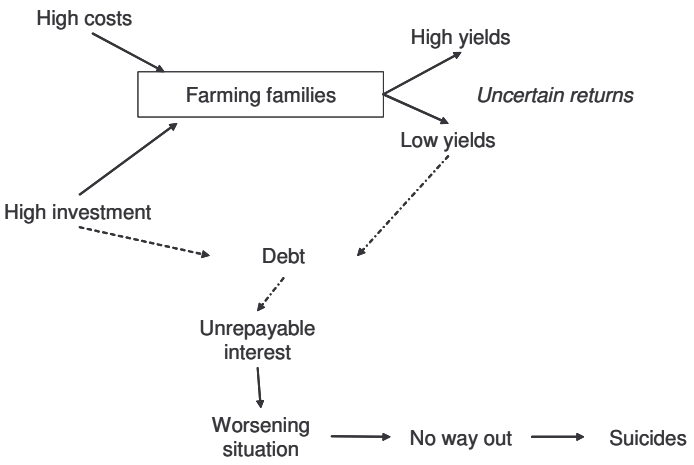
levels of organic matter in soils, as manure and organic farmyard fertilisers have been replaced by mineral fertilisers. Soil structure and stability, water holding capacity, cation exchange capacity, etc, suffer as a consequence and certainly play a part in the often increasing mineral fertilisers necessary for maintaining yields.

Most of the new chemical inputs used present health hazards, both by direct contact, but also by food and water contamination. Initial introduction of these new chemicals was often done without any proper warnings and instructions as to their use. Even today, inappropriate levels continue to be used and particularly dangerous chemicals are still regularly sprayed or applied to crops or directly on produce for prolonging its conservation. In certain areas, agricultural labourers are involved in very hazardous pesticide spraying operations, with their employers taking no concern for potential health consequences.

1.1.5 A new form of vulnerability for farmers

The increase in inputs has also changed farmers' situation from one where they control their raw materials, seeds and manure mainly, and consume a large proportion of their produce, to one where they are dependant on external suppliers to obtain the inputs and rely on the market to generate their income. Changes in policies then become an extra hazard for them. Since 1991, India has had to implement a structural adjustment plan to reduce public spending. One consequence was the leap in fertiliser price. Farmers' dependence on seed suppliers also mean that the suppliers can take advantage of the situation: seed companies have supplied particularly low percentage germination batches, or even totally duff ones (Sainath, 2004). The consequence of a crop failure can be of the utmost gravity.

Figure 5: The debt traps



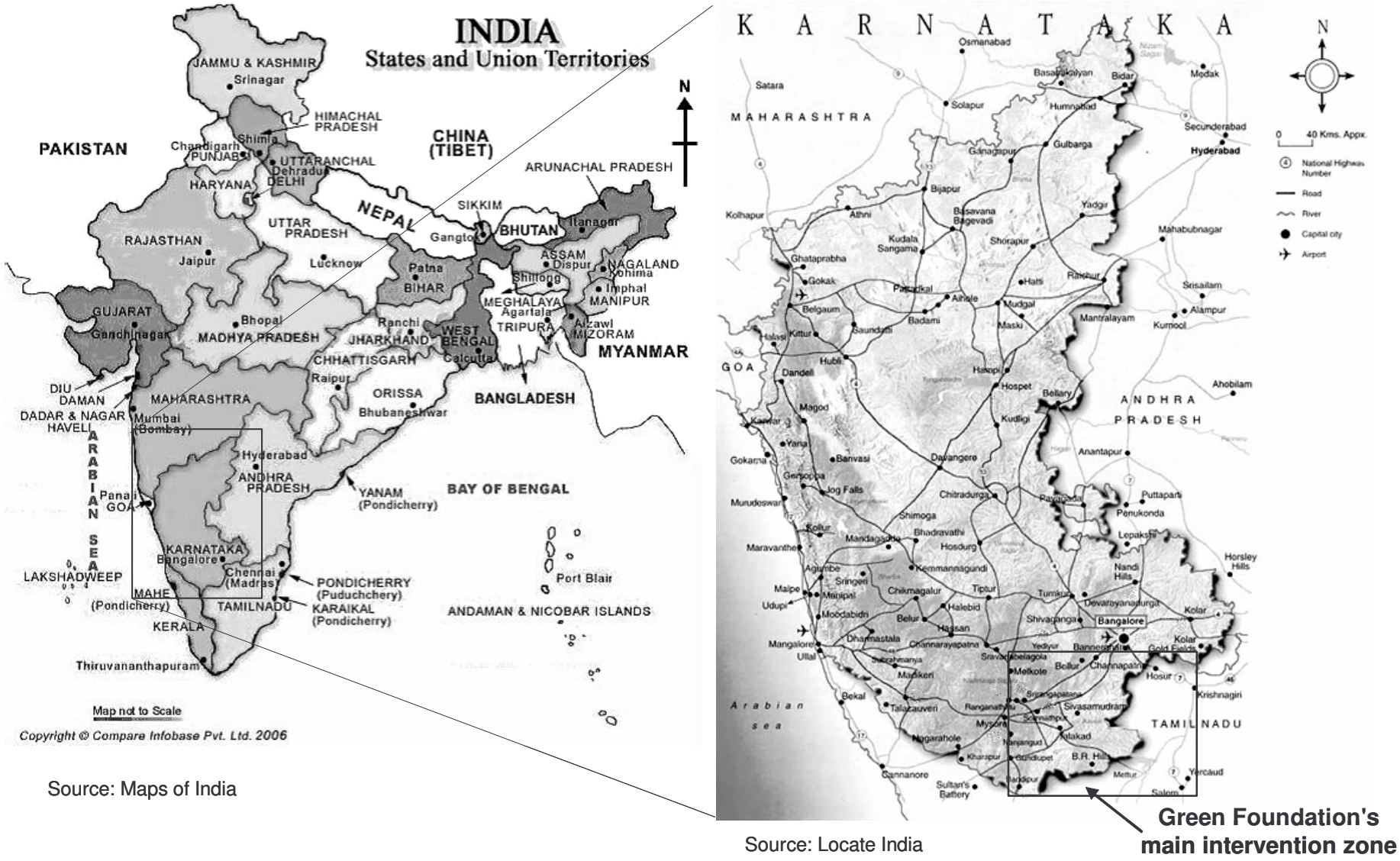
Attempts to call attention to the serious situation which farmers face have been numerous. Thousands of farmers have been driven to suicide. The reason involved is usually mounting levels of indebtedness (Sainath, 2004; Shiva, 2004; Shalmali Guttal, 2004; Courrier International, 2006) due to a negative net return, or to high investments required for obtaining irrigation possibilities for example (Figure 5).

1.1.6 A policy shift towards low external-input farming

The suicides that started around 1997 have probably had an impact on the thinking within the national and state governments. Although changes in policy are slow, there are some positive signs that problems with the intensive external input type of agriculture favoured until now are being recognised.

The government of Karnataka is a precursor in accepting these facts as realities and looking for alternatives. It is implementing a state policy on organic farming in which it has explicitly stated all of these negative impacts (Government of Karnataka). The concept of organic

Figure 6: Green Foundation's principal intervention zone

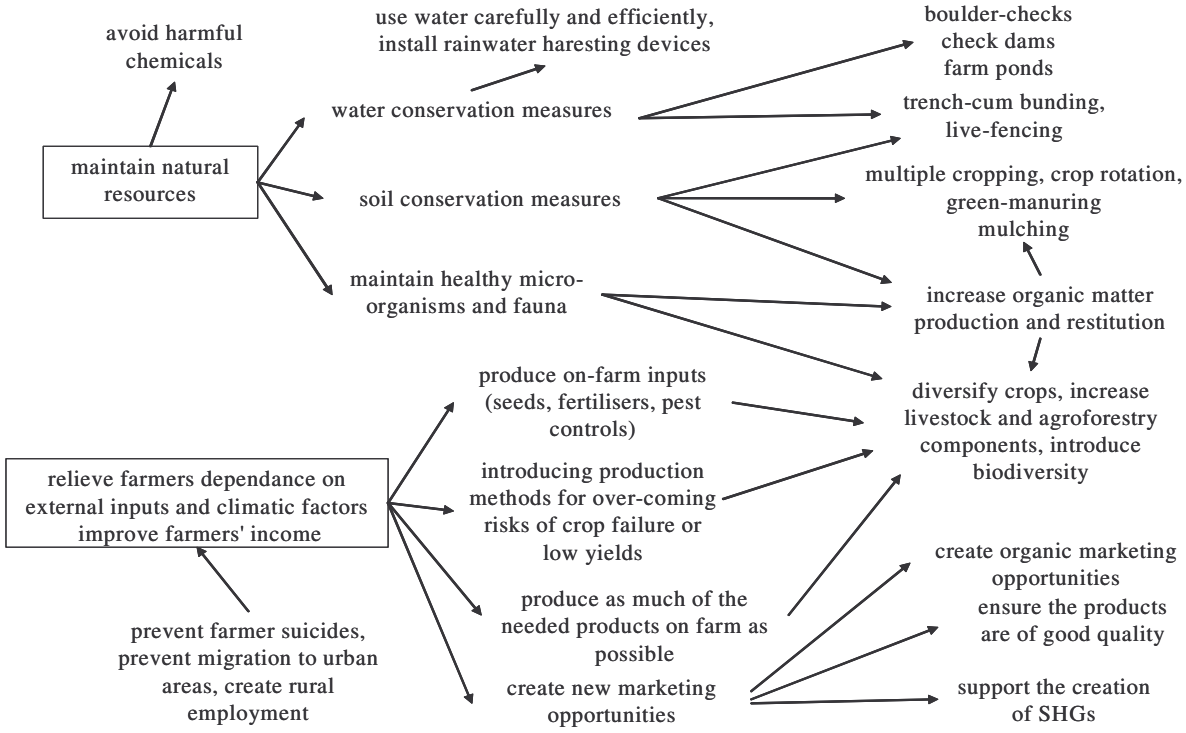


Source: Maps of India

Source: Locate India

farming adopted is a holistic approach, aiming as much at reducing farmers' dependence on external inputs and their vulnerability in the face of the suppliers, as putting a stop to the degradation of natural resources. Some of the numerous different components of the policy are illustrated on Figure 7, along with how they contribute to the main objectives. Elements concerning health, loans, education, training, public awareness are also included in the policy.

Figure 7: Organic farming policy - a holistic approach to providing sustainability and security for farmers



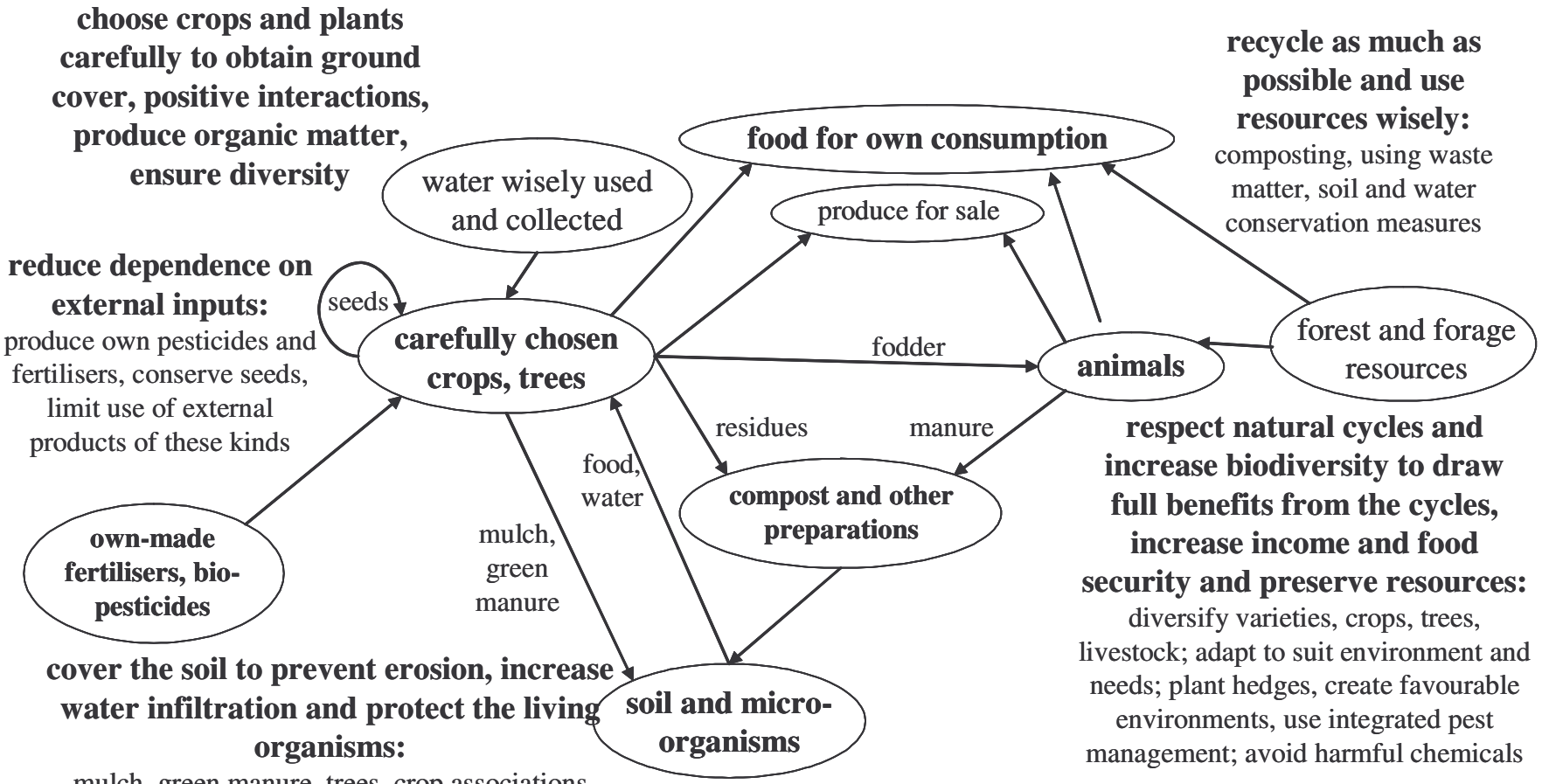
One particular aspect of the policy is the selection of a number of villages throughout the state, where the conversion to organic farming will be tried first. In these villages, all aspects of organic farming should be developed: animal husbandry and agroforestry as ways to produce organic matter for use within the cropping systems; adopting a bio-diverse and mixed farming approach as a way of providing for different needs and assuring security in the face of uncertainties such as climatic events; improving soil and water conservation measures and working on the fertility of the farming system. The concept of organic farming chosen is an integrated, natural-cycle based one, as described in section1.2.2.

Part of the civil society in India has been ahead of the government on these issues. For many years now, a number of organisations such as Green Foundation, have been promoting and implementing integrated farming of this nature, with a holistic approach.

1.2 GREEN FOUNDATION: HELPING FARMERS ACHIEVE SELF-SUSTAINABILITY

Green Foundation is a small Indian NGO, with its office in Bangalore. The organisation works throughout Karnataka and in neighbouring states. Activities have spread and staff frequently travel to other parts of the state and the country, engaged in training schemes and collaboration with partner organisations; but their main field work takes place in the south-eastern part of Bangalore Rural district and over the border into Tamil Nadu (Figure 6). The farmers they work with are in a semi-arid region of the world, where droughts are frequent and not all have access to irrigation.

Figure 8: The integrated organic farming idea **Sustainability: nursing and mimicking natural cycles**
Security: producing one's inputs and using biodiversity



1.2.1 Security and sustainability for farmers

Green Foundation was set-up because of the problems discussed above: the spread of high-yielding varieties and the consequent difficulties for some farmers; the "forgotten", low-productivity, dry-land farmers, or those with low capital or income, who cannot afford irrigation or inputs and have received little or no support.

The initial focus was the conservation of land races as a way of reducing the risks incurred by farmers and ensuring their food security: technical risks of crop failure from climatic conditions, or unknown quality of purchased seed, or from degraded natural resources; economic risks linked to the cost of the inputs and the possible need of resorting to credit as explained above (Figure 5). Knowledge about different varieties can help in choosing which ones to sow; knowledge about seed conservation and production frees farmers from dependence on external suppliers.

Progressively the work has broadened to encourage farmers to practise integrated farming as a way of achieving security and self-sustainability. In this respect, the objectives of Green Foundation are totally coherent with those enounced by the government (Figure 7), as they cover the sustainability of both the natural resources and the farming families' livelihood. Green Foundation has indeed been supporting the government in drawing up this policy.

1.2.2 Organic farming as an integrated system relying on natural cycles

The basic concept of Green Foundation's idea of organic farming is taking care of and making the most out of the biological cycles that occur in a sane farm environment. In this way, the health of the soil, the water and the ecosystem can be maintained. The farm must be considered as a whole, where as much as possible is recycled and where the living organisms are the centre of attention. Along with preserving natural resources, this can help reduce farmers' dependence on external inputs (Figure 8).

The system should use diversity to mimic natural ecosystem functioning and make the most of its biological potential. It can be thought of as feeding and caring for the soil and the living organisms, and carefully selecting numerous plants and animals. Increased biodiversity ensures a rich ecosystem which will limit unbalanced situations, such as heavy pest attacks. Moreover, it will reduce the risks of all of a farmer's crop suffering from adverse climatic conditions, or from sudden price changes. Organic matter is given great importance, as it is food for the living components of the ecosystem, but also protection against the elements, just as in a natural environment.

1.2.2.1 Outside input to better use community knowledge and overcome social inequalities

There are several hypotheses behind Green Foundation's work. They believe that traditional practices have managed to produce food for farmers over generations without degrading resources; that between them farmers have a wealth of knowledge and can get many benefits from exchanging their know-how, on practices become rare or ideas from other areas; that they can sometimes pool resources to use them more efficiently; and of course that safe and sustainable farming can be achieved by good on-farm management of bio-diversity, and attention to natural cycles and equilibrium.

There is no denial of the problems that farmers faced prior to the introduction of new varieties: lower yields and thus precarious food security after a bad year for the smaller landholders; low value addition, dependence on intermediaries for selling produce and

therefore precarious economic security; strong social inequalities… Indeed, Green Foundation's work is aimed at overcoming poverty and a lot of effort is directed towards farmers at the bottom of the social ladder. They are therefore not proposing traditional practices as a panacea, but as a base to build upon.

New practices, which can be traditional ones from other areas, or ones arising from all kinds of experimental farming, can be introduced to improve the functioning of a farm ecosystem. By applying ecosystem respectful innovations, farmers can, with a little outside support in the first instances, improve their farming without the risks: the risk of obtaining high yields some years only, the risk of them being short-lived, or the risk of them being counter-balanced by the cost of the inputs. Moreover, this low or no external input farming is low cost and can be particularly beneficial to farmers whose geographical location or social status has left them out of previous transformations. Reducing inequalities by helping certain categories overcome initial social handicaps is an important objective of the organisation.

1.2.2.2 The field activities

Green Foundation therefore works by proposing participatory and community-based initiatives, that involve creating support amongst farmers at the village and regional level and enabling them to exchange knowledge. It provides different training schemes for farmers and encourages and supports them with the implementation of changes they choose, within the following domains for which Green Foundation has developed its expertise:

- strengthening communities and working on social issues and inequalities;
- exchanging knowledge about crops, varieties and practices, to overcome difficulties and improve the farming;
- general functioning of integrated farming for lowering costs, reducing risks and preserving resources;
- seed selection, seed storage and community seed-banks as bio-diversity reserves for stabilising yield and increasing community links;
- diversifying the crops grown, and introducing new components such as kitchen gardens, as a means of achieving food security and generating supplementary income;
- composting and organic matter strategies, to maintain a good healthy soil, via the restitution of organic matter to the soil as opposed to nutrients in mineral form;
- agro-forestry, with tree nurseries and tree planting, and livestock rearing as integral parts of the farm, necessary for maintaining soil fertility by producing organic matter and providing soil coverage, as well as useful by the products they yield and the other effects they will have through the increase of on-farm biodiversity and their interactions with cropping systems;
- soil and water conservation measures at the field level including trench-cum bunds to stop soil loss from the fields and to slow surface run-off; mulching, green-manure crops and vegetative ground cover to prevent erosion, facilitate water infiltration and conserve soil moisture, increase soil organic matter and nutrient fertility;
- soil and water conservation measures at the landscape level such as farm ponds to stop water run-off, regenerate groundwater and increase local atmospheric

humidity, or check dams and boulder checks to stop the development of small ravines, increase water infiltration and recuperate the soil;

- cropping practices, and experimental and research activities destined at identifying practices that make the best use of natural resources and maintain a healthy ecosystem;
- value-addition via the transforming of produce and marketing to enable farmers to by-pass some of the intermediaries and obtain a more remunerative price for their produce.

1.2.2.3 Field implementation, spreading information and campaigning

The staff is composed of approximately 20 full-time members, three quarters of whom are involved principally in field work. This can be farmer training programs or direct support in implementing seed conservation activities, creating community groups, introducing integrated farming practices, setting-up field experiments or monitoring projects and research work. The office staff deal with administrative questions, but their main work is keeping track of the fieldwork being carried out, making this information accessible to the public, monitoring and setting up training programs for farmers, organising specific events destined at creating links between different farmers, as well as with the public, and informing and campaigning on issues related to food and livelihood security and sustainability. Green Foundation has, for example, made a significant contribution to the Karnataka government's policy on organic farming.

1.2.2.4 A government partnership for the organic village project

The essential part of the funds received by Green Foundation is from private sources, many of them overseas organisations. Recently, the government's interest in organic farming has enabled them to work with the agricultural department in implementing one of the government's organic village projects. Green Foundation was working in this area previously and the level of farmer interest there convinced the government to select this as one of the initial experimental sites. In this village, Green Foundation runs the project, but receives specific government funds, which are affected to particular components of the project, as decided by the agricultural department. Because of this financial support, Green Foundation must give detailed accounts of the use of this money and the results achieved.

It is not quite a whole village project. Natural boundaries (rivers, streams and forest) were used to delimitate a 100 ha surface area on which to convert all of the farming to organic over a 3-year period. Many, but not all, of the farmers in the village have land within this area. Some of the land is owned by farmers in neighbouring villages.

1.3 A LOW COST EVALUATION OF THE PERTINENCE OF GREEN FOUNDATION'S APPROACH

This study has been conducted over a 6-month period: 4.5 months of field investigation in India; another 1.5 months of write-up in France. All of the work conducted by Green Foundation could not be looked into, but instead, a particular area was selected. The necessary budget was very limited due to the methodology adopted, which privileged direct interaction with the farmers.

The central idea has been understanding the current situation of the farmers in the area and the reasons behind their farming systems and their farming practices. This is done on 2 levels: the

availability of resources to the different categories of farmers and the resources required for the various farming activities; the needs and aspirations of the farmers and the "products" that can be obtained from the different farming systems. By doing this in sufficient detail, the pertinence of Green Foundation's work in the area, along with other policies affecting the farmers there, have been assessed; necessary and possible changes have been discussed to suggest modifications in the approach adopted and interventions of a different nature.

The study duration was too short to carry out a detailed prognostic evaluation of the medium and long term impacts that Green Foundation's work will have for the farmers of the area. But elements that could be looked into in more detail have been mentioned.

1.3.1 Organic farming in and around Veereianadoddi

The choice of area was not an easy one. It the end it was decided to centre it around the organic farming village project. Due to the whole-village nature of the project in Veereianadoddi, there is a strong concentration of farmers there, implementing and experimenting with integrated farming practices initiated and monitored by Green Foundation. More importantly, if Green Foundation can find the necessary staff, it hopes to increase its activities in this area. This village and the surrounding ones were therefore chosen, to see how best Green Foundation can support the farmers there.

The drawback was that the work only started in the area approximately 3 years back and therefore the evaluation of the impact it can have would be difficult. Conducting an impact evaluation as well was a little ambitious anyhow, given the duration of the study. The focus remained on the current situation of farmers in and around Veereianadoddi and the difficulties they face. In a prolonged study, a comparison would have been made with farmers in other areas, practising integrated farming over longer durations and enabling prognostics to be made about longer-term changes in the concerned villages.

1.3.2 Living and walking in the villages

The size of the study zone was chosen so as to be able to walk it in one day. Exceptionally one of the buses crossing the area was used for moving around faster, but mostly the different villages and land were visited on foot. Accommodation close to the centre of the zone was for this reason particularly practical. It was a deliberate choice to live in the area for the duration of the study.

Both living in the villages and walking as a means of transport had similar advantages: spontaneous meetings with farmers working in the fields, or in the villages; direct observation of the work going on and people's daily tasks; stopping where and when one wants; generating curiosity among the local people and opportunities for understanding their practices and choices. There is nothing quite as helpful, for realising what people's situation is like, as spending time with them and seeing as much as possible with one's own eyes.

1.3.3 Communication

The language spoken in the area is the Karnatakan language, Kannada. A local man was employed as an interpreter for just over 1 month, which covered the historical interviews. Despite common problems with translations, it worked fairly well. When he was later offered other work, no suitable replacement could be found: local villagers speaking English are very rare and people from Bangalore do not wish to have to live in a rural village, even for a very short duration such as one week.

I thus proceeded with the interviews alone, which constituted the main difficulty of the work. It made the interviews very long and I often had to carry out 2 instead of 1: to check I had correctly understood; or to complete partial interviews, if I had concluded the previous one prematurely because the need for my interlocutor to repeat his words several times had become too much. Having to conduct the interviews alone did have certain advantages. It meant there were no misunderstandings between me and the translator; it made it easier for me to ask the questions I wanted, when I wanted. I was also free to work the hours that suited the study and the local farmers best, and had the opportunity of spending time with them very early in the morning for example, when they are engaged in different tasks. But more importantly, it meant I could communicate with the villagers outside of formal interviews. I learnt a lot that I probably would not have otherwise.

1.3.4 Always observing and questioning

The limited logistics chosen for the field study contributed to making the possibilities for observations as numerous as could be hoped for. This is one of the principal tools for conducting the study: seeing who the different farmers are, the environment in which they live, which farmers grow what crops and which animals they keep, where and when they grow or rear them and how they do so.

Observing is always done with the central objective of understanding. If the reasons behind the observations can be determined and the current organisation understood, pertinent classifications and the necessary approximations can be made. This is central to this study, which has used no statistical methods. A representative and useful picture can then be given of who and where the different farmers in the area are, the situation they are in, the difficulties they face and what can be done about it.

Without direct observations first, it is difficult knowing what questions to ask, or who should be asked. Once some of the factors that influence the organisation can be picked out, many questions appear. Some will be answered by further observations. Most will require carefully questioning chosen farmers: interviews with selected farmers constitute the other principal tool of this study (Figure 10).

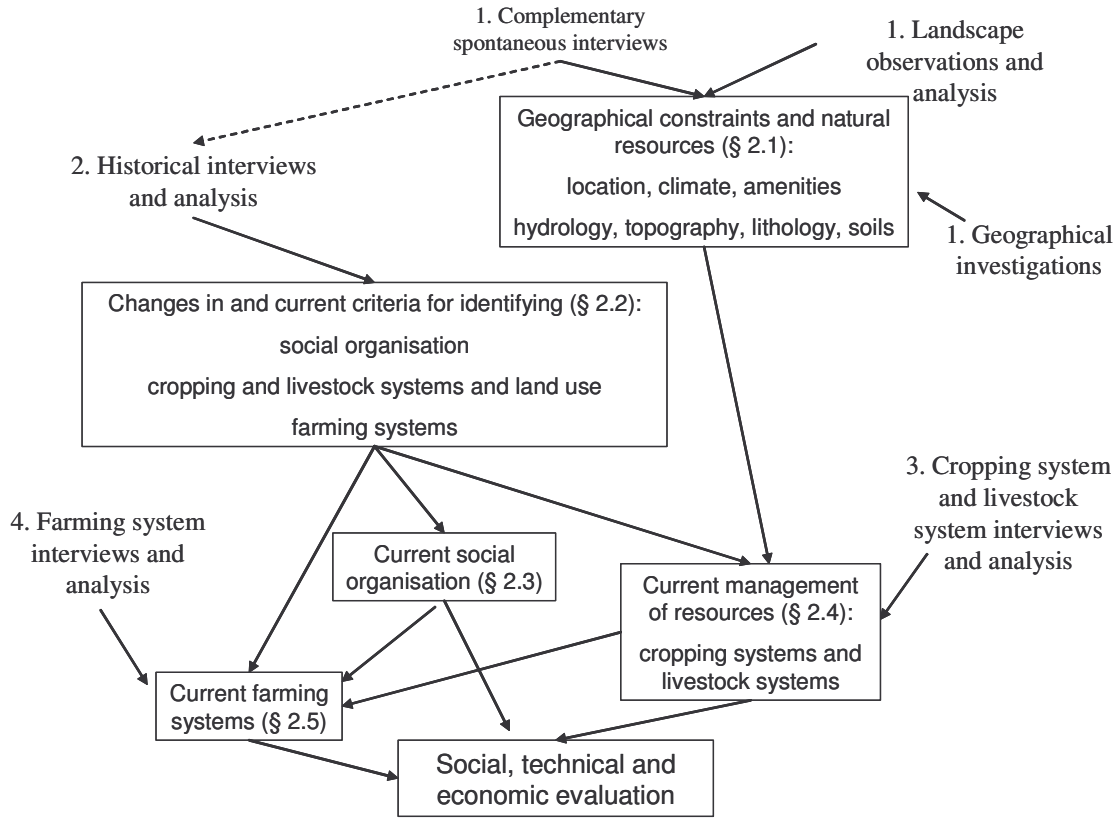
The organisation of the landscape…

Although the observations were carried out through the whole of the field study, a fifteen day period at the beginning was set aside specifically for this. Time was required to identify the biophysical and human induced factors that might be constraints for the farmers in the area (Figure 9). The layout of the area, with the natural landmarks and man-induced modifications, was studied; the climate was investigated; vegetation and soil observations were made. The types of crops, the size of fields, the nature of the animals and how they are led, along with the localisation of these different elements were noted. The positioning and nature of the villages, the means of transport and of roads were observed, as was the work that was taking place. Some elements of the social organisation and the different types of people and farmers were identified. During this phase, a few spontaneous interviews were conducted, to help with the identification of crops for example, to get farmers perspectives on the type of soil or to understand a little more of the social organisation (Figure 10).

The observations can then be structured by determining the main zones in the area based on the factors enumerated above: different biophysical factors, different amenities, different land use and farming. From there, hypotheses are made as to the factors that explain the observed

differences: why certain types of crops and animals in one area, why particular combinations, why certain practices are chosen, etc.

Figure 9: Study methodology - the phases and their objectives



… and of the society

The questioning of crop and livestock practices that comes next, relies upon a good classification of the types of farmers in the area. If this is not the case, it is difficult knowing the validity of the answers: for example, despite growing the same crops, is this farmer really farming in the same way, and with the same resources and constraints, as the one interrogated previously? Once categories of farmers have been established, based upon an understanding of what is happening in the area, the answers from farmers of one category can be compared. A pertinent classification of the farmers is only possible through a good understanding of the dynamics at work in the area.

This understanding of the current situation therefore rests upon some knowledge of the changes that have come about. Over a period of between 1 to 1.5 months, a series of interviews were conducted throughout the study area, focusing on what the farmers remember about the situation in the area previously (Figure 10).

Initially, some of the older farmers or other elders were searched out. This enables the historical changes to be traced back some 60 to 70 years, based on their memories. Care is taken during this phase to make the interviews as open as possible. As little is known about the area to start with, many elements cannot be guessed at unless the locals mention them first. It is therefore interesting to leave the farmers free to talk about what they remember and avoid too many suggestive questions. The questions try to get them to give personal and precise accounts of their lives and those of the other villagers around them, to avoid what can quickly become very general answers. Later, younger farmers were interviewed as well, so as to cross views on the more recent past. Progressively, more specific questions arose as

information was compared and new hypotheses emerged to explain how today's situation has come to be.

Figure 10: Period, number and objectives of the interviews conducted during the study

Stage of the study	Type of interviews conducted	Period and duration	Number of interviews	Objectives
Landscape analysis	spontaneous interviews in the fields to complement observations	2-3 weeks	10-15	crop and animal identification, initial idea of cropping patterns beyond what can be determined by simple observation
Historical changes	semi-directive interviews followed by ones with more specific questions	1-1.5 months	30	determine the principal changes that have taken place in the area
Cropping system and livestock system study	interviews with farmers practising these CS and LS	2-2.5 months	70	identify the precise CS and LS in the area (rotations, associations, varieties;..) technical operations and work organisation inputs, outputs
Farming system study	complementary questions at the start or end of the last CS and LS interviews; a few specific interviews for complementary information	1 -2 weeks	10 extra interviews	confirm or modify the previous FS classification identify the families concerned, characterise the FS socially, technically, and economically
Necessary income	specific interviews	2 days	4	determine the income required for survival and for a more general upkeep

These interviews were the main source of information for the reconstruction of the area's history and the understanding of the current social and technical organisation (Figure 9). The social organisation includes identifying the origin of the families in the area, migrations that have or are taking place, the structure of the families and the villages, the rules that govern the relationships between people, the resources they can access, the tasks and jobs that befall them. Used jointly with the elements that intervene on the landscape layout, the principal factors that have created or maintained differences between farmers were identified. Based upon this, a first classification of the farmers was made along with the farming systems.

Proper sociological tools and analyses were not used. These are part of the training provided by the CNÉARC, but only in the second year of the course. Without them, an attempt was made to describe some important elements of who the farmers are and the local rules and norms. Networks and links between farmers and other actors are only marginally included here.

1.3.5 Crop growing and livestock rearing

The observations and the first series of interviews allowed the main crops and animals in the area to be noted. Moreover, some guesses as to their relative importance could be made: both from the extension of their growing or rearing and from tendencies to be developing further or on the contrary to be disappearing.

Farmers growing the different crops and rearing the various animals were interviewed over the next 2 to 2.5 months. The numbers of interviews conducted totalled over 70, but the

numbers per cropping system or livestock system varied from 3 to 15 depending on the complexity of the system (Figure 10). These technical interviews questioned all of the farmers' practices for the rearing of their livestock and the growing of their crops.

For the crops, the elements that require understanding are firstly the spatial and temporal cropping patterns. The animal rearing activities need to be described by: the numbers and composition of a herd; its dynamics, based on reproductive parameters, purchases, sales and mortality rates; the splitting of animals into batches and the source of food for each batch throughout the year. For both cropping systems and livestock systems, farmers are also questioned about: the different operations carried out, their reasons and the quantity of work involved; who carries out the different tasks; the nature, quantity and origin of inputs; the use and quantity of the different products obtained.

To evaluate the impact of Green Foundation's work in the area and establish which farmers would potentially be interested by their work in the future, particular importance was given to varieties grown, the source of the seeds sown, and the nature and origin of the inputs used.

The quantitative aspects are linked to the acreage of each crop or the size of a herd. These were elements that were questioned during each interview. It was often difficult getting precise information and as many direct observations as possible were made (§ 1.3.8).

With a good understanding of the farming practices, the crops and animals can be divided into cropping systems and livestock systems (Figure 9). This is done at a small regional level, so that the crops grown or the animals reared by farmers throughout the whole area can be identified as belonging to one of these systems.

Cropping system is taken to mean the technical management that applies to all the fields treated in an identical manner if both spatial and temporal dimensions are considered. "One cropping system will be defined by: the nature of the crops, [their combinations within one field] and the order of their succession on that plot; the technical operations [and the dates at which they are] carried out." (Sébillotte M., 1982).

Livestock system is used in a similar sense for the technical management of a herd of animals of particular composition and all of the elements in dynamic interaction with the herd. One livestock system will be defined by the composition of the herd and the batching that takes place; the management of reproduction and feeding; the nature of the products obtained and their use.

Due to these definitions, the livestock system includes the fields used for producing fodder. In the case where these fields are also used for other productions, the system has been split into a livestock system and a separate cropping system. The fodder inputs to the livestock system are then considered as external inputs and a cost affected to them; the cropping system has the fodder as an extra output to which a return is associated. If the cropping system and livestock system are combined, cost and return cancel out. For that, the price of an output that is reused on the farm is considered to be the price the farmer would have to pay if he purchased it from outside.

Once the cropping and livestock systems were established, further interviews were conducted to identify all the tools, equipment and services necessary for each one. Further details on the source of labour and land tenure were obtained. Prices of inputs, outputs, necessary equipment and services, as well as labour wages and land lease were obtained from farmers and local tradesmen. Some data on price changes were collected from the agricultural marketing boards.

Work calendars can then be drawn up for each cropping and livestock systems. They allow work peaks to be identified, and the maximum size of such a system that a family can cultivate, along with the need or not for external labour and the total amount of work necessary, to be evaluated. Livestock forage calendars are also established to determine the surfaces necessary for producing the food required for the animals. The costs and returns of each system can then be evaluated. A comparison of the different livestock and cropping systems is done by looking at the net return generated by each: both as land productivity, a measure of the net return per acre, and as work productivity, a measure of the net return per labour-day.

Production costs = total cost of all the inputs consumed and all the services required in one year

Gross return = total return obtained on the sale of the different products in one year

Note: in the case where some of the produce is consumed by the family, this reduces what they need to purchase and thus it is as if the family sold their produce at the local purchasing price.

Net return = gross return - production costs

The net return does not take into account the sums necessary for replacing worn out tools and equipment, as these forms of capital are often shared between several cropping and livestock systems.

Land productivity = net return / acreage of CS or forage system

Work productivity = net return / yearly work quantity

The study could not go into the detail of all of the different cropping and livestock systems and some choices had to be made. For example, several cropping systems were left aside, including sugarcane and various flowers, as only few farmers are growing them.

1.3.6 The farm as a production unit

To establish the situation of the farmers, the farm needs to be considered as a whole unit, combining different crop and livestock systems, on land that can be under different tenures, requiring labour and equipment from different sources and producing a range of products to be used for the family or sold. The idea in this study is to identify general problems in the area. As such a classification is needed of the different types of farms present there. For this the concept of farming system is used.

Farming system is used to mean "the ways in which **a whole group of farms** combine land, labour and capital in order to obtain products from crops or animals. A farming system is characterised by the nature of the products, of the workforce (qualification) and of the means of production used, and by their proportions." (Reboul C., 1976)

The work calendars for the different cropping systems and the food requirements for the animals, along with a few further questions and observations, allowed crop and livestock combinations to be established. They confirmed and extended the answers farmers had given about the different components of their farm and their size, and the nature of the land tenure and the workforce, questions routinely asked at the start of interviews. The results of the historical and landscape analysis were then integrated with the technical constraints and

economic results of the cropping and livestock systems. From this a classification of the farm systems could be established (Figure 9).

An economic evaluation of each farming system was then done. This involved determining the proportion of each of the elements of the system and calculating the net return of the whole. The net added-value was calculated to take into consideration the cost of maintaining the necessary equipment. Lastly, the farm income was determined, which also considers the cost of labour, land-lease and taxes. The income generated by the farmers is compared with the minimum income level for survival, that for ordinary upkeep, and that for other social requirements such as sending one's children to school. The upkeep and social requirements (annexe 4) were estimated based on a separate set of interviews (Figure 10). A few of the farming systems are presented here to illustrate the technical and economic situation of the farmers.

Net added-value = net return - necessary capital depreciation

Farm income = net added-value - wages - taxes

Minimum survival income = total cost for staple food and basic upkeep consumptions

Ordinary upkeep income = total cost of food on a simple diet, basic upkeep

Schooling cost = cost of sending 1 child to secondary school (13- to 16-year-olds)

The primary school cost is very low and so has not been included.

1.3.7 Proposals

A few bibliographic sources were consulted during the course of the study and write-up, to obtain some complementary information and check some of the hypotheses made.

The whole of the information collected was analysed. Some of the farming systems were selected to be presented here and form the basis for the subsequent discussion on what the current realities are for the different farmers in the area. Proposals for Green Foundation to consider have been formulated. Required measures beyond the scope of their interventions have also been presented, as this report will be read by some other rural development actors.

1.3.8 Precision of the information collected

Most information recorded in this report has come from at least three interviews, but often many more, which were coherent with each other and with any observations that could be made. The number of interviews of each type is given in Figure 10.

Sometimes information which was not able to be checked to that degree has been included, because of its potential use in any further studies or experimentation in the area. In that case, the uncertainty on its validity is mentioned. This is the case for example on some of the levels of yields or of seed or chemical use, where the field sizes could not be verified at the time of the interview and the length of the study did not permit that particular farmer to be interviewed a second time. If the information appeared to be interesting enough to deserve checking, it is presented. Otherwise, the precision of many of the numerical values given is in the 10% range.

The precision of the information given by the farmers is always one source of uncertainty. Values given were checked when it was possible. For example, it was noticed that farmers' knowledge of their land surface in acres was not always very accurate. By measuring different

farmers' fields, a reliable estimate of the time required to plough an acre with 2 fit cows was obtained. This proved a far better way of estimating the size of farmers' fields, as the time required for ploughing is usually a very well known quantity. Of course, when possible, direct measurements continued to be made.

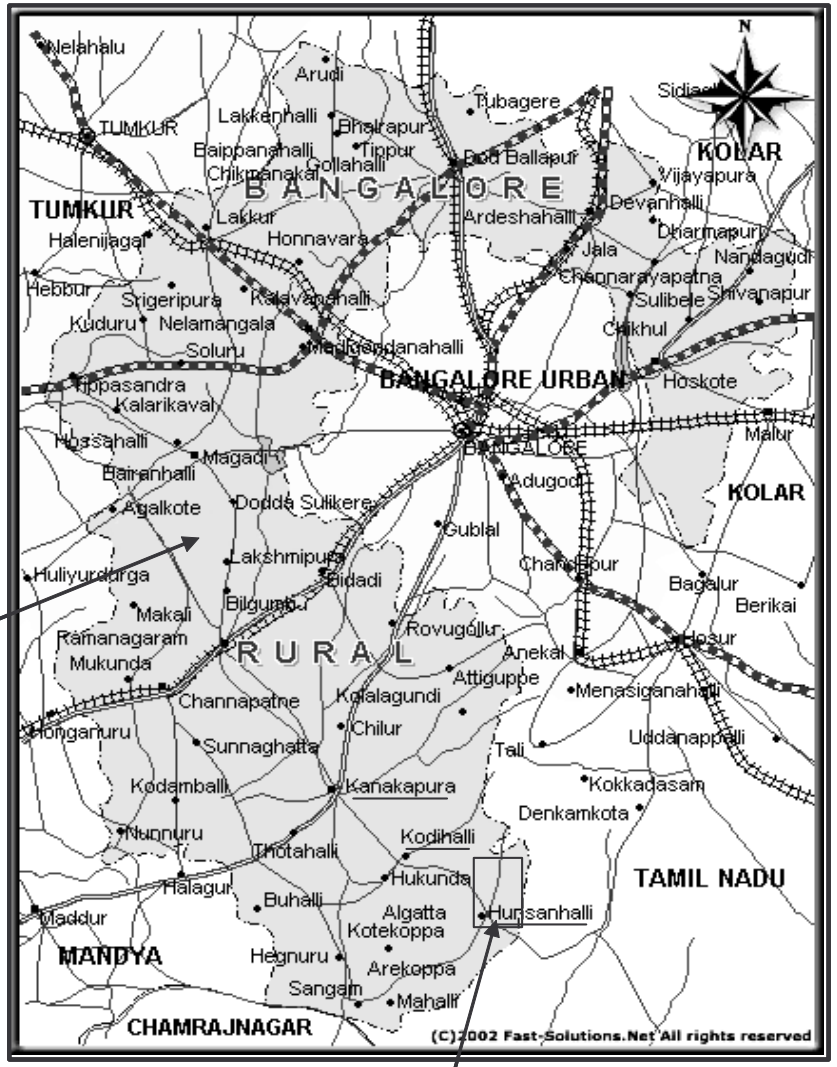
Some farmers also tended to give very general answers when questioned on how they proceed or the quantities they use or obtain. "One should" do this or that first…, "from one acre one grows" so many quintals of… are answers that can be frequently heard. Questions were therefore formulated to get the farmer interviewed to give the total yield he obtained for that crop, or the total quantity of manure he applied, last year. Asked specifically in this way, and not per acre but in total for a particular crop or cropping system, it was easier to break away from what could or should be added or obtained and find out what farmers really use or get.

What I interpreted as wanting to give the right answer sometimes went even further and became a personal answer, "We feed the young lambs so many kg of this and so many kg of that" one farmer said, conscious that this is how it can be done. Maybe he was worried about how he might be judged if he admitted he just left them to drink milk, graze progressively and fed them nothing extra. A few farmers did not seem to want to admit that they use no chemicals on some crops, as if it was a sign of poverty.

Annual and farmer to farmer variability is another source of uncertainty. Where this is important, ranges of work times, or quantities of inputs or outputs have been given (annexes 6, 7 and 8), along with what was established as the most representative level (ordinary year, common land "quality" and most frequent input level, etc.).

Figure 11: Localisation of the selected study zone within Bangalore Rural district

Source: Locate India



Study zone

Source: Maptell

2 ALL KINDS OF FARMERS AROUND VEEREIANADODDI

The small area selected is full of diversity: farmers of different castes; some with lots of land, some without; some with their own land, some with forest land; some with dry-land, some with irrigation; most using chemicals, some trying organic; some with only sons, some with only daughters; some lending money, quite a few with debts; many hoping the future will be a little safer…

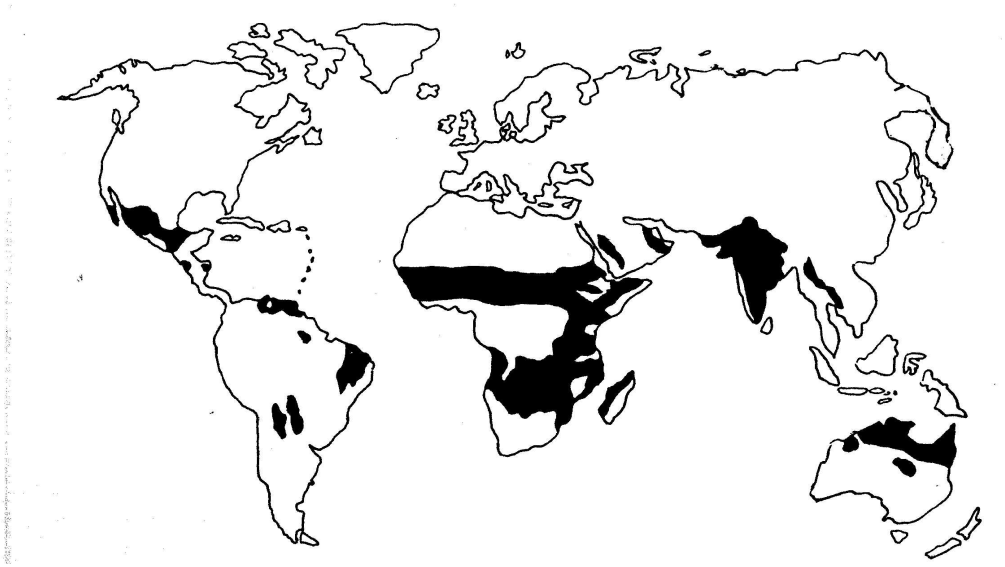
2.1 VILLAGES IN A HILLY PART OF SEMI-ARID SOUTH KARNATAKA

The zone studied is situated in southern Karnataka, approximately 70 km South of Bangalore and 25 km South-East of Kanakapura, but just a few kilometres from the border with Tamil Nadu (Figure 11). The selected area of nearly 70 km^2 includes 9 villages, and nearly as many small hamlets, sat in a zone of undulating hills close to 800 m above sea level (Figure 13). The size of the villages ranges from around 40 to nearly 500 houses. One road runs through the area, joining Kolgondanahalli and Hunasanahalli, the 2 largest villages. Frequent buses follow this route and enable one to reach Bangalore in the North in 2.5 hours and Kanakapura in the West in 1.5 hours. These are the 2 main urban centres nearby. From both Kolgondanahalli and Hunasanahalli roads also run East into Tamil Nadu.

2.1.1 Typical semi-arid characteristics

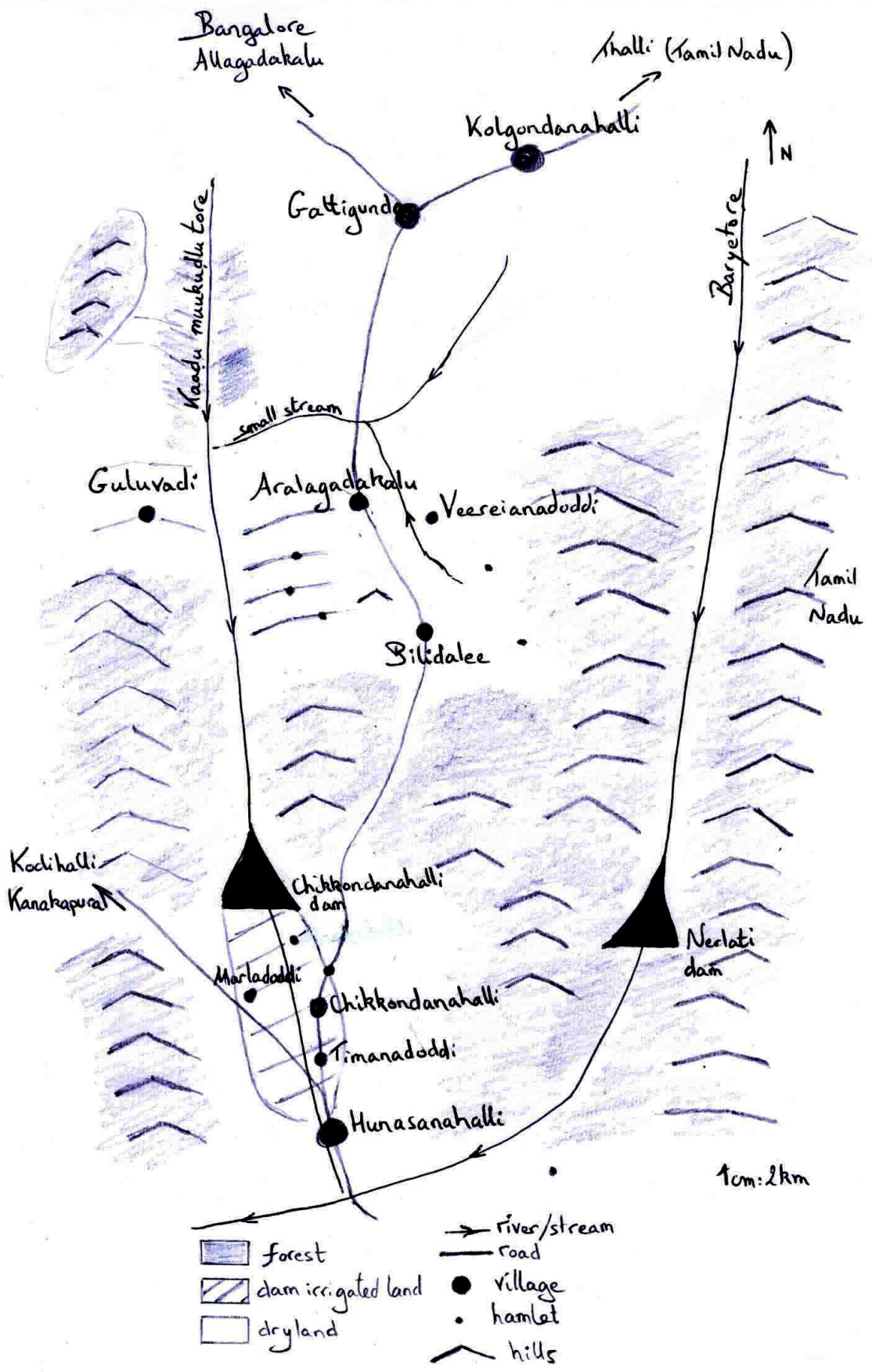
Other than a small western coastal zone, the major part of southern India is classified as having a semi-arid climate by the ICRISAT (Figure 12). Numerous definitions of aridity and semi-aridity exist. The ICRISAT bases their definition on the number of dry months per year: the climate is considered to be semi-arid if there are 5-10 dry months per year. A dry month is defined as one where mean rainfall does not meet potential evapotranspiration. This definition is chosen because of the pertinence of these parameters for agronomy (ICRISAT). Potential evapotranspiration data is difficult to come by, so that the Bagnouls and Gaussen method of estimating a dry month is used here: the months for which the rainfall (mm) is less than the mean temperature multiplied by 2 are considered dry.

Figure 12: Semi-arid areas of the tropics as defined by ICRISAT



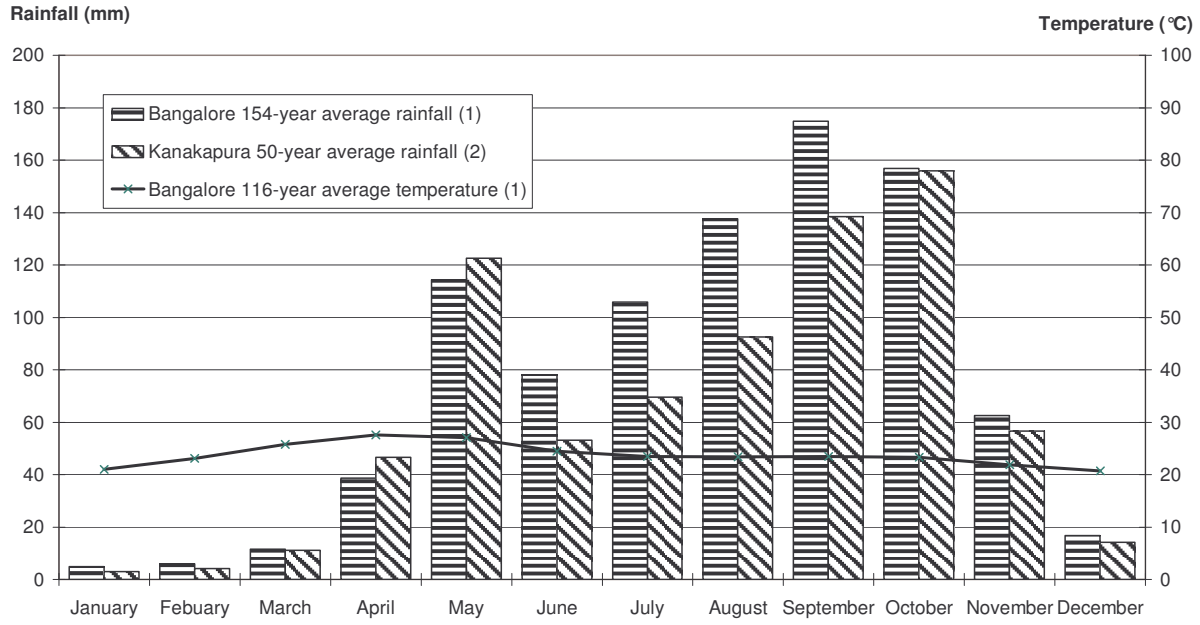
Source: ICRISAT (1976) in Van der Tas (1986)

Figure 13: Schematic map of the study zone



The ombrothermic diagram for Bangalore, which is at 920 m altitude, shows that there are 5 dry months per year there (Figure 14). Temperature data is not recorded any nearer to the study zone in Bangalore rural district. Rainfall data is however available for Kanakapura and Kodihalli. The zone studied and Kanakapura are approximately 100-150 m lower in altitude than Bangalore, and a maximum of 1 or 2 extra degrees in average temperatures can be expected. It is clear from Figure 14 that the 5 months from December to April are dry months in Kanakapura as well. June is very close to the limit and there will quite often be a total of 6 dry months. The area indeed falls into the semi-arid category.

Figure 14: Ombrothermic diagram of Banglore and Kanakapura



Source: (1) World Climate; (2) Kanakapura talluk head office

The yearly rainfall totals 910 mm in Bangalore, but only 770 mm in Kanakapura. The annual pattern has a slightly bi-modal shape, with 2 peaks: the first in May, the 2nd in October, with a sharp drop in June. These correspond to thermal convection rains: the monsoon rains are stopped by the western Ghats and do not reach the Mysore plateau or the zone beyond, further East. The thermal convection rains are created by the warming of the land mass, as the sun tends to the zenith, and an increase in atmospheric humidity (Pascal, 1982). The farmers link the rains to 2 winds: westerly winds for the May rains; easterly winds for the July-October rains. In between, June and sometimes early July, are a time when the winds are often very strong, blowing in from the West and bringing very localised showers when the humidity is sufficient.

The wet part of the year is situated from May to November. But the drop in rainfall in June, means that farmers do not use the first rains of May to sow; they wait until the start of the next set which can be as early as the end of June, or not until late July, to sow the main crops.

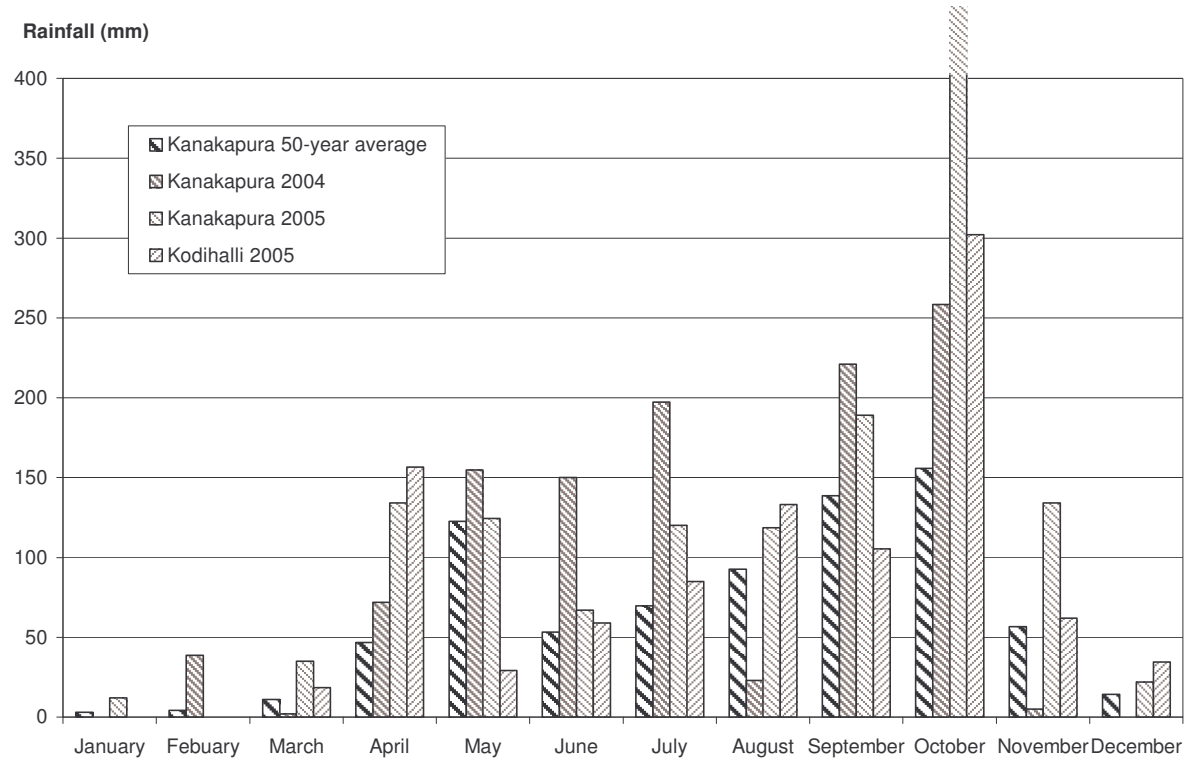
Average temperatures vary between 20°C and 30°C. They are stable during the main cropping season, at close to 25°C (23.5°C in Bangalore). The temperatures drop at the end of the rainy season and December is the coolest month of the year. In November and December, heavy mists are common. From January, up until the rains start and regulate them, the temperatures increase to reach a maximum in April and May. At this time of year, the highest daily temperatures average well over 30°C. The day to night variations are larger than the seasonal ones.

The year can be divided into four seasons:

- the main cropping season from July to October, wet with stable temperatures; it is sometimes called *kharif* season (using the name applied to the monsoon areas);
- the cold and dry winter season from the end of November to January, or *hingaru* (for "retreating" monsoon);
- the hot and dry summer season, *beysige*;
- lastly, *mungaru* ("advancing", a term again borrowed from the monsoon areas) , the early wet season in May and June, with very irregular short showers that are sometimes considered sufficient for an early crop.

Semi-arid climates are often subject to highly irregular rainfall both from one locality to the next and from year to year (Aubert and Fauck, 1997). This is the case close to the study zone. The 2005 rainfall data of Kanakapura and Kodihalli illustrates important differences: the total annual rainfall in Kanakapura was 1470 mm, while that of Kodihalli, approximately 15 km South-East, only 980 mm (Figure 15). The 2004 data for Kanakapura appears on the same figure, 1120mm in total, what with the 770 mm average, high inter-annual variability indeed.

Figure 15: Monthly rainfall - examples of spatial and annual variability
Kanakapura/Kodihalli 2004 - Kanakapura 2004/ Kanakapura 2005



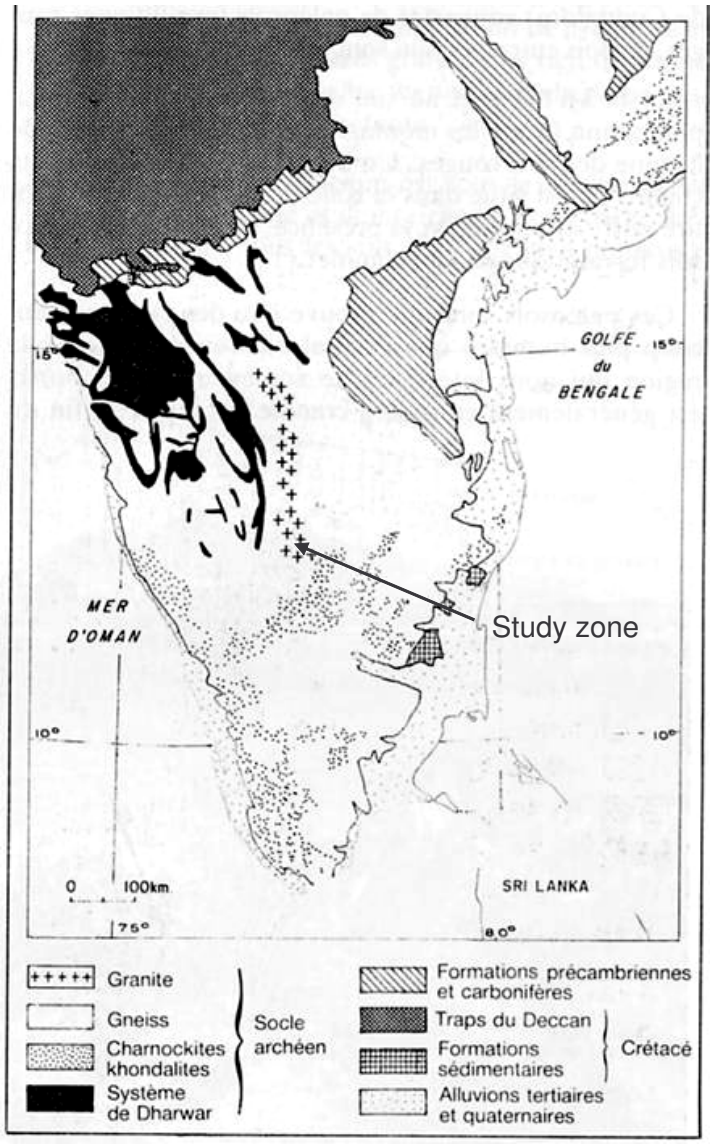
Source: Kanakapura talluk head office

Moreover, the monthly distribution explains some of the agronomical difficulties: from one year to the next, the rains fall at very different times. Kanakapura saw August and November as dry months in 2004. For the many crops harvested in December, their grains will be swelling in November and an early end to the rains can have serious repercussions on yields. 2005 on the other hand saw extremely high rainfalls in October, 2 or 3 times an already high average monthly quantity. Most farmers report very low yields as a consequence. 2006 may

not be more promising: after the usual fairly low rainfall of March and April, with the characteristic heavy, but short showers, and a satisfactory level in May, the next 2 months were almost completely dry. In August, the farmers were left still waiting for the rain. "Normal" yields are sometimes few and far between.

2.1.2 Rounded hills on old crystalline foundations

Figure 16: Geological map of the Indian peninsular.
Source: Geological and Mineralogical Maps in Bourgeon (1987)



Most of the area is on granite bedrock of heterogeneous nature. It varies both in mineral composition, as indicated by strong colour differences, and in crystal size. The most commonly observed type is a predominantly light-coloured granite that makes up the rocky outcrops of the zone. Some particularly dark granite is also found. In certain areas, the rock shows a slight gneiss resemblance, with some undulating schistosity. In others, the grain is too small, barely visible, for the rock to be granite: a type of gneiss or a metamorphic rock with a massive structure such as an amphibolite.

The field observations are coherent with the geological map of southern India (Figure 16). The whole of the central part of the peninsular is composed of pre-Cambrian crystalline rocks, with numerous subdvisions. The study zone sits on granite, but not far from areas with gneiss and other metamorphic bedrock, such as charnockites.

The hilly topography must be the result of one of the various uprising or collapses that geologists consider have affected the Indian peninsular. However, the conditions and dates of formation of the major mountains on both the East and West of the peninsular, the eastern and western Ghats, are themselves still unresolved. The rounded shapes of the hills are characteristic of the weathering of crystalline substrata. Their upper parts often have large smooth rocky outcrops. The convexo-concave shapes contrast with convex half-orange ones closer to the Western Ghats, where the high rainfall has created intense weathering. In between, West and North from the study one, but not as far as the Ghats, is the plateau of Mysore, on which Bangalore also sits.

Within the zone, 2 rivers run roughly parallel in a North-South direction (Figure 13), cutting quite steep valleys, especially in the central part of the zone: over the last 0.5 km to the river, the drop in altitude is frequently close to 100 m. Further upstream the top of the landscape is not as high and the valleys are thus not as deep. Further downstream, they valleys open out as can be seen by comparing Figure 25 and Figure 26. Just under 5 km separate the two rivers. They join shortly after Hunasanahalli, over 10 km south of Kolgondanahalli, the northernmost village of the selected zone (Figure 13). They are but a stream in the summer season, then turn into fast running rivers later in the year. Besides these, and a couple of other just about perennial streams, numerous ditches cut through the hillside, usually roughly perpendicular to the rivers. They fill with water once the rains start.

All the villages lie in the watershed of the more western of the two rivers, although some of the land of Veereianadoddi and Kolgandanahalli stretches into the watershed of Baryetore, the other river. The exterior parts of the two watersheds, in their downstream half, are composed mainly of rocky hills covered with low growing forest. The mower part of the slope is sometimes cultivated, such as around Marladoddi; the higher part rarely, other than in the northern section, around Guluwadi. These 2 villages are the main settlements outside of the interfluve, although there are a few hamlets as well.

Rocky hilltops are also present between the two rivers, in particular around Bilidalee, where the highest point of the study area is to be found, at approximately 800 m above sea level. Some of the visible hills, just outside the zone, culminate a good 100 m higher. A large area of forest persists, east of Vereianadoddi and Bilidalee, then spreading south on the land sloping down into the more open valley South and East of Chikkondanahalli. North or Aralagadakalu, the land levels out and the cultivated fields take over, as the rocky hilltops become more localised (Figure 13). The landscape is a kind of undulating plateau in this area.

2.1.3 Mainly shallow reddish soils

Although red soils do not make up the entire soils of the zone, they are an important feature. Without the necessary equipment for digging, the observations were made in the first 10-20 cm of fields, or along ditches or other excavation points. These proved very useful, although they were not always situated exactly where I would have liked!

2.1.3.1 Typical red soil profile

There are several variations, but the most common soil profile is composed of 3 main horizons, developing on top of the light coloured granite (Figure 17), under forest or on the upper part of slopes or the flatter tops of the landscape.

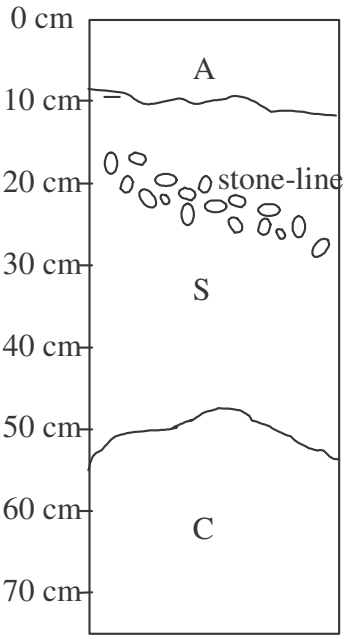
The top horizon shows definite signs of organic matter presence: brown colouration and higher structural stability than in the next horizon. It is an A horizon. There is important biological activity: a great number of small pores and rounded aggregates.

The lowest horizon contains no evidence of new soil structures. It has a massive structure, but fragile, that fragments into mainly sand-sized particles at a touch. It is the granite bedrock in an advanced stage of weathering and can be called a C horizon. Below it, the bedrock is sometimes visible.

In the middle, a distinct horizon stands out by its reddish colour. As opposed to the horizon below, it has obvious soil structure, with the formation of small aggregates. Both the colour and the structure, different from the C horizon indicate a more advanced stage in the soil formation process. It can therefore be characterised as an S horizon. This horizon ranges in

thickness from 20 to 100 cm, but often does not exceed 50 cm. The soil proper hence constitutes a shallow layer on top of the weathered rock.

Figure 17: Common reddish soil profile under natural vegetation



A horizon: ~ 0-10 cm; light to dark brown; mixed texture, presence of both a notable clay and sand fraction; many small pores (<0.5mm); main structure: 1-2 mm sub-angular polyedric aggregates or rounded aggregates in the darker horizons; low to medium structural stability (10 mn in water)

S horizon: ~ 10-50 cm; varying shades of red, but rarely a bright red; often high proportion of stones and gravel material; fine fraction texture: significant clay content; very hard when dry; main structure: ~ 0.5 cm sub-angular polyedric aggregates; very low structural stability, aggregates immediately decomposing in presence of water

C horizon: ~ 50-100 cm; pale yellow or whitish; weathered rock fragmenting easily into sandy material, with many mm sized crystals

In the middle or at the top of the S horizon, there is often a stone-line. The granite is of heterogeneous nature with many streaks of coarser grained material running through it. In some of the weathered rock these streaks are nearly intact, evidence of the differential rate of weathering. If the soil suffers disturbances, such as those created by soil fauna moving large volumes of earth towards the surface as suggested by Bourgeon (1992), the stone-line collapses to take-on a more or less horizontal orientation.

2.1.3.2 Red cambisoils of the fersiallitic type

The majority of the red soils hence appear to be "moderately differentiated" soils, according to the classification proposed by Ruellan et Dosso (1993). Such soils are in an intermediate stage of development, with the soil formation well engaged, but not yet any signs of degradation. However, in a few locations, the pale colour of the surface horizon, under open-land, did suggest that there might be some loss of clay from the surface horizon. The presence of a large quantity of coarse elements in the profiles, along with the soil being extremely dry and hard, did not permit differences in texture to be determined between the supposed A and S horizons during the field observations. No clay coatings were visible in the red horizon and it seems unlikely that this horizon should be an illuvial one. The sometimes pale colour of the top horizon, probably due to a loss of clay and with it of iron, might result from a lateral transport of the finer particles. This is discussed below.

The main pedogenetic process is a weathering of the rock, transforming its component minerals and freeing certain chemical elements such as iron, aluminium, potassium, etc. The red colour indicates that the iron is in an oxidised state, coherent with the existence of a dry season. The alternation with a wet season allows the weathering to be sufficient to free significant quantities of iron in the first place. The soils with a profile like that of Figure 17 show no signs of water stagnation at any time of the year. It is therefore probable than the bedrock underneath allows good drainage.

As to the nature of the mineral transformations, Bourgeon (1987) studied a set of red soils some 100 km away, on a metamorphic substratum South of Mysore, under similar current climatic conditions. He established that they had undergone a fersiallitic process rather than a ferrallitic one. The basis for this was the analysis of the clay fraction. Without such analyses, there is still strong field evidence that in the Veereianadoddi area, the processes have been similar. Indeed, there is some macro-structure of polyedric shape and the soil does not crumble into the characteristic micro-granules of a ferrallitic one; the soils are not very deep; the current climate is probably not wet enough to allow the full weathering necessary for the formation of kaolinite as opposed to 2:1 clays. A determination of the cation exchange capacity of the mineral fraction would enable these hypotheses to be confirmed.

Bourgeon (1992) talks of past climates much wetter than the present and of typical ferrallitic soils in several areas, including close to Bangalore, where they often have the characteristic crust of iron oxides. However the existence of other ferrallitic soils showing signs of degradation by eluviation, suggests that there have been important climatic changes and these soils are no longer in equilibrium with the climate. Bourgeon (1992) believes that they are paleo-soils, most of which have been removed by subsequent geological processes this far South on the peninsular. Just a few relics remain, such as around Bangalore. The study zone does not seem to be concerned.

If the fersiallitic hypothesis is correct in this area, and the assumption that there is no real washing of clay down the profile, these soils can be classified as cambisoils using the World Reference Base for Soil Resources (Deckers et al, 1998). Indeed they are "moderately differentiated" soils without any other particular traits.

2.1.3.3 Other profiles and their position in the landscape

There are many variations on the profile described above. The differences include:

- differences in depth of the different horizons, with thinner horizons near rocky outcrops and over a large area South of Bilidalee (under forest), but also part way down slopes; there is thus evidence of the influence of the bedrock as well as the topography;
- varying shades and structural stability of the A horizon; very dark in a few areas that were often close to streams; very pale with low structural stability in some of the farmed fields;
- absence of an A horizon in places; very red soils (*kebbe monnu* if clayey) on the surface, as opposed to the "black" soils (*kappu monnu*) that the farmers used to designate those with a well-marked A horizon;
- absence of either the A or S horizons; weathered rock at the surface (*karlu monnu*), where the fields were on steep slopes, or where deep terraces had been cut;
- differences in texture of the A and S horizons essentially due to variations of the bedrock; the higher clay content soils were called *kebbe monnu* if red or *kappu monnu* if brown; sandy soils came under *mollu*; some soils had a high proportion of gravel, sometimes through most of the profile; lastly there was a category of soils with an important stone content.

A few very different profiles were also observed. Some due to differences in parent material:

- a few brownish soils formed on fine colluvial or alluvial material near the rivers;
- brown, loamy textured soils with low structural stability and no net A horizon, formed on a very fine grained, dark bedrock with no apparent schistosity;
- deeper red profiles, high clay content and low structural stability, with large (10 cm) roughly square-shaped white stones forming a stone-line, formed on "black" granite.

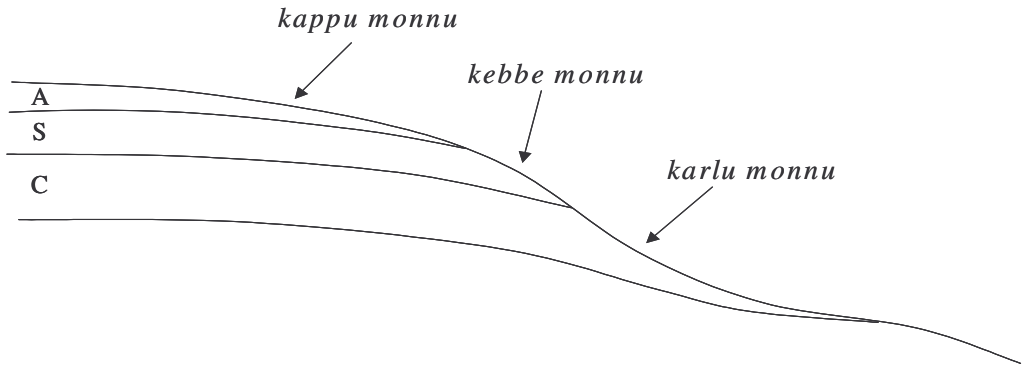
Others profiles were evidently consequences of different processes intervening due to their topographic positions:

- red soils as described above, but with a second S horizon below the first, distinguishable by the presence of orange streaks in the otherwise dark red horizon and the existence of grey or black nodules that could be concretions of iron or manganese; these hydromorphic characteristics started part way down the profile, indicating a perched water table throughout parts of the year; the observations concerned soils close to the river, in an open part of the valley;
- red soils but with a very high clay content and no coarser elements or stones in the top part of the profile; these were situated in the higher parts of the landscape, but in shallow depressions, often close to the water tanks; the soil there was often used for brick making.

2.1.3.4 Landscape scale organisation of the soils

Insufficient observations were made to be able to give a clear picture of the soils throughout the whole area. Differences in bedrock were not investigated. Neither were the soils in the more open valley area, in the South of the zone, above and below the dam irrigated level observed. In this area, accumulation of soil washed down from higher parts of the slope is probably important and there might have been alluvial deposits before the dam was constructed. The conclusions drawn below may well not be applicable there.

Figure 18: A common topographic soil sequence



Having excluded the soils on a different bedrock, most of the others fit into a topographic sequence (Figure 18). Starting from the flatter tops of the landscape and moving downwards, one encounters the "typical" red soil profiles of the area with:

- all of the horizons including a brown A horizon;
- without this A horizon;
- without the A or the S horizon either.

This could be explained if the horizons are considered to have been thinner to start with, before the forest was cut to farm them. Once the forest is cleared, the intensity of the surface erosion is much increased. The steeper the slope, the more soil is removed. The flat parts of the landscape thus hardly suffer at all. The steep slopes lose large quantities of matter rapidly. Hence the observed position of the soils relative to each other could be a consequence of this erosion. At the top, all the horizons are still present. On the slight slopes, the A horizon has been removed. On the steeper parts, both A and S horizons, thin to start with, have both disappeared, leaving principally weathered rock as the surface material. Cutting into the hillside to make level terraces has in some places aggravated the situation.

This hypothesis rests on important lateral transport of soil matter. It is backed up by the existence of important layers of red clay material in the depressions used as sources of brick-making material, or by the rapidity at which the local tanks fill up with clay and silt. After the heavy showers of April and May, orangy-brown water runs down the hillsides. The deep-cut ditches that must have formed since the land was cleared are also proof of the very heavy soil erosion. Many fields have small gullies running across them; these must have been formed between the last ploughing and the time of the observation: no more than one month, and probably just during 1 or 2 showers!

Another element supporting this hypothesis is the transport phenomenon observable at the plot scale. Even on the small slope of a terraced plot, accumulation of clay as layer deposited on the surface can be observed on the lower side of the plot after just one shower. The clay is deposited where the water stagnates. It can form a film that cracks when it dries out.

Part way down the hills, where there is an inflexion in the slope, there can be areas where the soil becomes very thin or the rock apparent. Below these, and before the slope becomes steep once again, similar sequences of soil can be observed as those of Figure 18.

2.1.3.5 Fragile but fair agronomic potential

The transport at plot scale also indicates the low structural stability of the soil. The clay particles can be carried by the water because they detach easily from the rest of the soil. Where the water stagnates, a film is formed, but even below that, the soil has lost most of its structure, the clumps having disintegrated and the aggregates broken. Structural stability tests conducted in many of the field farmed were conclusive: the natural aggregates immediately disintegrated when placed in water. This contrasted with the observations under forest, where in the top horizon there was some structural stability. It would seem that organic matter is essential for maintaining structural stability.

Moreover, there are important lateral transport phenomena. These seem to be much less severe under forest, where deep ditches are rare. Both the reduced direct arrival of rain to the ground and the higher structural stability must play a part.

From this point of view, the soil is fragile once the natural vegetation cover is removed. Both increased organic matter inputs to the soil and vegetative cover of the soil by growing green-manure crops and mulching should be very beneficial in these circumstances. Care should also be taken when constructing terraces not to remove the top layers of the soil.

The farmers classification of the soils and their comments on their behaviour give a good insight into their properties.

Karlu monnu: yellow sandy soils. "Poor soils for most crops".

Mollu monnu: red sandy soils. "Appreciated for growing groundnut". "Gives good yields of ragi on dry years".

Kebbe monnu: red clayey soils. "Difficult to plough". "Cannot be ploughed when too wet or too dry". "Give good yields of ragi when there is enough rain".

Kappu monnu: brown clayey soils. "Like *kebbe* soils, they give good yields when there is enough water". "The best soils".

These opinions confirm the observations. The *karlu* soils which are not really soils but mainly weathered rock have poor agricultural potential. The clayey soils difficult to work are "superior" to the sandy ones when rain is sufficient to over the plants needs. They probably have a significantly higher cation exchange capacity than the sandy ones, which would be the case if the clay is of a 2:1 type. The brown soils might have higher still potential. If they have a higher organic matter than the others, this could be explained by better structural stability and better water holding capacity, as well as extra cation exchange capacity due to the organic matter contribution.

The information on the sandy soils is also very interesting. Some years, water evidently becomes the limiting factor. In dry conditions, a little rain falling on sandy soils will occupy larger pores, accessible to plants, whereas in a clayey soil, this water will be held too strongly in the smaller porosity. This importance of the water holding capacity also means that in dry years the depth of the soil will also be determining. Crops apted to dry conditions usually have a very deep root system. In deep soils, they will be able to access the water of a much larger volume of soil than in the shallow soils. Most soils being less than 1 meter deep, this factor will be very important. Again, the soils on the flatter parts of the landscape, that tend to be much deeper, will have a considerable advantage over the others.

To sum-up, many of the soils of the area have a fair agronomic potential, with a reasonable cation exchange capacity in the clay fraction. Their shallowness can pose a problem to water storage. Their structure can break down, causing a decrease in porosity, loss o matter by lateral transport and the formation of crusts at the surface, further decreasing water infiltration. These 2 disadvantages can be lessened by high levels of organic matter inputs, to improve the structure and the total porosity, as well as structural stability. Vegetative ground cover would also diminish crusting and erosive loss of soil matter.

2.1.4 Water and soil constraints on the vegetation distribution

The vegetation cannot become established in the areas where no soil has formed. But the soil also plays an indirect part in the vegetation distribution. The area South of Bilidalee is covered in forest. It is surprising that this land has not been cleared for cultivation like most of it around. The soils there are however mostly very shallow. A hypothesis is therefore that the forest has been left there because the agronomic potential is too low.

The forest is principally of a low growing "dry" type. The bushes are thorny and form a dense cover, except where the soil becomes too thin. They are interspersed with trees, many of the Cassia genus. Lantana (*Lantana camara*) grows on the edges or on thinner parts of the soil. The forest vegetation also includes teak (*Tectona grandis*), glyricidia (*Glyricidia sepium*), jatropa (*Euphorbia pulcherima*) among the lignified species.

During the dry season, most of the land is very dry. The soil is hard and even weeds have difficulty growing in many of the fields. But where there is water, the vegetation changes radically. Along the ditches and streams, a metre or two of lush vegetation, such as different bamboos and reeds as well as trees such as eucalyptus and various bushes, make it difficult to access the waterside. The rivers, streams and ditches thus stand out in the landscape due to the vegetation that lines them (Figure 22 and Figure 25).

Where the land has not been cleared, the forest in the low lying areas is lush and dense, more of a jungle than a forest. Taller trees make up a much larger proportion of the ground cover and creepers create extra strata of vegetation.

In the cultivated fields, individual trees are scattered around. Frequently encountered ones are pongamia (*Pongamia glabra*), tamarind (*Tamarindus indica*), jackfruit trees (*Artocarpus heterophyllus*), alada mara (*Ficus bengalensis*)... A common weed growing in the fields is congress (*Parthenium hysterophorus*).

Closer to the villages there are neem trees (*Azadirachta indica*), of which the leaves are used in cooking. Sometimes fields are separated by hedges, especially along the ditches or where the larger tracks run. Lantana is a very common plant found there, growing naturally or planted. Other live hedges have been planted with glyricidia, jatropa or *Agave sisalana*, a succulent- and spiky-leaved, low-growing species that keeps cattle out of people's "gardens". Coconut trees (*Cocos mucifera*) line the village streets and close to the houses there are other fruit trees such as papaya.

2.2 ESSENTIAL ASSETS: ONCE LAND AND ANIMALS, NOW ACCESS TO WATER AND THE MARKET

Animals and land have always been the main capital in this rural area. More recently access to irrigation and the possibility of commercialising crops have been another source of disparity between farmers.

2.2.1 The persisting problem of land and animal ownership

Access to land remains a critical issue for a number of farmers here. For many families the situation has improved, but not all have gained access to sufficient land or animals to feed the whole family and there are still a number of labourers without any capital of their own.

2.2.1.1 An uneven start

The interviews conducted have enabled the historic changes to be traced back until the early 20th century, somewhere between its start and the Indian independence (1947). The further back one goes, the less certainty there is about dates or just what proportion of the population was in each particular situation.

A century ago, the land and animals were split very unequally between the different families. Figure depicts the different categories of farmers at that time and the transformations that could affect individual families. But the overall system persisted unchanged in its organisation up until 30 to 40 years ago.

The large landowners…

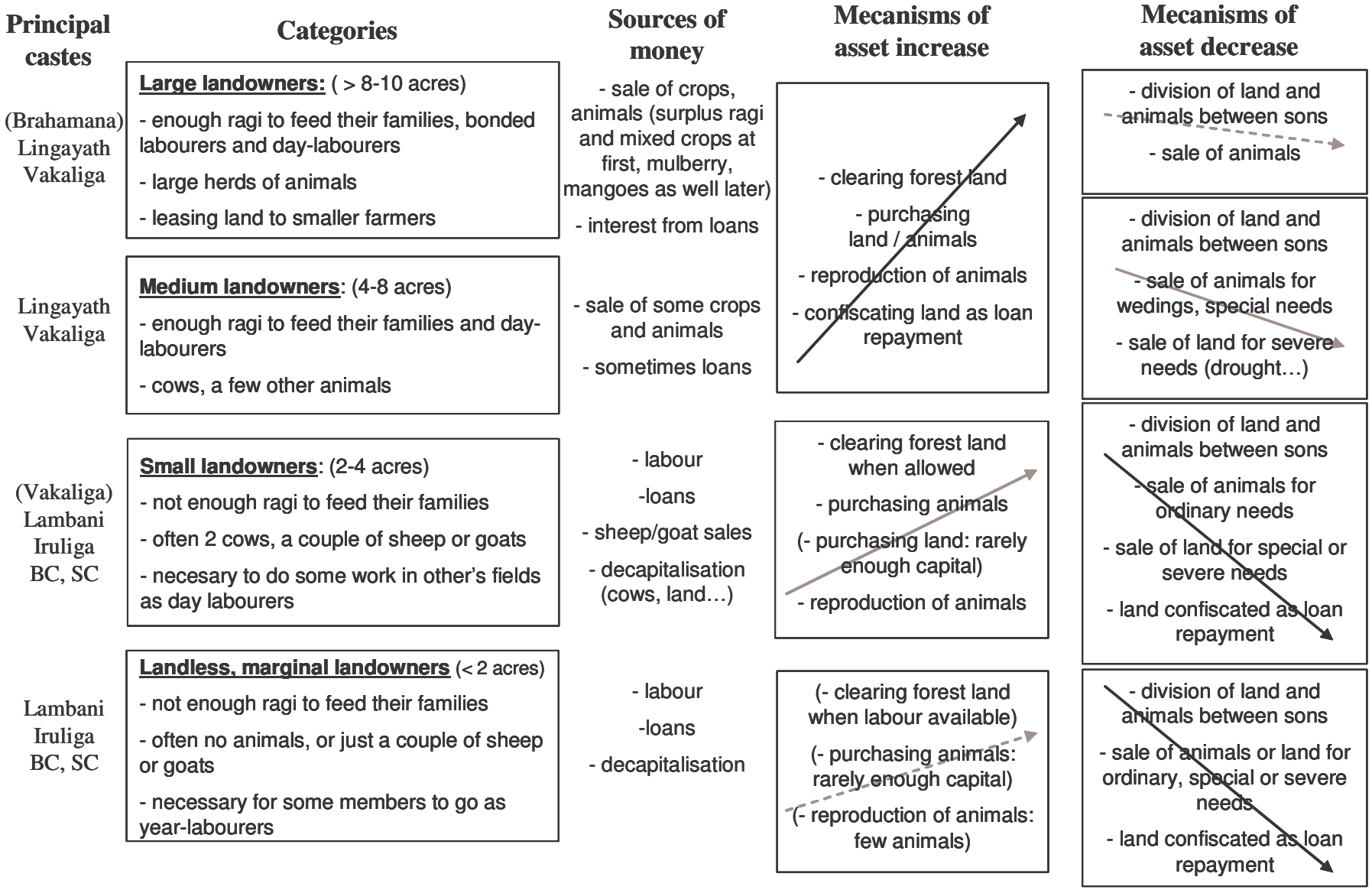
At the beginning of the 20th century, a handful of families, of the Lingayath, Vakaliga and less frequently Brahmana castes, were in possession of nearly all the village land. The land farmed had a limited extension around the village, quickly becoming forest (Figure 22). From village to village, the large estates were of different sizes. In some places, a few families might have 10-100 acres. In others, the largest landowners could have several hundred acres, sometimes a couple of thousand spread across several villages. Along with cultivated land, most of them would have access to extra forest land, when and as was needed.

The land in their possession was more than one family could work. Being able to produce far more than their own families' needs, they could employ labourers: a combination of yearly labourers and extra day labour during the peak work periods (spreading manure, sowing, weeding, harvesting -Figure 35). The daily labour wages consisted first of measures of ragi, later of money.

These landowners would also own large herds of animals. Over 100 cows, as well as several pairs of bullocks and often some 20 or more buffaloes were common. Some of the landowners also had many sheep and goats. They might require 4 or 5 year labourers to watch the animals and do general tasks around the farm, as well as a couple of women for housework. As with the land, there were also landowners with more moderate herds, but who could still employ year labourers to watch the animals and do general tasks around the farm.

Some of their land was also farmed by other families on a lease basis: all the products harvested would be divided into three shares; the landowner would keep one and the farmer would get the other two, unless the landlord was also supplying the manure and the animals for ploughing. The land was probably leased in this way because it was too much for one

Figure 19: Early 1900s to 1970 - Caste and class of farmers and their chances of change

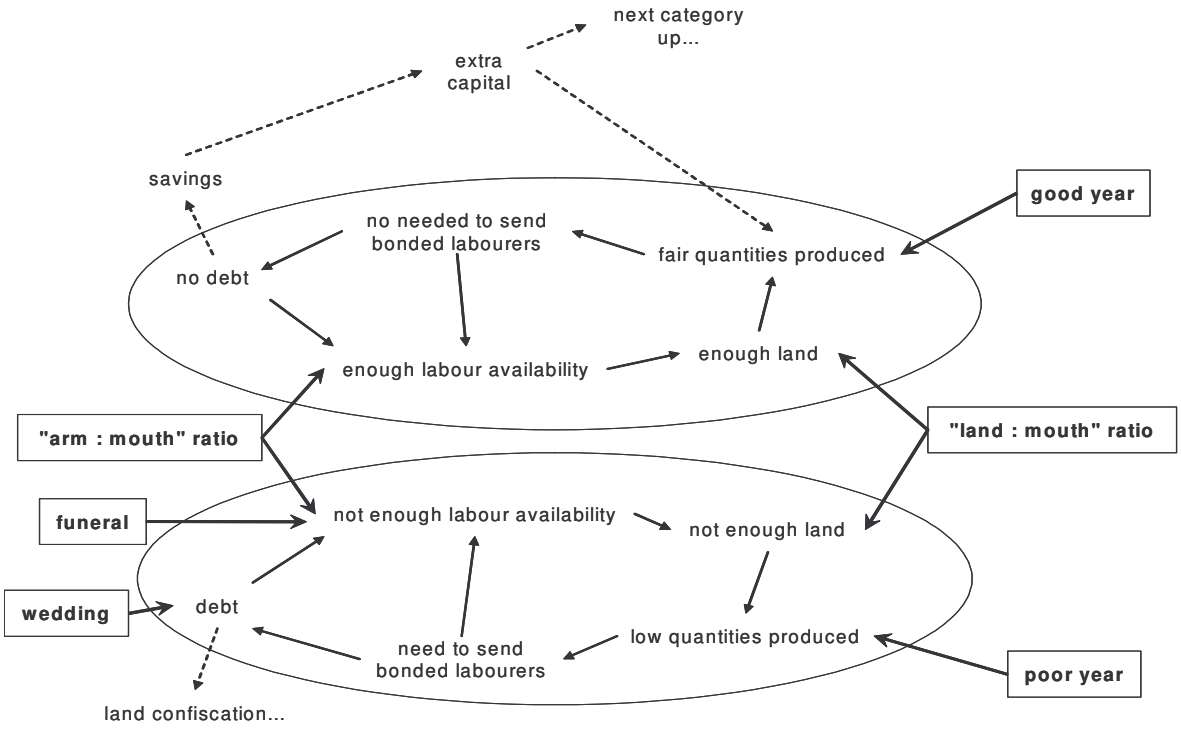


family to oversee the work on all of it. It might also have meant that the workers' families had more chance of surviving.

… the labourers…

This system relied on the abundance of cheap labour. Landless farmers, or families with just a couple of acres of their own land, were such a workforce. Principally of the Lambani and Iruliga casts, as well as from 'scheduled' or "backward' casts (SC and BC) often from Tamil Nadu, unable to produce enough food to live off, they had no choice but to work other's land. The working conditions varied from one landholder to the next, although the wages were always very low. Indeed, some of the landowners were satisfied with having year labourers that they only need "pay" six bags of ragi per year. Sometimes the wage included one meal a day; sometimes it included a set of clothes or two per year. Later a small amount of money was added to the wage. The labour involved whole day availability, every day of the year. The landlords might also grant the labourers up to 3 or 4 acres of land to farm under the 3-share system. They would be able to work this land or their own once the work was completed on the landlord's. Sometimes they would be able to send another family member to replace them and be free to work their own land. This might involve pretending they were ill.

Figure 20: The bonded-labouring trap - who and why?



Other year labourers were not that "lucky". Some landlords had access to even cheaper labour. The smallest landowners or landless labourers would frequently find themselves with insufficient food from their few acres of land. Many of them had numerous children, lots of mouths to feed. As the family grew, the few acres of previously sufficient land ceased to be. Other events could upset the balance, such as particularly dry years, or a daughter to be married and the extra expenses that then needed to be covered. The families would turn to the landowners for a loan. Obtaining such a loan would require many trips and much begging. It would be granted in exchange for a signed guarantee of handing over the land in case of failed repayment. Until the loan was repaid, work would be due as interest. A few measures of ragi would result in a few days of labour obligations. A few hundred rupees not returned would

mean sending one or several family members as year labourers. This made it more and more difficult to return the initial sum (Figure 20).

Most of the labour class families in some of the villages had one or several members caught up in such labour obligations. It would mean they were not free to do other tasks, such as work their own land at the most opportune time, let alone any extra they might have cleared in the forest. The ploughing, sowing and harvesting of their own crops were delayed. In some cases, even after many years of such labouring, families would see part of their land claimed by the moneylenders.

Other families (Figure 19) in a less critical situation, managing to work more land of their own or having less mouths to feed, would be able to generate the income necessary for complementing their own production. All or most of their members would be free to work their own fields before going for day labouring for others. They had more chance of obtaining reasonable yields and possibly of having a little money spare to invest. Their greater land surface might stem from a better inheritance, or from having a more favourable ratio of "working arms to mouths to feed" (Figure 20). If there were sufficient men, labour would be available to clear extra forest and cultivate it, as long as too much of it was not caught up in paying "interest". Men also had the advantage of a daily wage twice that of women's.

Some of the labouring families had managed to acquire a couple of cows and a plough. Others had none and had to wait for the opportunity of hiring them from a neighbour if they had their own land or were working some under the 3-share system. A few had small herds of goats and sheep.

… and the medium-sized families…

Although all sizes of landowners existed, an intermediate category can be defined: those families possessing sufficient land to cover their food needs, but not sufficient to employ more than day labourers at the peak work times. They could originate from families who had divided their land between their sons over a couple of generations, or from families who had been lucky enough to accumulate capital. They belonged to both “higher” and “lower” casts.

These families would usually have their own cows for ploughing. In fact, they would often have bullocks for transport and field work and cows for milk and reproduction. Most would have at least some goats or sheep.

2.2.1.2 Harsh labouring conditions: the importance of land and animals

The different forms of capital served different purposes and were accessible under different conditions. If the labouring wages had not always been so low and the year-labouring system not involved near servitude conditions, the access to land would not have been so determinant. As to animals, cows were essential for the cropping system but other animals represented capital to overcome specific needs.

Rock bottom wages and year servitude

With enough land, food could be produced to cover the family's needs. With more, workers could be paid to come and work one's land. For 6 bags or ragi paid in advance, plus another half or so as food for the labourer throughout the year, a full-time labourer could be employed. The payment was given at the start of the year, ensuring the labourer had an obligation of work towards the landowner, hence the term bonded labourer. The labourer often lived at the landlords' and was more of a slave than a labourer, what with the whole-day, every-day-of-the-year service.

The landlords could produce 6 bags of ragi on less than an acre on a good year. A family with 10 acres could produce enough for their consumption on 2 or 3 acres and so could employ 3 or 4 year-labourers. For an upper-class family, not actually working the land themselves, a couple of labourers would be enough for ploughing and other such work; 1 or 2 could then look after the animals, allowing a reasonable herd of cows to be kept, possibly as well as a herd of goats or sheep… These animals provided extra produce and extra income. With more land, or for a family using their own workforce on their land as well, the possibilities were greater still.

Six bags of ragi just about cover the staple food requirements of a family of 4; but the family still has to buy or produce a minimum quantity of other food stuffs like beans or vegetables, or live off of plain ragi and suffer nutrient deficiency… The completely full-time nature of the year-labouring obligation meant that the members involved in this work were barely available for any work on their own land. This condemned many a family to remain perpetually trapped in this status (Figure 20).

If they had enough land and no debts, not to need to offer themselves as bonded labourers, their hopes were quite different. Enough land sometimes rested on having enough time to clear an extra patch in the forest and work it. As such, part of the land issue boiled down to the labour availability within the family.

The two partially inter-dependant ratios of "land to mouths to feed" and of "arms available on one's own land to mouths to feed", itself linked to the family being in debt or not, thus created a fine divide between 2 situations: having a chance of finding a way out of this category and into the next, or being condemned to be a labourer forever. Access to land was in that respect determinant, as it could save families from having to resort to such labouring to try and survive.

The system described here is reminiscent of a semi-feudal society. It explains some of the inequalities still in existence today. Saki (2004) gives an insight into how it remained in operation until so recently.

On the origin of this system close resembling semi-feudalism

According to Saki (2004), the British hold a lot of responsibility in the existence of such an unequal society up until so recently. The various dynasties that ruled over the South of India maintained a feudal then semi-feudal system for a long time. However, under Haidar Ali then Tipu Sultan, two Muslims who ruled over Karnataka up until Tipu Sultan's defeat by the British in 1799, things may well have started to change. They were progressively removing power from the various landlords and changing the structure of the state, in Saki's opinion (2004). The reign of Tipu Sultan is controversial. Landy (1994) talks more of the numerous wars that he waged.

However, the two authors agree that the British, in their desire to rule over the whole of India, soon realised that they could not do so directly. They therefore reinstated the previous lords or pressured them into collaboration.

"*The entire effort of the British* was to prop up and secure the local rule of a class of big landlords - landlords who only a few decades before had been vanquished by the rule of Haidar Ali and Tipu Sultan." (Saki, 2004)

Saki backs up his arguments with quotes from various British officials of the time, such as this one from Munro, Governor of the Madras Presidency in the first half of the 19th century:

"Our power is now too great to have anything to apprehend from our Zemindars. They know they cannot oppose it, they also know that it is not our wish to turn it against them, in order to deprive them of any right which they now enjoy; […] and they will, for their own sakes, be more disposed than any other class of our subjects to support our Government in all times of disturbance. […]

Not only zemindaries, but the official lands of the village servants have been divided up and parcelled out among different claimants and, unless measures are taken to stop this evil, every landowner will in time be reduced to the state of a common cultivator. With this fall of the upper classes the character of the people sinks; they become less attached to our Government, they lose the principal instrument by which we can act upon and improve them, and the task of conducting the internal government becomes everyday more difficult. I am therefore of the opinion that we ought by every expedient in our power to maintain the ancient zemindaries; and official landed estates unbroken. This will keep up a class of native nobility and gentry and preserve those gradations in society through which alone it can be improved in its condition." (Munro in Saki, 2004)

Precisely how the British interacted with the landlords in this area is difficult to know: they tended to reinstate the system as it had been prior to Haidar Ali and Tipu Sultan, but this varied a lot from one part of the state to another. Landy (1996) affirms that the zemindary system was one of northern India and that in the South, the farmers paid their taxes directly to the colonialists. He also says of Karnataka (Landy, 1994) that the large landowners were relatively few. This is not backed up by local farmer's accounts. In this area, there were several huge estates and generally, the large landowners took part in the British administration, at least as tax collectors. They appear to have more or less controlled the access to new land resources, such as forest land.

Despite some uncertainty as to the details of the links between the British and the local landlords, the statement above and similar ones, make the attitude of the British colonialists very clear. They did nothing to reduce the previous inequalities. On the contrary, they often made sure they were maintained or reinstated.

Cows and the cropping system: traction power and manure

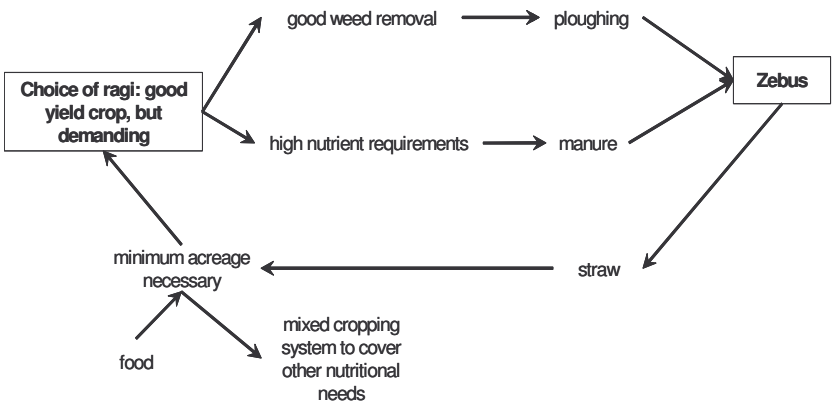
In the semi-arid conditions of this region, with the hilly landscape and few possibilities of irrigation, rain is essential to start growing any crops. These first rains create a crust on a soil that was very hard just before (2.4.2). Allowing the water storage capacity of the soil to be filled means opening up this surface. The preparation of the surface by mechanical work after the rain favours the growth of weeds. The choice of a crop like ragi, particularly sensitive to weeds and requiring a fair nutrient supply via the soil, means removing the weeds. The easiest method for this is ploughing. But ploughing requires cows or bullocks, although there have been reported cases in Karnataka, of people dragging the plough themselves. The animals require straw to complement the meagre grazing of the dry season (Figure 21). A minimum amount of the cereal crop must be grown, about one acre per cow (§ 2.4.3.2).

Milk would be obtained from the cows, but this was by no means their main purpose. Indeed, the breed, Hallikar, is one selected for its work potential. The cows were needed for ploughing and providing manure.

The larger landowners hence disposed of large quantities of manure. The labourers had very little. If they had no cows of their own, they might rely on hiring them, or more frequently would organise teamwork, all working in one person’s field, then in the next, etc. Of course, those who did not have their own cows or instruments would be last on the list. The delayed

work, for this reason, or that of labour obligations, and the small quantity of manure would mean their yields were often very low; yet another source of inequality.

Figure 21: Zebus - an essential part of the mixed cropping system



During the summer season, the animals roamed the fields, eating crop residues and weeds. In the cropping season, they would be taken to the forest. But the large herds of cows of the main landowners would find it difficult obtaining enough food from the forest only. They would therefore be taken off on transhumance to extensive rangelands situated south of the area.

The traditional mixed cropping system: making the most of the space

On smallholdings, the mixed cropping system (§ 2.4.2.1) of this area makes a lot of sense: with a minimum acreage of cereal required for straw, few fields would be left for growing other foods. Yet from a nutritional point of view, for nearly vegetarian populations, pulses and vegetables are required to cover the body's needs. The mixed cropping system, it would seem, allows more produce to be obtained per acre (Van der Tas, 1986).

The choice of ragi as the main crop stems principally from the fact that under the right conditions, it is more productive than other millets or than sorghum (§2.4.2.1). Previously, a mix of different millets was grown, insuring greater security in the face of variable yearly rain patterns. But ragi, easier to prepare and a nutritious grain has always been preferred.

Other animals: milk and money

Buffaloes provide good quality milk in much higher quantity than the traditional cows. They were kept for this purpose. Moreover, they require virtually no care or extra food.

The sheep and goats require watching, but no extra food and little care. Their purchasing cost is also much lower, making them more accessible to the labouring families. The young could be kept to increase the herd size, or sold to provide a cash income. They often serve as a savings account, to get over a difficult cropping season, or cover exceptional costs such as those linked to a daughter’s wedding. Some of the goats were previously milked to make curd. In more fortunate families, with a largish herd, the money from the sale of the young could be reinvested.

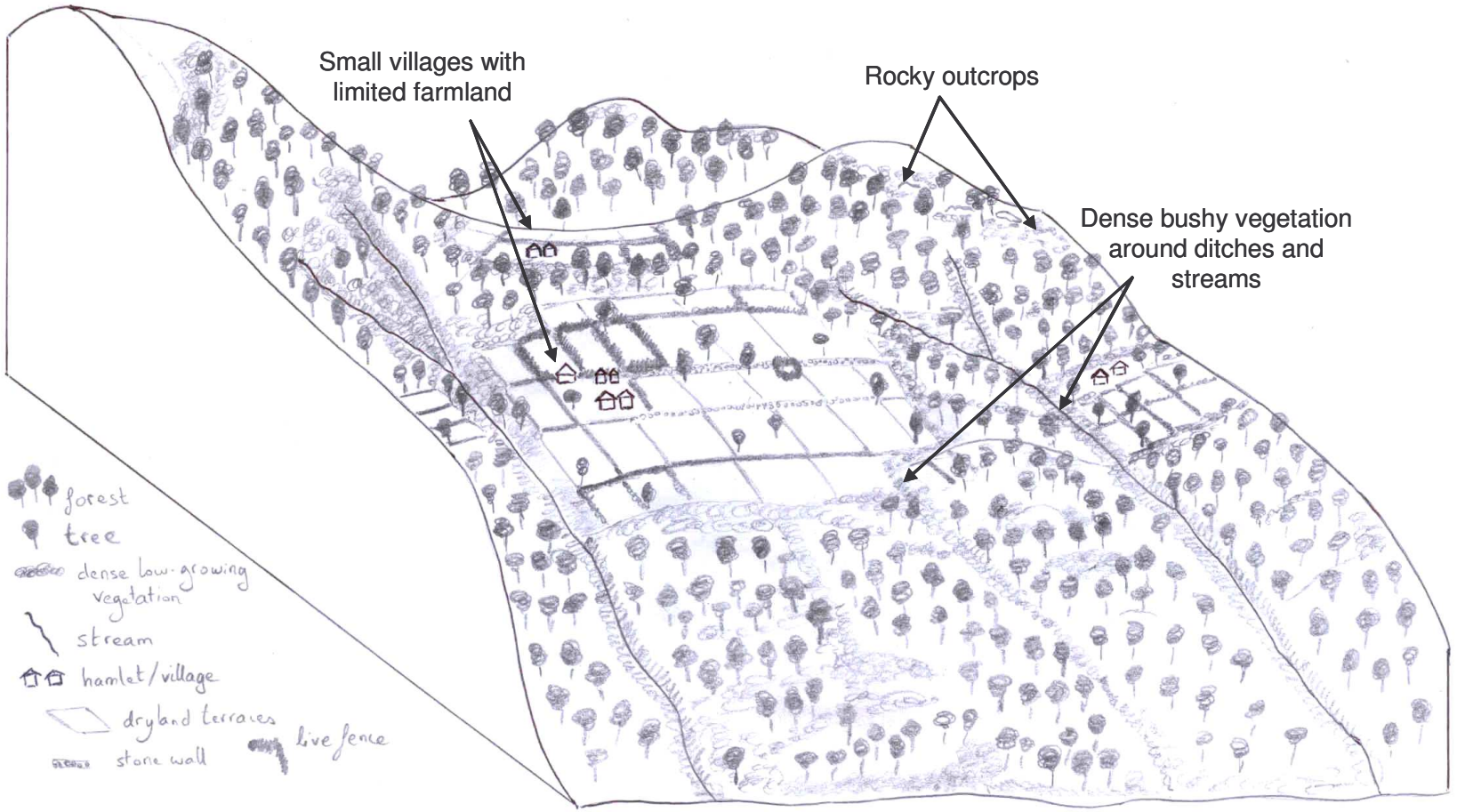
2.2.1.3 Dividing, losing and acquiring capital

Events involving land and animal loss and accumulation are specific to each family. A certain number of characteristic mechanisms can however be identified in the changes that could take place for a particular family (Figure 19).

Dividing between sons

In India, each son normally inherits an equal share of his father’s capital. Regulations concerning adopted children changed (under British rule), but these concern only marginal cases. In situations where the family has only daughters, the land is divided equally between each of their husbands, or those of their husbands who come to live in their wife’s village.

Figure 22: A schematic view of the landscape of the upstream part of the zone around 1950



Otherwise the uncles are the legal inheritor. In some cases, if each share is so small, one of the son's gives up his one and leaves for another village. Principally though the land and animals are divided between the sons. With 2 sons for example, a lower than average number at that time, over two generations, a 100-acre family becomes four 25-acre families. As to a 4-acre family, they become four 1-acre families! Higher numbers of sons were very common, so the size of the landholdings rapidly decreased.

Clearing the forest

The forest spread across most of the land here a century ago. In the midst were a few small hamlet villages (Figure 22) and several villages dating back a few centuries, with their landlords, a few other tradesmen families and landless labourers. Migration occurred for various reasons and a few villages were set up on higher land, in the middle of the zone, not previously farmed. Possibly events such as diseases or very wet years problematical in the lower parts of the land were one cause of migration from previous hamlet villages. Probably more frequent are families who were seeing their land be split up with each new generation: to compensate for this, they needed new land and one of the sons would settle in a new village. He would arrive with a family or two supplying the necessary year labourers. The labourers would clear the forest, construct the necessary bunds and work the land. They might be given some of the land to farm themselves under the 3-share lease system.

A large proportion of the forest cutting was done for the medium or large landowners. Some of the small farmers did however manage to clear some land of their own. This was sometimes done with the help of the more cooperative landowners, at least for obtaining official documents. A few others cleared land without any proper authorisation.

The settlements first grew as a result of newcomers: other families able to claim land there, or realising that land could be acquired. Some people arrived as a consequence of the new labour needs generated in this way or directly as bonded labourers, with their masters.

Subsequent growth of the villages happened mainly through the children born there and the expanding size of families. Marriage was a cause of mixing, the woman usually going to live with her husband, but similar numbers came and went. Sometimes the whole family moved away, or a new family came to settle, though this was not a principal factor of change in population numbers of most villages. Some villages have attracted families throughout the whole period. These are the larger villages of the area, where labouring work was available: agricultural, but also brick making, building, dam construction as well as the development of various businesses.

Loss of capital

While land and animals could be acquired, they could also be lost due to different events.

Droughts and loans

During the extreme drought periods that have occurred on several occasions over the last century, (the last very severe one in the 60's), most families were pushed to their limits. The ragi yields were nearly reduced to nothing. The larger landowners had stocks from previous years. Other families resorted to eating products found in the forest (tubers, leaves, bamboo shoots). When that supply dwindled, they left to work in irrigated regions near Mysore for example, or in the coffee plantations of the Western Ghats. If there were sufficient members old enough and fit enough to do so, the family could manage in that way. In some places, the villagers talk about half of the members leaving several years running.

Despite this, other families, for lack of fit members or for an excess of mouths to feed, had no choice but to sell some of their animals, or some or all of their land. In some cases, the land

was sold directly. In others, it was lost subsequently, as a consequence of having to take a loan from one of the moneylenders and then never having a chance of returning it as another member or two had to be sent to work as labourers to cover the interest.

Less severe droughts could upset the balance for families in the most precarious situations. Losses could also be incurred due to boars or elephants sometimes eating large percentages of the crops. The fields most affected by this were the ones closest to the forest, those usually owned by the labouring classes.

Some of the animals also died through lack of food during the exceptional drought periods. The cows seem to have been the most affected.

Weddings and funerals

The loss of a son through death or departure, meant one less pair of arms. It might result in a family no longer having sufficient members to work their land or look after their animals and having to sell one or other (Figure 20).

The money required to marry a daughter was also a frequent cause of land or animal being sold. Many families took a loan on such occasions and were not able to repay it. They found themselves having to work for the moneylenders, and could end up dispossessed of their land (Figure 20).

Savings

Some families were able to save some money, through labour, to buy an animal or two. If they were careful and lucky, they would be able to increase the size of the herd by keeping sufficient young. This was not necessarily as easy as it seems. In the small landowning families, it required having available labour to watch the animals. The number of young given by the first animals was also fairly critical. Animals were susceptible to exceptional illnesses, routine deaths during delivery or more frequently to being killed by some of the local forest wildlife. The sale of the young could cover routine expenses for the poorer families. If the family was lucky, at least some of the young could be kept to cover more exceptional needs. But generally the yearly requirements meant that this was impossible for the poorer families: they had just a handful of animals and often could not increase the numbers.

Families in a better position might have enough animals for the sale of the young to bring in more money than they needed. They could then capitalise through the purchase of new land, or employ labourers.

Some of the animals owned by medium landowning families, with insufficient land to pay a year labourer the 6 bags of ragi due, would negotiate another type of contract for the watching of the animals. The watcher would get half the young (and half the milk if relevant) and the owner would get the other half.

2.2.1.4 Policy changes

For many families real change was not possible during the phase described above. The labouring conditions were too harsh.

Indira Gandhi

Indira Gandhi is cited as the landmark by local farmers. However, policy changes happened in different stages. Most had little effect in this remote area, where the road only dates back 50 years and the first bus some 35 years…

The initial post-independence agricultural policies had tried implementing land reforms, but only a few states had really attempted putting them into practice. After the 1960s droughts,

the cursor switched fully to increasing productivity in the high potential areas (§ 1.1.1). It was Indira Ghandi who put agrarian reform back on the political agenda at a national level in the 1970s. Once again, only a few states went ahead with any vigour in limiting the maximum land acreage that could be owned and in trying to apply the "land to the tiller" policy.

At this time in Karnataka, the Congress party was in power (Landy, 1994). There was a strong movement to help the backward castes. The policies included attempts to translate the agrarian reform into reality.

The accounts of farmers in the area confirm that this was rarely effective. Some farmers did acquire the land they had been working under the 3-share system. Many did not and most of those who did had to pay for it, even though it might have been at a reduced cost. The large landowners had many strategies for getting around this regulation, as well as the one limiting the number of acres owned. On paper, they would divide their land between their sons, or other people. They might sell some of the land. To avoid leasing it, they would plant trees: mangoes or coconuts most frequently. They might make an arrangement with a local labouring family: free use of the land for five years in exchange for care given to the trees. In this way, they got around the regulations related to leased land. There was however some reduction in the size of the larger landholdings, even if it was more from sales than from losses.

A few farmers also talk about a regulation whereby after several year of labour, the landlord had to give them an animal. For some it was the means of acquiring their first cow, or goat or sheep.

New chances for the smallest landholders

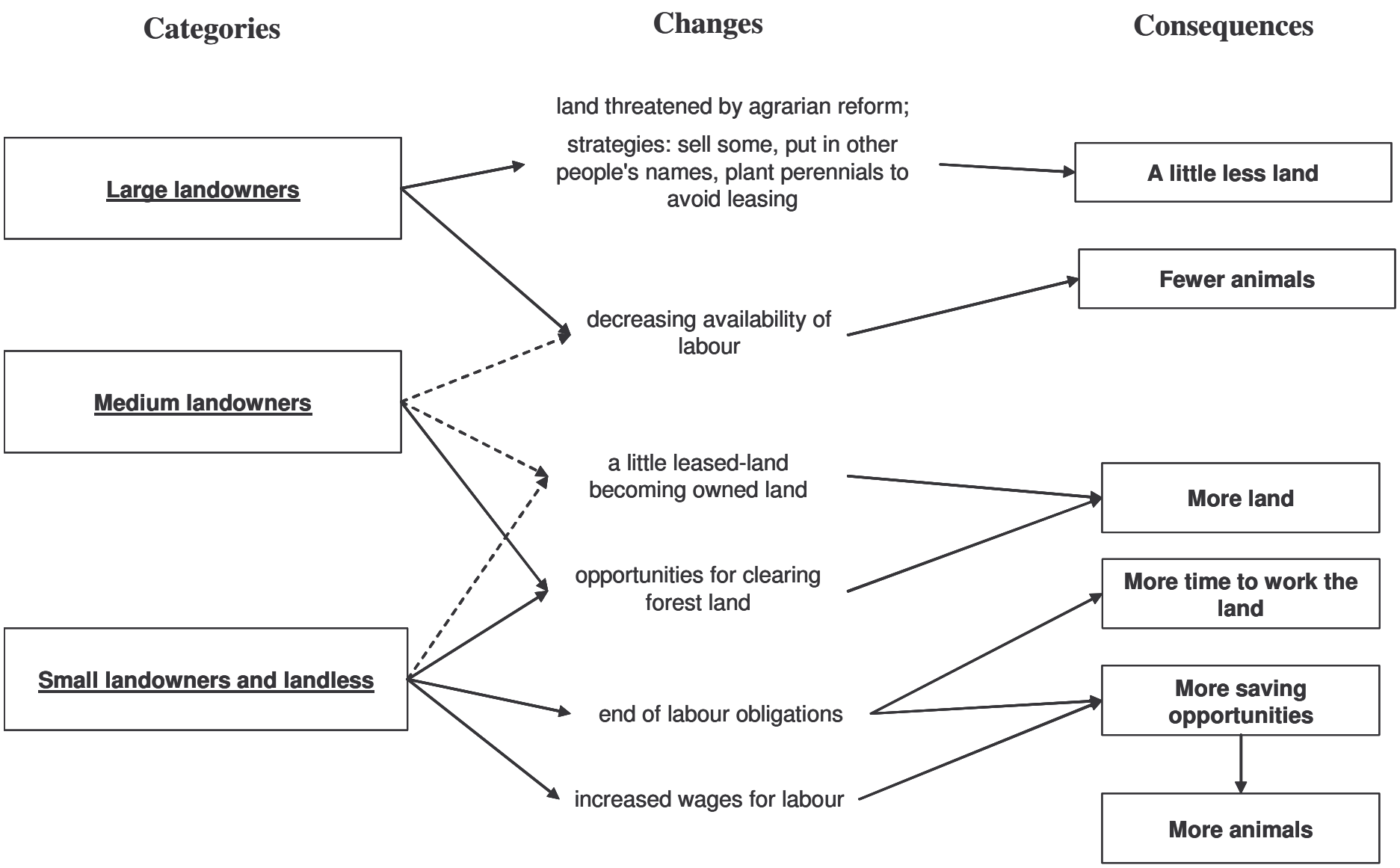
The main change, which appears to have been implemented, is the end of the bonded labouring system. Accounts of government officials descending into the fields to inform farmers of the illegal nature of the practise were given. It did not completely terminate it of course, but it appears to have been the first policy that had a significant impact on many people's lives. The bonded labourers, working for interest, were freed. The wage for other year-labourers showed a sharp increase, and the working hours shifted to a more normal regime. Moreover, the loss of "free" labour for the moneylenders modified the balance between the demand and the offer of labour. Due to this, the labourers gained extra weight in the negotiations and conditions continued to improve a little.

This relative change in labouring status gave the smaller farmers a chance (Figure 23). The higher wages meant they could sometimes save a little money. The freeing of the bonded labourers enabled them to work their own land… The situation did not become easy though.

Fewer labourers for the larger farmers

The drop in available labour created many a problem for the larger farmers. They had until then relied on guaranteed labour for both ploughing tasks, and most of the animal care and herding. This sudden decrease in number of workers meant that many of them had to sell a good part of their herds (Figure 23). They would start by selling one of the types of animal, usually the goats and sheep; next the buffaloes, and lastly the cows, keeping just a few for the mechanical work. They also had a tendency to work less of their land directly, and lease a higher proportion of it. In some cases, parts of the land became unproductive.

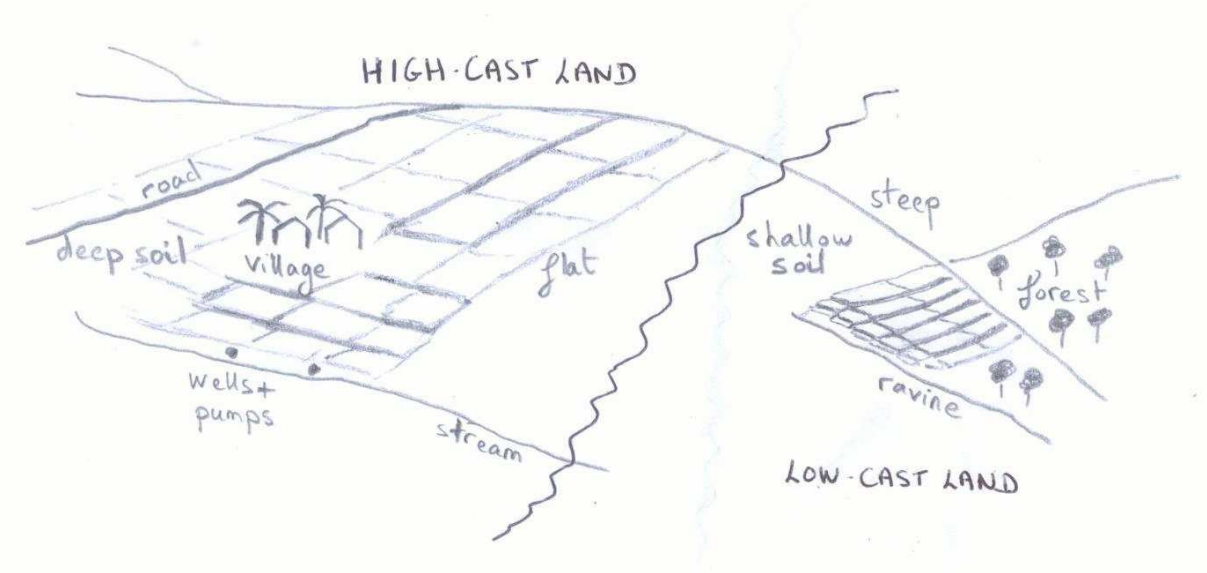
Figure 23: The impact of the 1970s Karnatakan government policies



More land for the poorer farmers, but some remaining inequalities

At this time measures were also taken to help farmers acquire documents for forest land. The clearing of the forest was authorised for several years. Despite this, not all farmers got access to land (Figure 23), although around the central part of the zone, where the villages are small and the forest still covers an important part of the landscape, the landless farmers are rare. Near the 2 large villages at each extreme of the zone, migration has continued and many of the people who have arrived within the last 50 years (often from neighbouring Tamil Nadu) are still landless. For the last 10 years or so, there have been strict interdictions on the cutting and exploitation of the forest, enforced by the forestry department.

Figure 24: Land resources for the high-castes and for the low-castes - pernicious inequalities



In the centre of the zone, there are a certain number of families, nearly always of lower caste, with very small areas of land, a heritage of the previous divisions. Moreover, for many of the lower caste families, whose land was acquired from cutting the forest, the "quality" of this land is often problematical (Figure 24). It lies closer to the forest and the animals that might consume the produce (elephants, wild boar, monkeys). It is often on stony land or on steep slopes with thinner soil, more prone to erosion, than can quickly turn into very poor *karlu*. The plots are far from the village, carrying manure there is difficult, and they are small, making the work on them longer. Although not all of the lower caste people cumulate all of these difficulties,Figure 24 being a slight exaggeration of the average situation, there is a strong contrast with the upper-caste land which tends to be on large flat surfaces with deep red soil, close to the village.

Because of the poor potential of much of the lower caste land, but also because they had fewer animals and therefore less manure, their yields were often very low. The change in labouring status helped, but did not solve all of the problems for the more vulnerable farmers.

Continuing government policies in the 1970s and 1980s

The government policies to try and reduce poverty and provide support to rural populations were pursued throughout the 1970s and 1980s. Measures, other than the agrarian reform and labour status discussed above, include the development of rural infrastructures: the road in the study zone had been constructed in the 1960s, but it was not until the 1970s that the first buses were put in service; the electricity lines were installed between the early 1970s for the 2 larger villages, and around 1980 in the middle of the zone, where current is available throughout the

whole night, as well as in the morning one week or in the afternoon the following week; water pumps, actioned by hand, were fitted for access to clean drinking water, and were followed by bore-wells with electric pumps in the late 1980s. A couple of coconut saplings were also provided to each family. Today these have transformed the appearance of the villages, where rows of these trees line the streets.

Specific measures were taken to help poor families. Grants were issued to purchase a site for a house and help cover the building cost, for the families living in huts. The number of brick houses rapidly increased, replacing the previous huts. The Public Distribution System for supplying low-cost staple food to the poorer segment of the population (§ 1.1.2) was also developed at this period. In the villages of the zone, all of the families qualify for access to low-cost rations of rice, wheat, sugar and kerosene (the prices of which figure in annexe 4). At one time, the lower caste families benefited from a cheaper price than the others, but today it is the same for everybody.

More recently

More recently, primary schools have been opened in the villages that did not until then have one. A hospital with a doctor has been provided in Hunasanahalli (§ 2.3). The government has also provided support in accessing more affordable credit: cooperative banks exist and numerous SHGs have developed in the villages, where some people at least can obtain loans at 1 % or 2 % per month.

Farmers have received increased support via the extension of the Minimum Support Price system (§ 1.1.2): Bangalore was the nearest Agricultural Produce Marketing Committee yard, up until 1997, when one such yard was opened in Kanakapura. In theory, the government buys farmers' produce if the price drops below the MSP. In practice it is not quite that simple, and farmers continue to sell most of their produce to intermediaries, as even Kanakapura is a long way. But the government does buy farmers' produce there at a relatively fixed rate and this market constitutes a regulated area where prices can be monitored. Silk is one product that all the farmers sell directly at the cocoon market in Kanakapura. This is separate from the APMC, but is another regulated area.

Government policies centred around increasing production had also reached the area by the 1970s, although they did not take off until the 1980s. They included providing or facilitating access to irrigation, and measures destined to introduce high-yielding varieties and chemical fertilisers.

2.2.2 Increasing access to irrigation and selling opportunities for some

Irrigation opportunities have appeared in several phases in the area. In semi-arid condition, they totally change the cropping possibilities and as a consequence, they can profoundly modify the classification of the different types of farmer in the area. The productivity per acre is greatly increased and possibilities for selling produce appear. Besides the irrigation, the introduction of high-yielding varieties has had important repercussions in the area.

2.2.2.1 Dry-land crops everywhere for local consumption

A century ago, there was no irrigation in this area, other than some hand watering of a few vegetables and a few trees in the premature stage. So there were just a few small mango and coconut plantations. Everywhere the crops were the same: ragi (*Eleusine coracana*) with mixed rows, some minor millets (kodo millet - *Paspalum scrobiculatum*, little millet - *Panicum sumatrense*, and more rarely foxtail millet - *Setoria italica*) and a very small amount

of groundnut (*Arachis hypogaea*) for the house consumption (Figure 22). Exceptionally, a little dry-land paddy might be grown on land in small depressions, where the water lies. Some rainy season vegetable crops complemented the families' diet: usually chilli, aubergines and some green leafy vegetables; more rarely beans, coriander and a few others.

At this time, most of the crops were grown for local consumption. The farmers with little land struggled to produce enough to feed their families. Their produce was all self consumed, unless they had animals. Animals if they had any, labour otherwise, constituted the only sources of cash (Figure 19) for other needs (salt, sugar, onions, garlic, clothes, pots, soap…). They would also rely on picking wild fruit such as tamarind, or vegetables such as bamboo shoots.

Large landowners might grow a few crops for selling: betel nut and betel leaves, hand watered, and rainy season mulberry. They would also be able to produce a surplus of ragi and other crops, even after paying their labourers 6 bags of ragi per year. An average of possibly half the ragi produced would be sold to local traders in Hunasanahalli and Kolgandanahalli. These middlemen were in contact with the large trading centres in Bangalore, but also in Tamil Nadu. According to the rates there, they would negotiate a buying price in each of the villages with the main 'leaders'. The price agreed would hold for the whole village. They would then collect the produce and transport it by cart to the local towns and on from there to the trading centres.

2.2.2.2 Progressive irrigation opportunities

The number of farmers with access to irrigation possibilities has heavily increased over the last 30 years.

The first irrigation possibilities: the tanks

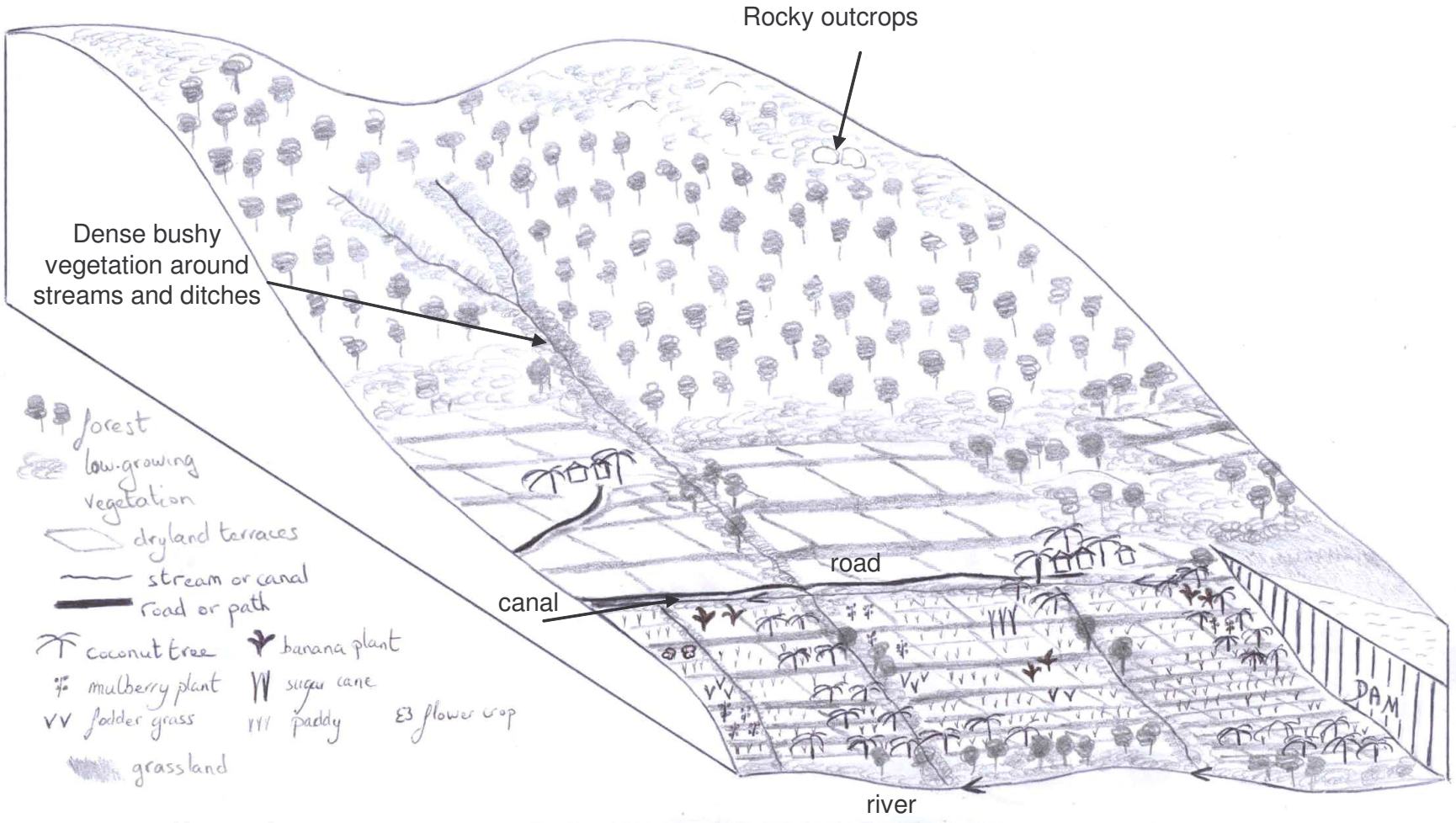
In Hunasanahalli and a neighbouring village, around 1950, two tanks were equipped with gates so that they could be used for irrigation. The capacity of these tanks only allowed the irrigation of around 20 acres of land below. Dry-land paddy was initially grown there, followed by wetland paddy once varieties arrived. The rest of the land saw no changes. The tanks in other places held insufficient water to permit irrigation. They conserved their role of providing drinking water for the animals and water for clothes washing when no other was available, as in some villages. In this respect, the situation was very different to a large part of the neighbouring Tamil Nadu villages, where large tanks equipped for irrigation were common (Bouzid and Perdrier, 2001).

Next the diesel pumps

Next came the diesel pumps, nearly fifty years ago. Only a few people had access to the water source (usually an open-well), as their land had to be situated near one of the streams or in a hollow where water would collect at least during the rainy season. They also needed the necessary money for buying the pump and for paying for the diesel. Their number remained very limited Most of the farmers fulfilling these 2 conditions (Figure 27) belonged to the "higher castes" (§ 2.3.1).

Coconut trees were planted, and paddy or mulberry was grown underneath. The water available in the wells also varied from one well to another. In some the level became problematical after a few years and today many are no longer in use. Most of those still used are connected to the electricity mains, installed some 25 years ago (§ 2.2.1.4).

Figure 25: The landscape and crops in the open part of the valley, after construction of the dam



The Chikkondanahalli dam

A dam has been built on each of the two rivers. Work on the one on the western river started around 1960 and was completed in the early 1970s, as compared to less than ten years ago for the other river. Consequently, this second dam is only used for irrigation on a small part of the potential area. A large part of the area below the dam level is still under lush forest, which will probably be cleared in the coming years. For the Chikkondanahalli dam it took another 10 years before it was really put to use, as the bunds for the paddy fields had to be constructed. It created a whole group of farmers with access to irrigated land (Figure 27).

Today, it gives a very different look to the landscape in this more open part of the valley (Figure 25). Large ditches carry the water from behind the dam, running parallel to the original river, from the level of the dam, along the hillside. Below these ditches, the fields stretch down to the river in small terraced fields, from only 50 m^2 in surface, to near 1000 m^2 for the larger ones, dropping in steps of around 30 cm or more between one terrace and the next. Regularly spaced gates allow the water flow to be controlled to each group of fields, via ditches heading down to the river. Dense bushy vegetation lines most of these water channels that run perpendicular to the river.

Paddy (*Oryza sativa*) was and is the main crop, although mulberry was introduced early on and many coconut trees were planted sparsely along the bunds. There are patches containing only these paddy fields. However, patches with paddy in some terraces, recently introduced hybrid grasses in others, and coconut trees regularly spaced along the bunds separating the terraces, forming a sparse plantation, can also be found.

The banana plantations are localised and are a more recent introduction of the last 10 to 20 years, as opposed to the mulberry. The banana fields are usually larger in size, up to 0.25 or 0.5 ha. A few small flower-culture and sugar cane plantations are present too. Exceptionally, some betel nuts trees can be found. Around the hamlets and villages of the zone, the coconut trees are numerous and hide the crops beneath, if looked at from above.

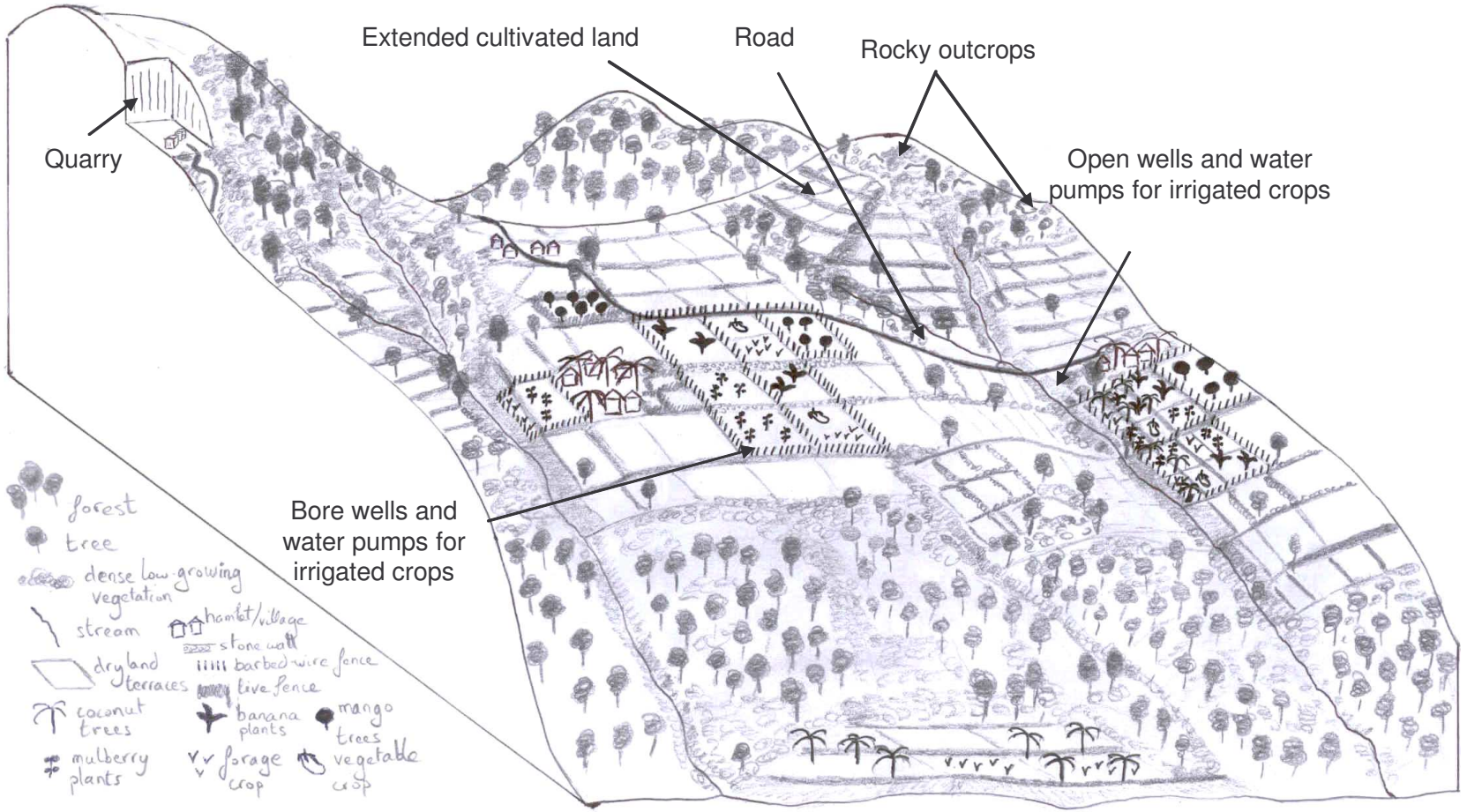
All of the perennial crops need a water-pump to be grown (§ 2.4.5). Indeed, the dam does not supply water throughout the whole year. This means that there are actually 2 different categories of farmers disposing of irrigation in the dam-irrigated area: those with a pump, and those relying solely on the water from the dam.

In some fields, bunds were never constructed and the fields remain dry, where some have more land than they can farm for example. Bund and waterway maintenance is a problem: true, some of the planned trenches were never constructed, but some fields that were initially irrigated can no longer be so; the control of the water level in other fields is impossible due to the lack of maintenance. Moreover, there is a problem with one of the gates, which one opened cannot be closed again: huge quantities of water are wasted (§ 2.4.5).

Fortunate bore-well owners

After the government had bore-wells dug, around 15-20 years ago, to provide clean drinking water to all the villagers, the idea caught on. A few people were able to finance the necessary investment (boring the hole, paying for the electrical connection, the pump, the pipes…) for their own private bore-well. The first ones were dug approximately 15 years ago. Larger landowners could afford it, as well as a few families who had educated members working in local towns, earning much higher wages than the local labour rate. There were also a few adventurous investors, prepared to take the risk of a large loan. They have gradually increased the number of farmers with access to irrigation (Figure 27).

Figure 26: A schematic view of the landscape in the upstream part of the zone - 2000



Usually the irrigated fields are situated close to the villages (Figure 26). These crops will indeed require more surveillance and more labour. They are frequently fenced in. The main crops include mulberry (*Morus indica*), banana (*Musa sapientum*), as well as vegetables or flowers. The vegetables include aubergine (*Solanum melongena*), green chilli (*Capsicum annum*) and more recently tomatoes (*Lycopersicon esculentum*). Exceptionally, some other vegetable crops are found, examples being cabbage, cucumber, or other cucurbitaceous crops. Jasmine and chrysanthemum are the main flowers. Sometimes the irrigated area will contain sparse coconut trees (*Cocos nucifera*). The edges of the fields have often been planted with trees such as teak (*Tectona grandis*) or papaya (*Carica papaya*). Still other crops include paddy (*Oryza sativa*), under sparse coconut plantations for example, fodder such as elephant grass (*Pennisetum purpureum*), introduced very recently, or sorghum (*Sorghum bicolor*).

2.2.2.3 Access to the market: growing more, an essential condition

The sale of animals has been on-going throughout the history. But up until 30 years ago, rare were those selling any vegetable produce (Figure 19). The increase in produce sold has been the result of several phenomena. These, along with the subsequent changes in categories of farmers over the last 30 years are illustrated on Figure 27.

Principally large landowners selling for the market

The larger landowners could produce surpluses of ragi and the crops that are sown along with it. Some of them also had some coconut or mango trees. Others, as well as several medium-sized landowners, grew rainy season mulberry, a crop definitely cultivated for the market. It might have been more of a medium-sized landowner choice, because of the importance of the important work input, but high productivity of the land (§ 2.4.4.3, 2.4.5.2).

Wetland paddy and other irrigated crops

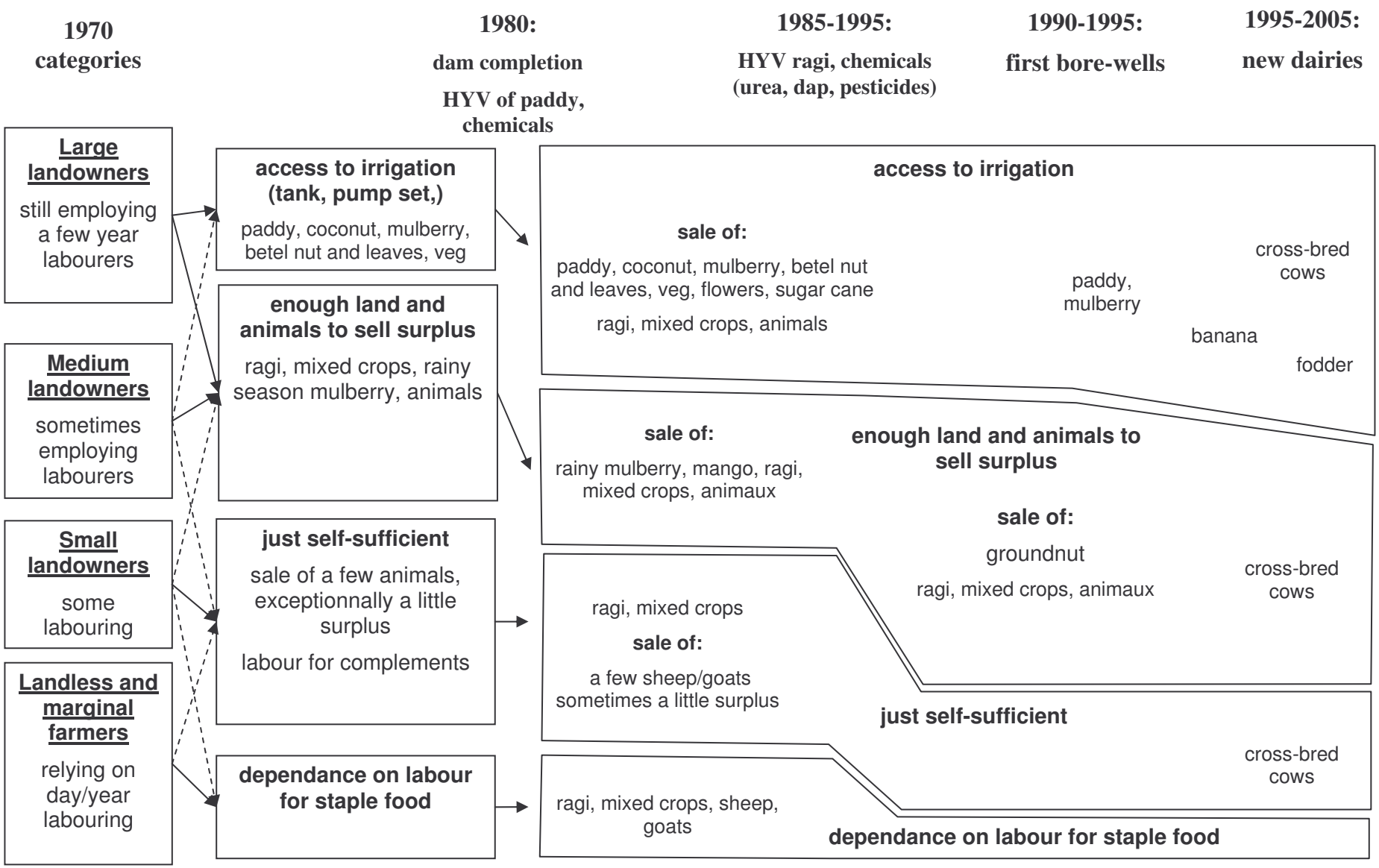
The introduction of wetland paddy happened at a time when new high yielding varieties along with chemicals had been in use elsewhere. The arrival of these new varieties in this area meant that compared with ragi, the crop yields were very high. Initially only larger farmers, who could install a pump, could grow paddy. Once the dam was constructed, many more families were concerned (Figure 27). Even those with access to a very small amount of irrigated land could grow more than they needed. Selling for the market started on a much larger scale.

Specialised crops were also developed, such as the flower crops. Surfaces planted with mulberry were extended. Coconut trees were planted. Bananas were introduced, along with a little sugarcane. These relied on having a pump though.

Selling opportunities close at hand

A silk cocoon market was developed in Kanakapura, at least 20 years ago. Price fluctuations are important within the year, linked to the quantity arriving on the market. For a couple of years, the average yearly price dropped very low, when silk from China was allowed onto the Indian market in larger quantities. Paddy, like ragi and the other dry-land crops, was and is often sold to local intermediaries. Sometimes the owner organises transport to the mill in Kanakapura and sells the rice obtained directly. Bananas are usually sold to traders who come to the area and pick them up. Monthly price fluctuations are very high.

Figure 27: Progressive access to water and the market



Chemicals and new varieties of ragi

Around 15-20 years ago, the first chemicals, along with a 5-toothed *kuurge* (sowing implement) were introduced in the area by agricultural extensionist workers. Some of these workers came to the area, but not in sufficient numbers to interact with many of the farmers. However, the new technology, followed by the new varieties spread quickly by word of mouth. The combination of greater row spacing, new varieties and artificial fertilisers gave a leap in yields. Within a few years, most people were growing the new varieties and using these chemical ferilisers. Many farmers went from a situation where their few acres of land were insufficient to feed their families to one were they could sell some of the ragi produced. The change is therefore considered positive by most farmers, although many do regret the taste of the old varieties.

Little millet and kodo millet were no longer grown from then on. Two different explanations appear plausible. Firstly, their yields would have been similar to those of ragi up until the introduction of new varieties. They might even have been preferred on the poorer soils, or in dry years. But with the new varieties of ragi and the significant yield increase, the other millets were no longer "competitive". At the same period (1980s), the PDS was established and people could access cheap wheat and rice to complement the ragi. Both kodo millet and little millet require a lot of time to process. People say they were not very appreciated, so that farmers stopped growing them when they no longer needed them to give extra diversity to their diet.

New crops

With this increase in yields, even smallish farmers could consider using some of their land to grow other crops. Those with a fair amount of land planted mangoes (*Mangifera indica*) for example, if near enough to a water source to water them by hand. The arrival of new varieties of groundnut (*Arachis hypogaea*) with high yields meant that over a couple of years this crop developed very quickly. The good return encouraged many farmers to grow half ragi, half groundnut (both with inter-cropping practices). Farmers with land close to the forest found themselves disadvantaged by the tendency of wild boar to eat their crops. Moreover, the last few years, a drop in groundnut yields has led many farmers to go back to growing ragi and intercrops on most of their land, or to include a few fields of solely red-gram (*Cajanus cajan*).

The farmers with access to water via open-well or pumps could grow a whole variety of crops, (§ 2.2.2.2). These are all market oriented crops. Most are discussed just above. Vegetables are taken to Kanakapura or to Bangalore to be sold.

New animals and fodder production

The last ten years has seen the introduction of cross-bred cows (§ 2.4.3.5). Farmers have started investing to purchase such a cow since the development of dairies in the different villages. Aralagadakalu for example has had a dairy for 3 years now. In Chikkondanahalli, it opened 5 years ago. Usually, after opening, the number of cross-bred cows in the village increases fast. The dairies are set-up as cooperatives; with support from the Karnataka Milk Federation (KMF) that provides a collection service twice daily.

The introduction of the cross-bred cows has increased the production of fodder on the irrigated surfaces. Sorghum (*Sorghum bicolor*) is sometimes grown, but more and more elephant grass (*Pennisetum purpureum*) is introduced to feed the cows. Sweet-corn is increasing in the area, sometimes grown for selling, sometimes for fodder production.

2.2.3 Green Foundation's intervention

Green Foundation has been working in the area for just over 3 years now, along their principle axis of intervention (§ 1.2). They started work in several villages in the area, discussing problems related to high-yielding varieties and chemicals with the farmers and introducing those interested to organic farming practices. Training schemes were set-up on such aspects as vermi-compost production, mulching, seed selection and conservation.

For the last 2 years, they have concentrated the main part of their energy in this area on Veereianadoddi. The choice of this village as on of the organic farming test sites in Karnataka is the reason behind this. Green Foundation's work in other parts of Karnataka continues as previously (§ 1.2). In particular, they are setting up a federation for the marketing of organic produce, which will be relevant to the farmers in this area as well.

The project in Veereianadoddi centres on organic farming. However work with the members of the community must take into consideration the organisation at that level. Hence Green Foundation have set-up a village SHG, where projects are discussed and planned. A small contribution is paid each week, to finance related activities. The SHG has been important in setting up a community seed-bank, where numerous varieties of the local crops are available.

Measures put into practise up until now include:

- organising seed production, seed selection and seed conservation at the community level;
- encouraging farmers to increase their organic matter inputs to the fields, to pay attention to the quality of this organic matter, to reduce their chemical inputs;
- training farmers in the production of compost and particularly vermi-compost and providing support in the setting-up of their individual production units;
- introducing soil and water conservation measures for the fields (mulching, green-manure crops, new intercropping practices especially under banana plants, trench-cum bunds) and at the village level (check dams and boulder checks, farm ponds);
- setting up a nursery and encouraging tree planting;
- training and providing support in the production of organic pesticides and fertilising material (chilli, garlic, neem or pongamia based preparations, cow urine fertilisers, j*eevamrutha*...);
- field-level experiments with different varieties, different sowing methods, different bio pesticides or fertilising material;
- supporting income generating activities, including encouraging the women's SHG of the village to produce red-gram dhal or providing a market outlet for some of the organic produce of the village (vermicompost for example).

Green Foundation has been present in the village for too short a time to make a proper evaluation of the impact of their work there. For many of the farmers of this small village, this is the first year they will be farming totally organically. Several farmers are in their third year, but amongst these, most are still in a phase where they are increasing their production of good quality compost material. Up until now, due to insufficient quantities, they have been applying it to selected cropping systems, usually the irrigated ones.

Due to this, specific categories of organic farmers have not been defined. However, the observed practices and results have been compared to those of the other farmers for specific cropping systems for which there seemed to be reliable evidence of how they are functioning at the moment (§ 2.4). These results are extended to understand the consequences for the families with different farming systems (§ 2.5). The durations are too short to be able to know how the results are likely to evolve in the future.

2.2.4 A global look at the changes in and around Veereianadoddi

Many transformations that have taken place in the area are directly related to various national, or more frequently state government policies that have been conducted since independence. The changes have had a repercussion on the links between the area and other parts of India, on the appearance of the landscape, on the social organisation, on the use of resources within the area and therefore on what factors introduce differences between families.

Support from the government

Government intervention in the zone has followed the same general trends as throughout India (§ 1.1). The policies have included land reforms, which were not ever so effective, but did constitute some limitation of the largest estates. More important was the end of the bonded-labourer status, although it did not completely disappear, and the increase in yearly labouring wage. This wage still remains low (§ 2.5), but its increase and the official end of the bonded status did give the families concerned some hope of being able to progressively improve their situation.

The government policies have also included measures to increase production. The dam construction created opportunities for irrigation for all the people with land in the right zone. Free electricity during many years, for pump owners, constituted government support for obtaining access to irrigation. High yielding seed varieties and fertilisers have been subsidised by the government who has also played a direct part in their diffusion via agricultural extension workers, who did sometimes travel to this particular area. The impact of this policy has been determinant in enabling many farmers to reach the staple food self-sufficiency level, or even produce enough ragi to sell some (§ 2.2.2.3). The opening of an APMC yard in Kanakapura, to regulate the prices receive by farmers, was another means of supporting production. However, it remains a long way away from this particular zone, and most farmers still sell to intermediaries.

There have been sets of policies introduced to improve the rural population's living conditions, without being directly linked to agriculture (§ 2.2.1.4). These include measures to ensure very poor families have access to lodging and food, the support of micro-credit schemes, the extension of infrastructures such as roads, electricity installations, etc., and the provision of water, health, education and transport services.

Inputs to and outputs from the area

The exchanges with other areas and towns have increased significantly over the last half a century. Initially, there were just a few animals and a little ragi being sold outside of the area, as well as taxes that were being collected. The imports would have consisted principally of a little food for those who could afford it, to diversify their diets, but not much else.

Concerning the exports, there has been a net increase in the total production in the area, made possible through an extension of the cultivated surfaces, but also a higher land productivity. The increase in productivity is a result of the new opportunities for obtaining irrigated surfaces and of the introduction of chemical fertilisers and high-yielding varieties of the main crops. The possibility of growing other crops has led to the export of products such as

groundnut, or very recently a little sweet-corn. Another new export has been milk, since the set-up of the dairies and the introduction of cross-bred cows.

There has also been a movement of people out of the area, over the last ten years. Important emigration from the area has started, in direction of Bangalore or other towns, in search of work.

The inputs to the area have included high yielding varieties of seeds, as well as the chemicals that go with them. But there has also been an increasing quantity of food arriving. The bulk of this comes through the PDS and concerns rice, wheat and sugar. On a national scale, these products are produced on a large scale in the North of India, and there is an overall transfer from the North towards the South. Diets are changing as a consequence, with more rice consumed on average, in replacement of part of the ragi.

Very recently, there has been an influx of new land managers. These are land investors, from Bangalore or other local urban centres, who have started buying up the available land, that tehy use to farm on a managerial model. There are hints that the main motivations are not so much investing in farming, as tax evasion or money laundering.

Today's landscape

A comparison of Figure 22 and Figure 26 shows how the landscape has changed over the last half a century. Amenities have developed, such as the road. Coconut trees have appeared in all of the villages. Huts have decreased and brick houses increased, although overall, the villages and hamlets have grown.

As to land use, the forest has receded, as fields have extended up and down the hills. Today its size is stabilised. The most striking change though is the appearance of irrigated fields: either as one large area, downstream of the dam, usually green for an extra cropping season (Figure 25); or as private individual gardens, close to the villages, fenced in with live-fencing for the older ones, or barbed-wire for the more recent ones, and lush green all year round (Figure 26). Four main zones can be defined to describe the land use: the forest, the dry-land fields, the dam irrigated fields and the localised pump irrigated fields.

The social organisation

The semi-feudal organisation lasted until very recently. Embedded in the caste system, it has left strong prints on the current social organisation, of which elements are described in § 2.3. They influence different families' access to land, water and capital, as well as opportunities such as education. They also condition the relations between different members, the perception of one another and hence people's aspirations.

The use of resources

The cropping and livestock systems have not changed that much in nature, although over the last 30 years, a few new ones have appeared and a few have disappeared. Today's ones can be classified as dry-land or irrigated cropping systems, and livestock systems (§ 2.4).

From the transformations studied here, the main dry-land cropping systems are:

- CS1: ragi and intercrops, which remains the main dry-land cropping system;
- CS2: groundnut and intercrops; this cropping system appeared once the ragi yields had increased greatly, allowing a much wider part of the population to dispose of the necessary land to grow other crops;
- CS3: horse-gram, a cropping system used on a small proportion of the land, usually poorly productive for other crops;

- CS4: red-gram, a cropping system that has also developed since the ragi yields have increased, but not on very important acreages;
- CS5: the ragi and intercrops CS, with a supplementary early season crop of sesame; this CS used to be more frequent, but might be becoming popular once again.

The irrigated cropping systems are numerous, but the main ones for private pump owners are:

- CS6: mulberry used for silk making; CS7: banana;
- CS8: vegetables, which will not be detailed in this study, because it is in fact composed of many different cropping systems (all kinds of vegetables are grown today) practised by just a few farmers.

In the dam irrigated zone, the principal cropping system is:

- CS9: paddy followed by ragi, which has been left aside, so as to concentrate on the CS for which water is guaranteed each year, unlike with the dam water (§ 2.4.4).

As to the livestock systems, they can be defined as:

- LS1: Hallikar zebus, a livestock system for which the practices have changed very little, although the number of animals has significantly decreased;
- LS2: land race buffaloes, which have followed the same trend as the Hallikars;
- LS3: land race sheep; LS4: land race goats;
- LS5: cross-bred cows, introduced very recently, with the set-up of local dairies.
- Several cropping systems have disappeared, such as kodo and little millet. Other ones have appeared, but so far on small surfaces, thus are not studied here. They include sweetcorn, cow-gram grown separately, or sugarcane on irrigated land. Perennials like mango and coconut trees are not detailed either.

The changes in the management of the resources available to a family that concern these cropping and livestock systems include:

- a huge increase in the water consumption, probably causing an overall drop in water tables (dropping water levels in open-wells have been frequent);
- a decrease in the number of animals, therefore a reduced transfer of organic matter from the forest and scrub areas to the fields; this is particularly accentuated on the large landowners' land, as they had many animals; sometimes there has been an actual increase on the smaller landowners' land, as their numbers of animals have quite often increased (§ 2.2.1.4);
- an increase in the export of organic matter through the extension of cultivated areas, and the increase of land productivity (increasing yields of dry-land crops, and introduction of irrigated crops);
- a decrease in the practise of applying tank silt to the fields and hence of some balancing of the losses due to erosion;
- an increase in inputs from outside the area: fertilisers, pesticides, seeds, cattle food for the cross-bred cows; this last element can partly counter the increase in

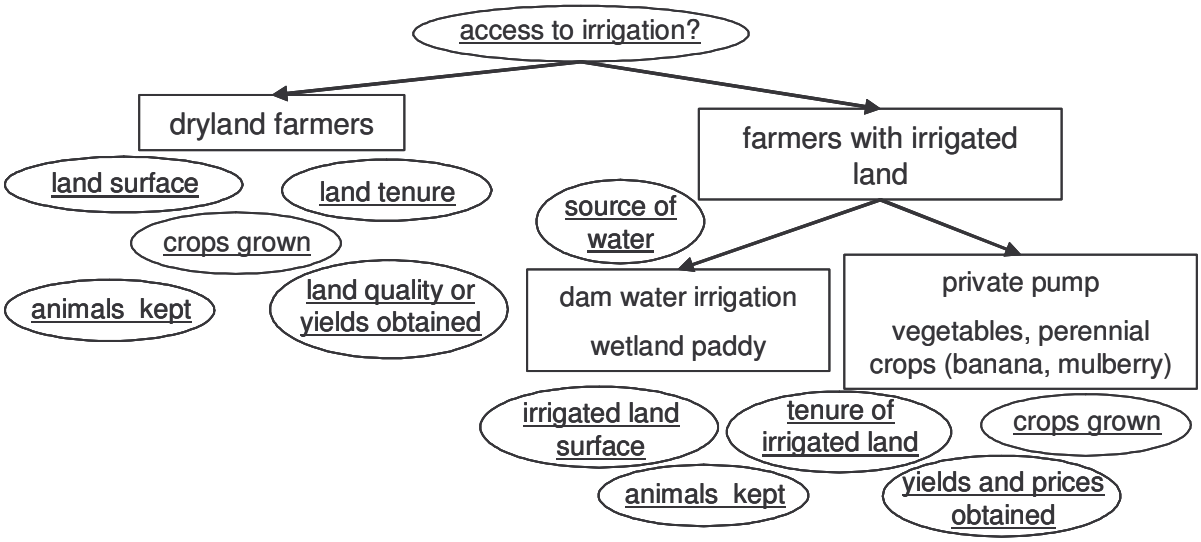
exports of organic matter, but represents a cost, both in energy for transport to the area and money, that could possibly be avoided.

Within a long term perspective, these changes present a certain number of risks and must be kept in mind. Green Foundation is encouraging farmers to change their practices in the opposite directions, or to find ways of avoiding the negative impacts of these changes.

The factors differentiating farmers today

The possession of land and animals was certainly the most determinant criteria for understanding farmers' situations up until 30 or 40 years ago. Large landowners often had more animals, hence the land surface owned could nearly be a criterion in itself for establishing a classification (§ 2.2.1.2). Moreover, inside any of the categories that could thus have been defined, the farmers would have belonged to relatively homogeneous castes and had access to land presenting similar characteristics in terms of quality. Today, to establish a classification of farming systems and look at the situation of the farmers within each (as done in § 2.5), it seems pertinent to firstly divide farmers according to their access or not to irrigation, as this is determinant for their choice of crops (Figure 28).

Figure 28: Factors of differentiation between farmers today



Within the non irrigated systems, the land surface farmed, but also the land tenure, and the quality and location of the land will be essential (Figure 28). Not only will this condition the amount of ragi that can be grown, but also the amount of land that can be used for growing other types of crops. The possession of animals, with types and number is another important factor. They have significant income generation potential or "savings account" type of functioning. The milk-producing animals must be singled out from the others, as the income generating potential is much higher.

For those with access to water, the source of water is important to produce pertinent categories (§ 2.4.4.1): farmers with dam irrigated land, grow mainly paddy; those with their own pump prefer mulberry, banana and vegetables (Figure 28). For all of these farmers, the land tenure and the extension of the irrigated land will be very important, and for farmers with a pump, the nature of the irrigated crops is another factor of differentiation.

2.3 INHERITED SOCIAL INEQUALITIES

The local population consists of a large majority of Hindus, with just a few Muslims and a few Christians. But the divides in the society do not only run along the lines of caste, so deeply set within the Hindu society. The hierarchies go further than that and are no doubt a sequel of the social organisation that prevailed up until 30 or 40 years ago.

2.3.1 Status-based recognition

How you will be treated and how you will be recognised in this area depends primarily on your status. And your status is a consequence of your caste, your gender, your age and your qualification or salary. Of these, you of course control neither caste, nor gender, nor age, and if you are born in the area, you do not have much chance of controlling what qualification you can obtain either.

Marriages

The marriages are arranged. They can only take place between two people of the same caste. This is one of the reasons explaining why the caste structure is still so strong today.

The procedure is usually the following. The parents use an intermediary to put them in contact with a family wanting to marry a child of the opposite sex. An astrologer of some kind is called upon to establish the compatibility between the man and the woman to be married. If this is satisfactory and the parents can come to an agreement, the wedding is planned.

The agreement includes fixing the amount and nature of the dowry. The land and capital of the parents being divided between their sons, the bridegroom's contribution to the new family is his part of the heritage. The woman's family are therefore expected to finance the wedding festivities and provide a dowry. The dowry usually includes goods and money. A few years ago, the goods would have been sheep or goats, or a cow, along with some clothes and other useful equipment. Today, it often includes a watch, a chain and a motorbike for the new husband.

The dowry system used to concern mainly the upper-castes. It is becoming more generalised and the total sum required by the woman's family is increasing fast. It has always been a burden on poorer families, who had to borrow the money (Figure 20). Today, despite many more families generating a little income, the huge sums that a dowry can represent makes marrying their daughters crippling for many people.

"Will you not take her with you when you go?" asked the woman next to me on the bus, her little girl sat on her knee. *"How can I ever marry my 3 daughters?"* a question to which she did not expect a reply. (Aralagadakalu to Kanakapura, June 10th 2006)

The sums involved increase as one goes up the caste or salary scale. At many levels it is far over what families can afford. For the lower castes, Rs. 20 000 is common; an intermediate level is now frequently Rs. 50 000 to Rs. 100 000; higher castes often have to spend Rs. 100 000 to Rs. 200 000.

Marriages that have been decided by the future husband and wife are very rare. In that case, they sometimes occur between people of different castes. Whatever the case, they are called *low marriages*.

Women have no status as unmarried women. Not marrying one's daughter is therefore criminal (box "Marriages"). It would be proof of a lack of love or care towards her. It

becomes harder to find a husband as the daughter gets older. The ones who do not pursue their education are often married when they are 16, rarely after 18, and it is not uncommon for the bride to be as young as 14 years old. After the wedding, the new wife will go to live with her husband and his family. There, a large part of the house work and responsibilities will now befall her (box "Family composition").

Family composition

When a young woman or young girl is married, she usually goes to live with her husband. Exceptionally, if her parents have no sons, her husband might come to live with them, to take over the land once they become too old to manage it themselves.

In the more common situation, she moves in with her husband. If his family becomes too big, the land and property can be divided between the brothers. The parents then live with their oldest son and wife. The brothers have a new house built for them and their wives, or the existing house is split into parts. If they are too young to get married, they continue to live with their older brother and their parents. Whereas daughters in the family are usually married between 16 and 18 years old, the sons often not until they are close to 25.

A family can thus be composed of just 2 active members if the couple is on their own with their children. But it can also contain up to 5 or 6 active members, if there are also the husband's parents, and if there are several of his brothers still living with them. Today, the number of children per woman is much reduced (box "Family planning").

However, the need to have a son, as inheritor of the land, sometimes pushes families to have a 3rd child if the first 2 were daughters. This can put the family in an even more difficult situation, be it just to afford their schooling. If the 3rd one is another daughter, the parents can despair of being able to marry them all. It creates an imbalance in the number of boys and girls born, even without supposing any elimination of baby girls. Probably more dramatic a consequence, it contributes to the situation were sons are desired and daughters a burden. The relative status and worth of men and women is further pulled apart (§ 2.3.3).

The Hindus are split into innumerable castes. In the area, one's cast is still of the utmost importance and figures among the first questions that will be asked about a newcomer. The main castes in the villages studied are, in roughly descending order of hierarchy, the Lingayats, the Vakaligas, the Acharies, the Lambanies and Iruligas and various other casts classified as "Backward castes" (BC) or "Schedules castes" (SC). In the area, many of the BCs and SCs have crossed the border from Tamil Nadu.

The hierarchy is imprinted via notions of purity and cleanliness. There is a whole scale of vegetarianism: the purest who consume no eggs or meat, next those who eat eggs, then those who eat fish, followed by the people who eat chicken as well, and lastly those who eat all kinds of meat, except of course beef. Moreover, someone from an upper caste will not eat in the house of any person of lower caste. Meat-eating is still sometimes regarded with disgust by the higher castes.

Labouring work is also linked to status. Higher-caste families will not do labouring work, even if they need the money: it is considered degrading and is linked to the lower castes. Intermediate castes do not like admitting in public that they have to resort to such work.

2.3.2 Land and capital: the caste divide

Because of the historical heritage, the current land tenure has strong links with farmers' caste. As can be seen on Figure 19, most of the land in the area was initially owned by the Lingayats

and the more numerous Vakaligas. They have been affected, like the others, by the dividing of land at each successive generation and many of them today have small landholdings of 4-5 acres. However, all of the larger landholdings still belong to these 2 castes and most of the very small landholdings, of less than 2 acres, belong to the lower castes.

Private land ownership and different forms of land leasing

The different forms of land ownership practised in the area are the following:

- **ownership** - the owner disposes of full rights on the land; the right to use the land as he chooses (usus), the right over the produce obtained from it (fructus) and the right to dispose of the land as he sees fit (abusus);

- **tenancy** - this is used principally for irrigated land; a fixed sum is paid as yearly rent for the use of the land and for benefiting from the produce; or in some cases, the crop is set, and the owner only has the right to the produce (e.g. mulberry crops);

- **share-cropping** - the share-cropper receives two thirds of the produce in general, and usually the right to use the land as he sees fit; in some cases, notably for irrigated or perennial crops, the owner imposes the crop, leaving the share-cropper with the right over his share of the produce; if the owner supplies the inputs (seeds and manure), he often receives two thirds of the produce and the share-cropper one third; the produce can be divided equally when owner and share-cropper pay half and half of the cost of the inputs;

- **long-term lease** - in exchange for an initial sum paid to the owner, the farmer leasing the land is granted the rights of using the land as he chooses and obtaining the produce; the land is returned to the owner when the owner returns the initial sum; this is usually used by families to obtain a lump sum of money, instead of or on top of taking a loan.

Private ownership is the most common form. The land is then transmitted from father to sons, as was previously the case (§ 2.2.1.3), with each son receiving an equal share. There have been government measures to incite people to put land in the names of their daughters, but these measures are not known about locally, or have been ineffective.

Beyond the number of acres owned is another very important inequality: as explained previously, the lower castes acquired land later, so that it is of poorer quality usually (Figure 24), being closer to the forest, on steep slopes, with poor soil, etc. They have little chance of getting as good yields as the upper-caste farmers who have fields with better soil, closer to the village. Again, this must be moderated a little, like most sociological differences: some of the upper castes are part of the disadvantaged landowners, usually because they arrived in the area later, or their family was to big at one point and had to clear extra land in the forest; all of the lower-castes do not face all of these handicaps, although rare are those with land that has all of the advantages.

Moreover, because of their smaller areas of land, the low-castes more frequently resort to the lease of land. The rules in place have stayed the same: usually, 2 thirds of the produce for the worker and 1 third for the owner, although there are a few variations if the share-cropper does not supply all of the inputs (box "Private land ownership…").

These variations illustrate the value of capital. Indeed, they mean that the 3 shares appear to be split roughly according to the following rule: one for the landowner, one for the worker, one for the input supplier. The work therefore receives one third of the money generated; and the investment necessary for obtaining the products receives the same quantity. For ragi growing, the cost of the inputs is approximately equal to half of this extra return, so that if the

landowner supplies the inputs, he obtains 100 % interest on the price of their purchase over the growing season. It would be interesting to know how widespread such a situation is in the area.

The vulnerable situation that the more marginal farmers were and still are in, profits to those who detain the capital. Labour remuneration might be better than it was (§ 2.5), but it remains low; capital remuneration remains high, as the applied interest rates also illustrate. The capital detainers remain mostly higher-caste families.

The lower-castes' needs or obligations of year-labouring, that lasted until so recently, meant that most only started having any hope of being able to accumulate capital some 20 years ago. They were dependant on the higher castes for loans, to cover their food requirements on bad years for example, giving these latter families a lot of power and no doubt explaining why capital remuneration was so high. What with their low acreages and poor soil, their situation has stayed very difficult (§ 2.5). They tend to have much fewer animals than higher-caste families. Significant numbers still do not have their own 2 cows for ploughing. The lack of capital for investment remains a strong constraint for them.

The creation of SHGs, or the existence of cooperative banks or government run funding schemes, that provide low interest loans, can, in that respect, be of much help (box "Loans"). They have enabled the purchase of a few animals over the last few years: several sheep or goats, or more recently a cross-bred cow.

Loans

The functioning of the loans obtained locally is also an inherited system. The larger landholders had the monopoly of credit or surplus foodstuffs for a long time. Very high interest rates were applied when loans were issue to the labourers, who had no choice when it came to getting enough food to cover the gap before the next harvest, or to marrying a daughter. These interest rates have remained: 3 % per month is the minimum, a very favourable rate by local standards; more commonly it is 4 %, or, if needed urgently, 5 % per month.

People can sometimes get access to cooperative bank loans. There are also many SHGs that have been set-up in the area. Both of these structures, the development of which has received government support, offer loans at 1 or 2 % interest per month. This is considered low. Some function very well, others encounter problems.

As to access to water, the caste divide remains: those who have irrigation possibilities are usually higher caste families. A few lower caste families lease a little irrigated land, but most of the pump owners belong to the higher castes. In the dam irrigated zone, some lower caste families do have access to irrigated land. But those with access to irrigation, as a proportion of the total number of families of a particular caste, remain fewer than for higher castes. The average acreage of irrigated land owned by a family of lower caste is again less.

2.3.3 Men's and women's work; men's and women's pay

Many of the tasks that are carried out are gender specific. All of the cooking and housework, including fetching the water is the woman' responsibility. She will also be expected to do the weeding, transplanting and any harvesting jobs, such as that of cow-gram, that require being bent in half. The woman will usually cook the food for her husband and any other workers working in their fields, bring it to the field, then continue the work there, along with the others. It is only the men who ever do any of the animal drawn work (ploughing, harrowing,

etc.). They are also the ones who carry out any digging that needs to be done. Trips made to the local towns to fetch inputs or sell produce are also in the man's realm; women do not often travel elsewhere, and only very rarely on their own.

On people's own land, as opposed to when it is done as paid labour, there are some exceptions to these rules. For example, if necessary, the men can sometimes be seen doing a little clearing of waste organic matter after the field has been ploughed, alongside their wives. There are also many tasks that are not gender specific. They include most of the harvesting jobs.

The daily wage for men is higher than the year labouring wage: the ordinary daily pay is Rs. 50 or 60. There are the tasks that require animals and specific implements, such as all the ploughing, thinning, etc. For these, the worker who comes equipped receives around Rs. 120 per day. The women on the other hand are paid only Rs. 25 or Rs. 30 per day. Some tasks, which are not gender specific, receive equal pay. Such tasks include the harvesting of ragi or paddy, or the transplanting of paddy. Many of the workers organise themselves into teams. They often negotiate a fixed amount for the entire job. Because of the shortage of labourers, the daily wage obtained is higher than at other times, when there is less demand.

The reason, advanced by farmers, for this difference in basic daily wage, is that women do less work than men in the same amount of time. This is difficult to believe. For a few jobs, for which muscle strength is determinant, they might require a little longer. For others, for which they are well practised, they are much faster. Most of it boils down to habits: I have seen men struggling, carrying the couple of buckets of water that their wives usually fetch daily.

However this difference in wage acts along with a general attitude and belief whereby women are inferior. *"Why do you want to talk with them? They only know about weeding and cleaning."* (Guluvadi, June 26th 2006), sums up a prevalent belief whereby women are not worth much more than that and certainly do not have a valuable opinion.

The hierarchy is so well marked, that it is imbedded in the way people address each other. Not within all of the castes, but within many, the wife will use the polite "you" form, as is customary to mark respect in the Karnatakan language, to talk to her husband; he will reply using the common "you" form, which is the one used to talk to children or to people considered to be below you. Conversations thus run something like: "Would you like to take your meal now?" from the wife to her husband, to which he might reply: "Yes, bring it to me here."

Alcohol

The drink, arak, is distilled locally, in one of the villages. One shot is sold at Rs. 12. One of the local shops, covering 4 villages, sells approximately 200 shots per day. There are therefore probably between 100 and 150 men drinking regularly, along with a couple of women. This is in an area with approximately 400 households. The gross return for the drink sellers is around Rs. 70 000 per month. The money no longer available for the upkeep of the family, in a household where the man drinks daily, is Rs. 360 if it is one shot per day or Rs. 720 per month if it is two shots: over Rs. 4000 / year in the first case or over Rs. 8500 / year in the second case.

The men's attitude is problematical. But it can become much more so when he has drinking habits. According to the women suffering from the consequences, the drinking has increased in the last 8 or 9 years. It now concerns probably nearly 20 % of the men in several of the

villages (box "Alcohol"). Associated with this are many reports of regular violence on their wives. This seems to be true of a lot of villages in the region (box "Violence").

Violence on women

"I went and fetched my daughter and brought her back to live with us. She could not take it any more. She was very unwell. Her husband beat her. He drank. Don't you think that was the right thing to do?" (Aralagadakalu, June 17th 2006)

"It is no good coming back later. My husband will be home and he will be drunk by then. I will have to be in the house to cook for him." (Veereianadoddi, May 22nd 2006)

"We have 2 acres of land. But my husband's drinking has got worse over the last 6 or 7 years. He does not do any work any more, so we do not farm them. I have to keep the sheep. And if anything happens to me, no one will come and see." (Aralagadakalu, June 14th 2006)

"I must go back and cook for my husband… All my back and arms hurt. Yesterday, he came in drunk and started moaning that I had not prepared the food. He hit me all over." (Veereianadoddi, July 12th 2006)

"I had 1 son and 1 daughter. My daughter died. She had been very unhappy for a long time. Her husband drank and was violent." (Aralagadakalu, July 6th 2006)

"My mother? She committed suicide. She had had enough. She knew that they would never stop: my father's drinking, my father's violence." (Veereianadoddi, July 2nd 2006)

"When my son is older, we will move to Bangalore. We can find work there. I do not want to farm here any longer. My husband works as a trader; he goes off for months at a time. When he is here, he is drunk most evenings. Then he complains or beats me. I could put up with that. But he will start questioning why I have spent so much this month. Look I wrote down everything. There were seeds and manure to buy, the school fees to pay, the electricity bill. Next he will be claiming money from me again, saying that I am farming his land." (Veereianadoddi, July 23rd 2006)

The women are not without their part of responsibility in the difference in status that is so profound. Although some have little choice, when they are victims of violence, others have husbands who might allow for a little improvement. But amongst those, many, by their attitude, will dissuade their husbands from doing any of "their" work. It might be hard for the husband to help with any of his wife's work, even when she is ill, because of the way he will be perceived by others; she will be concerned that she will be seen as a bad wife if she lets her husband, or a guest, help her. And so Bourdieu (1998) appears to be right, when he says that men and women share the responsibility for perpetuating masculine domination. It is deeply imbedded in attitudes and habits and is going to take a lot of energy to change.

The woman's daily house tasks, of which the cooking is not the least, and the fetching of the water cannot be excluded, mean that she cannot physically do much more than 8 hours of field work. At times of the year when that much is required, she will start the day at 5 or half past, as it gets light or before, and finish around 8 or 9 in the evening, well after dark, ready for bed.

The days can be very busy for the men as well, but even during the heaviest work periods, they seem able to find a few hours to sit and talk in the afternoon or in the evening. As many women's days are full for good stretches of the year, the men usually carry out the daily routine jobs with the cows. The milking, fetching of the straw or fodder, and taking the animals to the field, require a couple of hours daily (§ 2.4.3.2). As such, and with their few

hours of rest, the men are not available for more than 8 hours of other field work per day either.

The cows get a rest on Mondays. For religious reasons, this is a day-off for the sacred animals. People however work. All through the year, both husband and wife work 7 days a week when necessary. At quieter times, they can take a few days to go and see family elsewhere, or make a day trip to Kanakapura, but at busy times, it is non-stop.

2.3.4 Education opportunities: the class divide

In the different European countries where I have lived, there has always been a social bias in the access to education: on average, a much higher percentage of children from families with an educated background reach higher level qualifications than those from working-class families; the children from the lower-class families form a greater proportion of those leaving school early. Despite the obvious inequality, this is very difficult to change. It is not surprising to be able to witness it in this area of Southern Karnataka as well. The teachers say quite clearly that the children of lower-castes usually struggle more. They probably receive less stimulus at home, and their parents give less importance to school or homework, or are often absent, because they have to go and work for other people.

However in this area, there is another aspect to the injustice, one which is easier to put right. There are no public schools for children above the age of 13 years-old. The first option is to travel to Kanakapura, which takes 1.5 hours in the morning and the same again at night. The other possibility is to go to either of the private schools, in one of the 2 larger villages of the area, just a short bus ride away (less then 20 minutes in all cases). There, the number of children per class is well above 60, sometimes up to 80. Many families cannot afford the fees and the cost of books, school uniform and bus-pass for their older children.

After 16 years old, it becomes more difficult. They now have no choice but to travel daily to Kanakapura, or find a room to rent there, if they wish to continue their education. The costs increase still further with the bus or the rent to pay.

Most of the children study up to 13 years old. A few must help their parents with work and so drop out earlier, or do not attend school daily; tasks include goat or sheep keeping, as well as help with some of the fieldwork. Only about half of the children study further until 16. The ones who pursue from 16 to 18 years old are few and far between. Many more children who would like to continue studying, but their parents cannot afford it.

Family planning

Two generations ago, families usually had 5 or 6 children, or often a few more. Without going into the details of the problems for the women giving birth to so many children, this obviously created difficulties for the numerous families whose landholdings were already small.

Today parents rarely have more than 2 or 3 children. The government's family planning policy, which has involved social workers moving around the villages, awareness campaigns and access to sterilisation operations at nearby hospitals, has been very effective. Proof that where there is a will, responding to a true problem, there can be a way.

It has relieved families. But the following comment illustrates just what a burden the cost of schooling can be: *"Three children are too many. Maybe the younger two will be able to study."* (Aralagadakalu, July 6th 2006).

As a consequence, the local teachers are not local people: there are not sufficient students from the nearby localities qualifying at the required PUC level. Potential teachers from all over Karnataka come and sit the teaching exams in the Bangalore Rural district, as they are easier to pass than in their native districts where candidates with a PUC are numerous.

The situation has improved. There were previously no primary schools in the area. At that time, only the children of families who could afford to pay a tutor could access a primary education. These children would then go off to study at Kanakapura once they were old enough. Today, the existence of primary schools has been of great benefit to the children of the area. The children also receive a free meal there every day, funded by the government.

However, it must be highlighted that some of the teachers have up to 50 children of different ages. Despite this, in certain cases, being due to other teachers who have obtained a transfer to another area, the quality of the learning is decreased. Such transfers should be immediately compensated for, and classes that always function with such high numbers of children should be split into 2. Moreover, the free school lunches can become rice and turmeric for a whole month when the state does delivers only rice, without the dhal or necessary money for vegetables, at the start of the new school term. Added to the fact that schooling opportunities end at 13 years-old for many of the children, there is still much to be done to improve the education facilities in the zone.

Violence in schools

This is not an attack on teachers. I do not know how you keep 50 children of different ages working quietly, if you are the sole teacher in the classroom. However, the routine use of the stick as punishment to miss-behaved or noisy children, over and beyond psychological damage that might be done but that will not be discussed here, only serves to legitimate violence of the higher-status members on the lower ones. One cannot help but wonder if this does not contribute to the violence that men feel legitimate in committing on their wives, for example.

2.3.5 The status and power of officials

The government officials benefit from a definite respect from the part of the inhabitants. The teachers are a prime example. Their qualification levels and reasonable salary guarantee them a status above the common farmer. It fits into the importance that the society grants to hierarchy.

The government officials often abuse of the power that their position gives them. The most striking example of this, is the taking of under-the-table payment for services that they should provide free of cost. The ones that came to my attention directly included the doctors, who charge a regular fee (box "Health and hospitals") for a service that should be free. Another frequent case of such payments is to the electricity officials, for the connexion of a water pump to the mains. Not only is extra payment required, but the officials can make it deliberately long and complicated, to push the price up a little, and cause people to come again and again to ask for the service. They probably do not realise the distress that it can cause for those in particularly unenviable situations, like the farmers who are already in debt up to their necks. Whatever the case, it is not acceptable.

Health and hospitals

The study zone has one hospital. It should be free to get a consultation there. In fact it costs Rs. 10. There are no operating facilities. For serious interventions, people must travel to Kanakapura, one and a half hours away on the bus.

Just one doctor is present, most days of the week. When he is not there, people go to see other private doctors or nurses in the village. There are also a number of ayurvedic doctors in the different villages. Many people consult these first, before resorting to the "conventional" doctors if the problem persists or is deemed more serious.

The health policy has made some important improvements to people's well-being: the digging of bore-wells and awareness campaigns on the quality of water have meant that many water-borne diseases have nearly disappeared. There are no alarming health problems in the area. Nutritional deficiencies are not obvious. There have been no outbreaks of malaria. TB and gout are frequent though.

Because of the isolation of the zone, problems, such as those arising in pregnancy, can be fatal. Deliveries usually occur at home. In case of an emergency, transport possibilities are not available, or too costly.

The recent episode of chikungunya highlighted some other difficulties: the little hospital was full everyday. The doctor was run off of his feet. The needles were re-used with just sterilisation by boiling. Probably sufficient, but with cases of aids in the area, it does not seem a risk worth running. Aids has appeared recently, amongst some of the migrant workers, although cases are usually covered up by the families.

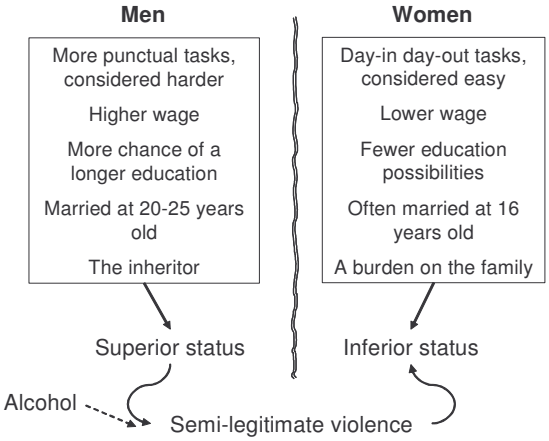
The difficulties of the functioning of the dam (§ 2.4.4) are another case in point. The gate which is the cause of so much water wastage should not be difficult to fix. According to farmers in the area, it has never been done because nobody can make any money out of it. It is more interesting to have a few engineers come and study the layout of the canals, to determine how they could be improved. It allows them to justify their salary and ensure themselves some work. But until the gate is fixed, there seems little point in working on the canals. Whatever the case, it is detrimental that so much water is wasted and is a sign of malfunctioning within some government bodies.

The money for the organic village project also suffers from the day to day corruption that prevails in many a government office. It takes much longer than it should for the money to arrive. On the way are numerous complications and several people take their cut. All of this complicates the field work, not easy to start with, and wastes public money.

2.3.6 Strong social determinism on families' hopes and opportunities

From the elements that have just been discussed, the pressures are strong to conform to the accepted way of behaving, as regards the payment of a dowry to marry one's daughter, or the respect of the social hierarchy for example. The poorest families' aspirations will firstly be earning enough to improve their diet, their upkeep and afford health care; but these will be closely followed by the wish to be able to pay their children's education and their daughters' dowries. For those better off, the desire to invest to improve their situation, and the need to pay labourers to conduct part of the work, means that the income generated is rarely much above their needs (§ **2.5**). This is even more the case now that many new consumer goods are arriving and dowries are increasing. Economic preoccupations therefore remain at the forefront of most farmers considerations.

Figure 29: Men and women's lot



Women are more trapped than men. Their inferior status means that they often follow some kind of a destiny laid out by their parents and then their husband (Figure 29), and imposed through symbolic and sometimes physical violence. Their hopes usually lie very much with their children, for whom they want a good education and a good husband or wife. For their daughters, no alternative is seen, by either the mother or the father, than paying a large dowry.

The social organisation imposes very strong constraints on the families of the area. The access to resources and therefore the opportunities for the future are often conditioned by the family's caste (Figure 30). The poorer lower caste families, with fewer resources to draw upon, are much more vulnerable in the face of the numerous agricultural risks that exist for all the farmers of the area.

Figure 30: Caste-based opportunities for improvements

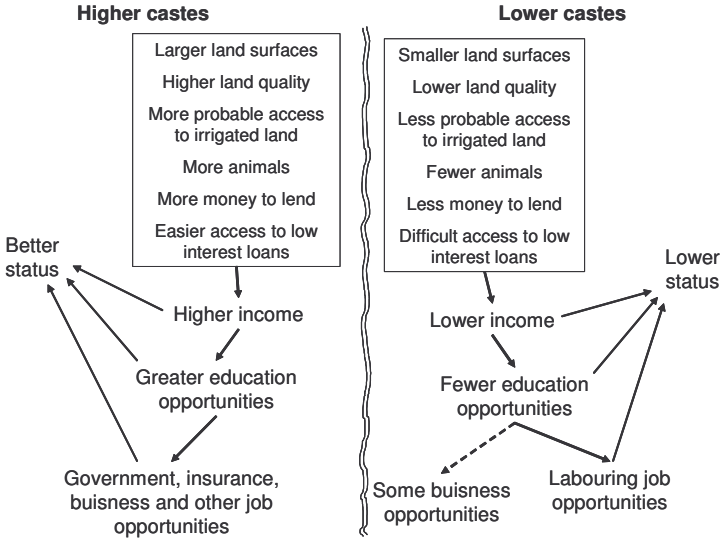
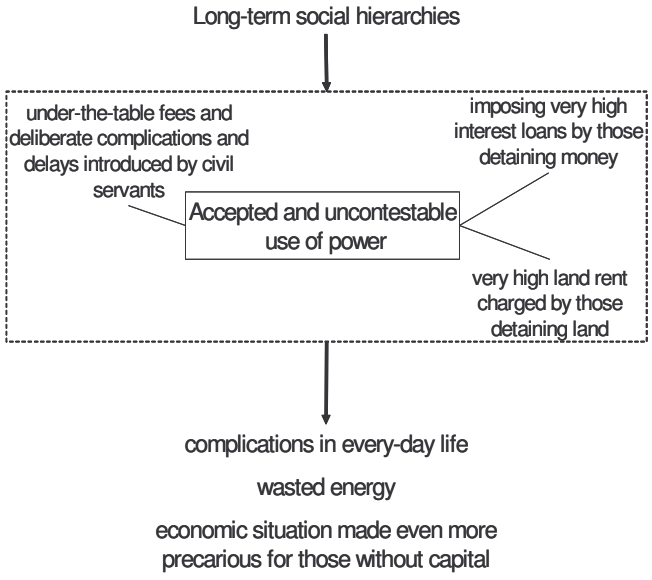


Figure 31: Some consequences of the strong social hierarchies



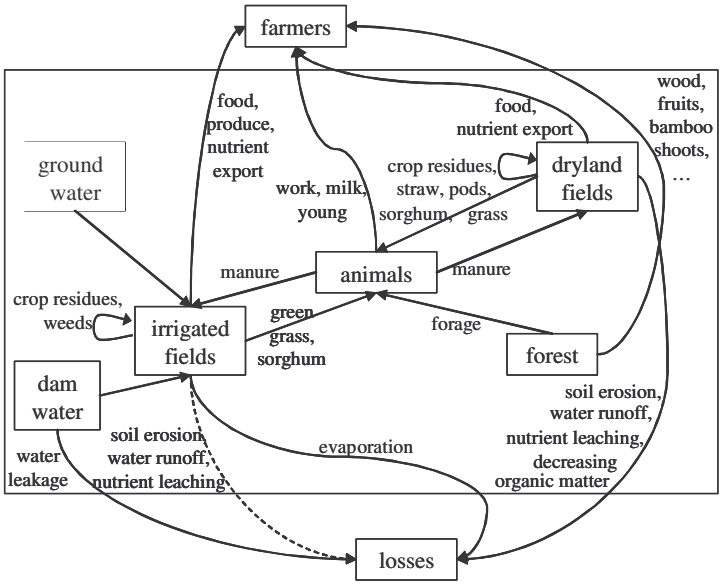
The long-term social inequalities that have existed mean that the accepted status and rules governing exchanges remain a handicap for those at the bottom of the income and resource scale (Figure 31). The money generated by lending money, leasing land, or charging under-the-table fees, could be regarded as an abuse of the fortunate situation some higher-caste families find themselves in. It is however accepted, and leaves few opportunities for lower-caste families, who suffer the complications caused and may have to contribute extra energy to try to improve their situation, or sometimes just to maintain their family.

These points must be kept in mind when trying to understand what choices farmers have and what choices they make. Of course, they pay attention to the quality of their food and their environment, and are aware of some of the degradations that have come about, but these are not always at the forefront of their worries.

2.4 PERSISTING INDIVIDUAL MANAGEMENT OF AVAILABLE RESOURCES IN A CONSTRAIGNING ENVIRONMENT

The general organisation of the farms in the area was, until very recently, as described on Figure 32. There were few external inputs; the livestock systems were the main means of restitution of organic matter and nutrients to the cropping systems; the cropping systems and the forest were the main sources of food for the animals. The losses that can undermine the long-term sustainability of the system are also shown. They concern mainly the soil fertility and water sometimes wasted. The outputs from the cropping and livestock systems firstly provide food for the family. Any surpluses and some specific products are sold.

Figure 32: The resources accessible to farmers, their use and the main causes of degradation



The last 15 to 20 years has seen the introduction of chemical fertilisers and pesticides, as well as new cows fed mainly on purchased feed, so that some of the practices have changed rapidly (§ 2.4.2.4). With the introduction of irrigation, the consumption of water has greatly increased, creating the risk of dropping water tables, but the appearance or development of new crops. The farmers with irrigated land can function quite differently. They sell a large part of their produce, usually use more external inputs, but also produce lots more vegetable matter. The organic farmers in this category recycle much of this vegetable matter, either via the various composts, or directly as mulch.

Despite the general Figure 32 and Figure 40 being valid, individual cropping and livestock systems will present many differences. Moreover, each farmer's choice of cropping and livestock systems and adopted practices is a compromise between the resources available to the family, the family's needs and the practices they would like to adopt. It is therefore necessary to look in detail at the functioning of the different systems, and how they are managed by various farmers. There are many constraints for the farmers here: often small land surfaces and different land quality, a lack of water for half of the year and uncertain rainfall the rest of the time, predators on crops, etc. These factors condition the options that farmers have and must be considered alongside their aspirations and the risks of resource degradation to understand what possibilities there are for introducing changes.

As will be explained for the different resources and the different cropping and livestock systems, there are still very few collective regulations on resource management. The free-roaming of the animals is about the only one. The forests are accessible to all, but are managed by the forestry department. Water has only recently become available and there are no common decisional processes. The dam water is shared between many farmers, but is regulated by a government official. As to the cropping and livestock systems, there are some exchanges of labour, but mostly each family manages their own.

2.4.1 State-controlled forests

Over the last century, in all of the higher central part of the zone, the cropland has encroached considerably on the forest, which is the property of the state. For some of this new farmland, farmers have official papers. The parts for which the farmer has not acquired documents are considered to belong to the government. Just recently, forest officials have redefined the boundary, marking it with stone cairns. The land which is now within the forest must no longer be cultivated, so that the forest can grow up again. This of course affects mainly the small farmers of lower-caste. Some will lose all or significant parts of their land.

Resources from the forest

Elephant hunting, exporting wood of species such as teak or sandal, are all band. There was previously significant smuggling of tusks and wood. Government intervention has apparently put a stop to this.

People fetch wood from the forest. But here, where the forest extends all around, it does not seem to constitute a real pressure. When possible, people often prefer to cut a few branches from one of their trees, which are closer, so that the wood need not be carried so far back to the house. The forest is also an important forage resource for most of the animals kept by the farmers (Figure 32). They will travel extensively to the forest during the rainy season, when the fields are full of crops (§ 2.4.3). Families will also get some food from the forest. For most of them, this is not a regular supply, but will be a little extra fruit and vegetables, such as bamboo shoots.

Wildlife threats on crops

The forests are home for wildlife. Elephants and wild boar are among the animals that interact with man: the elephants are particularly fond of ragi and sorghum, or bananas, and the boar dig up any groundnut if they get a chance. Monkeys are also a problem, for the groundnut crops, but for coconuts and fruit as well.

The last 2 or 3 years has seen extensive damage carried out by elephants. Previously there were some rare reports of elephants having ventured into the fields, but over the last few years, the visits have been repeated and regular. They have had very heavy consequences for the farmers concerned. Those with fields close to the forest probably lost an average of half of their crop last year. But the elephants can come right up to the village, especially if there are bananas around.

In all of the villages, farmers must watch their crops at night to prevent them being damaged or totally destroyed by the animals. This concerns the groundnut for a week after sowing, and then all of the crops that present a risk, for the last month or last 2 months before harvesting. There is little social organisation to deal with this. People watch their own fields alone when boar are the threat; there is no taking of turns. For ragi and sorghum, where the elephants are the menace, the villagers do organise themselves into teams: alone, nothing can be done about such large animals that descend in herds. The men will travel out in the evening and sleep close to the fields, equipped with torches to light and drums to beat or small explosives to set-off. They come home in the early morning.

2.4.2 Dry-land cropping systems: land, water and soil constraints

Everywhere that is not forest, and where water is only available when it rains, the small fields extend down the hillside in terraces of variable size and slope. Some fields reach 1 acre, but most are less than 0.5 acres. They lie virtually bare from the end of the harvest in January to

the time of sowing in June or July. The residual stalks remain, but are gradually eaten by the animals, and in moister areas, various weeds push up. As soon as the rains end, the ground dries out and becomes very hard. The April and May showers will often cause a crust to form on top. These first rains are necessary for farmers to start the land preparation work.

The residues in many of the fields are evidence of the extent to which the main cropping system still dominates: most of them are sown with ragi (*Eleusine coracana*) interspersed with rows of mixed crops. Some fields contain groundnut (*Arachis hypogaea*) with similar rows of intercrops; a few have horse gram (*Macrotyloma uniflorum*) or red gram (*Cajanus cajan*) in them; close to the villages, mango (*Mangifera indica*) plantations can be found.

2.4.2.1 The inherited ragi and intercrop cultivation, to cope with the constraints

The cropping system based principally on ragi, in the midst of which rows of intercrops are sown, is the traditional cropping system of an area covering the South-East of Karnataka and neighbouring parts of Tamil Nadu and Andra Pradesh. Like its relatives, the minor millets, as well as sorghum, ragi is resistant to drought, but does need more water than them. Hence in drier regions, sorghum or the minor millets take over. This no doubt explains why it is grown in a restricted area of the semi-arid zone.

A small amount of groundnut and intercrops is included in rotation with the ragi. In some parts of the zone, groundnut has taken on a much more important role, as explained below.

The needs of farm and family in a single field

The precise nature and proportions of the different crops sown with ragi vary from one farmer to the next. The most common combination includes mixed lines containing cow-gram (*Lablab purpureus*), red-gram (*Cajanus cajan*), sorghum (*Sorghum bicolor*), castor (*Ricinus communis*) and often a little cowpea (*Vigna unginenlatum*). A small amount of mustard seed (*Brassica juncea*) is usually mixed in with the ragi and sowing niger (*Guizotia oleifera*) around the edges of the field is a frequent practice.

Thus the cropping system covers the main nutritional needs of the population. It provides a whole grain cereal that will be transformed into the local "ragi ball" (*mudde*) and will be eaten with a sauce containing either of the above pulses (box "The local diet"). Mustard is among the main spices, and niger is still used as a rich flavouring.

The local diet of a virtually vegetarian population: whole grain cereals, pulses and precious flavour and nutrient suppliers

The main food in the area is *mudde*, a very thick porridge made from whole-grain ragi flour, from which the coarser bran has been removed before the preparation. Once cooked, the paste is rolled into large balls before serving. The sauces that accompany it are based on one of the pulses grown by the farmers: red-gram, cow-gram or more rarely horse-gram. These are served at most meals.

The flavouring too is obtained mainly from local sources: mustard, large quantities of fresh or dried chilli, curry leaves from the neem trees in the village, tamarind picked from farmers' trees, or those growing wild. All of these are used daily and contribute significant quantities of important nutrients or beneficial compounds to the diet, not least of all vitamin C. A few purchased additions complement the flavourings: onion, garlic and some other spices.

The vegetables are mostly grown in the rainy season, on a small plot by the side of the main field. The principal ones are tomato, aubergine, chilli of course, some of the fresh beans towards the end of the rainy season (cow-gram and cowpea), and local green leafy vegetables, one resembling cress. Other green leaves will be picked wild, growing as weeds in the wet season, or in the irrigated fields, or on trees throughout most of the year; they are a precious part of the diet. Some of the families can afford to purchase vegetables, such as carrot or cabbage, that are brought in from elsewhere, Kanakapura usually. Simultaneously, such vegetables are grown locally and sold at markets like that of Kanakapura.

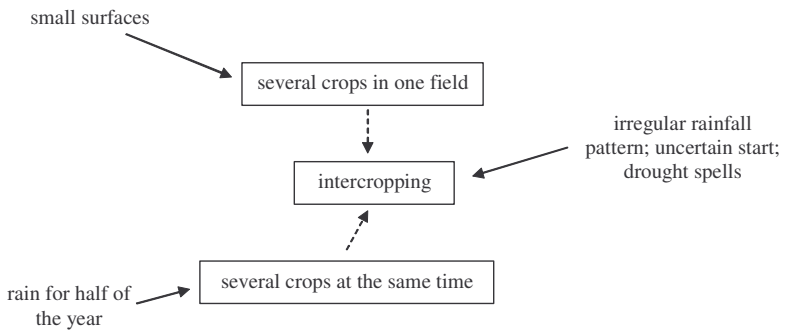
Oil would previously have been obtained from the niger. Today, it is replaced by groundnut oil, or even sunflower oil, the use of which is increasing. Niger continues to be consumed in a powdered form, combined with other ingredients as a chutney.

Since the set-up of the public distribution service, rice has also been introduced into the diet. Previously, other millets were used as alternative cereals and alternative crops to the main ragi. They have been replaced by purchased rice, supplemented by a little wheat obtained from the PDS. But according to the locals, if you want to grow strong, you should eat ragi…

Milk is drunk in tea or coffee. It is also made into a form of yoghurt (*mosru*) and eaten at meals, or drank as a refreshing drink (*majjige*). Other animal products are only eaten very rarely, and not by the upper castes. Eggs, chicken, fish and goat or sheep meat will be made into a stew by some of the castes. In ordinary families, meat is not eaten even once a week, but more often only fortnightly. As such, most of the essential nutrients must come from vegetable sources.

But this cropping system also supplies a large part of the food for the cattle, which are part and parcel of the system (Figure 21). Sorghum is grown to be distributed to the cattle as supplementary green food in the rainy season; the pods from the pulses cover extra energy requirements or particularly difficult parts of the year; and the ragi provides straw for the animals throughout a large part of the dry season, when grazing possibilities are meagre (§ 2.4.3.2). That leaves castor, which is turned into oil by the farmers themselves for use on hair, or sold directly to be made into engine oil.

Figure 33: Making the most of the available land and water



The development of this cropping system can be seen as a result of the constraints that farmers have to face in this part of Karnataka: a shortage of land for many of them; a rainy season which covers approximately half of the year; a great uncertainty as to the start of the wet season and the high probability of drought periods within the season (Figure 33). In answer to this, they have developed a cropping system that provides them with most of the produce they need for their family and the necessary cattle, in a single field.

Interactions between plants

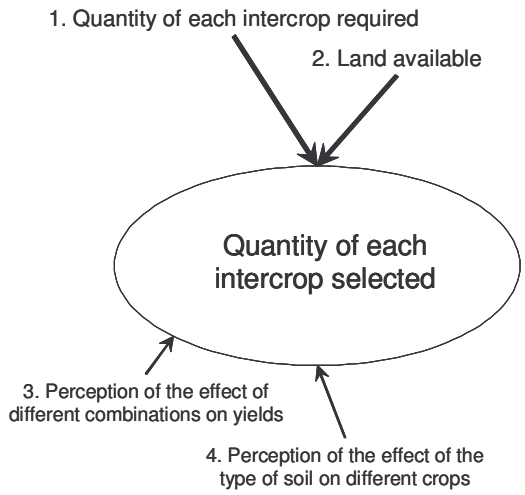
The farmers could cultivate small areas of each of the required crops. If that is not the case, there is almost certainly a comparative advantage in the combination of the crops in one field.

One such advantage is due to the difficult climatic conditions. If there is a drought in the middle of the season, it can occur at a critical stage for some of the crops. With many different crops, it is unlikely to affect them all to the same degree. Those that recover can benefit from the extra space, water and nutrients that will not be taken up by the others. Per unit of land, the productivity will be higher: if all the plots had been planted with separate crops, and some had failed, that part of the land would have been totally unproductive; the total quantity of produce obtained from the other fields would thus be less, coming from a smaller area.

On a good year, it is difficult to know the exact repercussions of the mixed cropping. There is competition between the plants; but is it more or less than between plants of the same species? No doubt some of the crops enter very little in competition with the ragi, and thus represent extra produce from the same field. There can also be other positive and negative interactions between the different species. In the case of the crops mixed in this area, the nitrogen fixing legumes probably have a stimulating effect on a crop such as ragi which requires significant quantities of nitrogen and phosphorus. Van der Tas (1986) discusses experiments that determined the best proportion of ragi and cow-gram to be mixed if a row intercropping practice is adopted. Depending on the location of the study, the best ratio varies, but in both of the experiments described, the combination of the 2 crops has a favourable effect on the yields obtained.

In the area, the ragi is sown in sequences of 5 or 10 rows usually. There are therefore differences in the total quantity of mixed crops included, due to this variable spacing between the inter-rows. Neither do the quantities of seeds of the different species included in the inter-row follow any set proportions, as farmers prioritise various ones. Cow-gram dominates in most cases (annexe 6), but a lot depends on the farmer's needs. Sorghum for example, which is grown mainly as green fodder for the cattle, will be adjusted depending on the number of animals owned.

Figure 34: Factors affecting farmers' choice of intercrops and their proportions



Farmers in the area talk of competition between red-gram and ragi. As a consequence, some grow it separately or only combine it with groundnut. The red-gram shades the ragi plants according to some, whereas for others the ragi hinders the red-gram development. But the practise of growing it separately, although it has increased, especially since the introduction of high-yielding varieties of this plant, is still not very widespread (§ 2.4.2.2). Most farmers continue to include red-gram with ragi.

Soil is another factor that affects the quantities of the different crops grown, as farmers have opinions about which ones grow well in different types of soil (Figure 34). For example, red-gram is said to prefer clayey soils, and on the contrary, on sandy soils, farmers may well sow a larger proportion of cow-gram and a smaller proportion of red-gram. Niger is considered to produce better on poorer soils: on richer ones the plant grows too tall and the seeds do not develop well.

The quantity of ragi seed applied per acre is variable from one farmer to the next: the difference can be four-fold (annexe 6). Depending on the soil humidity, the effects can probably be very different. The introduction of a 5-pronged sowing implement, which spaces the seeds more widely than the previous 8-pronged one, has apparently caused an increase in yields. The arrival of dap fertiliser and new varieties at roughly the same time, does however make it difficult to know how much of the increase is due to the implement. Transplanting techniques used in other areas produce higher yields, seemingly due to the wider spacing of the plants, as well as the extra care given to the seedlings in the nursery stage. Such methods are often carried out under irrigated conditions, making it difficult to be able to establish true comparisons. Green Foundation is helping farmers carry out experiments on the different sowing methods.

Gambling with the rain

If the rain comes early, most of the farmers sow early (annexe 6). This is considered best by many of them, as after October, the rains are no longer very sure: if sown late, there is a risk that the rain will have ended when the grains are meant to be filling. But they do not all give the same importance to the early sowing.

On many a year, the rains come late and early sowing is not possible. After some time, some will sow anyway, others will wait, all hoping that the rains will start soon. This was the case in 2006: at mid-August, farmers were still waiting for the rain; some had sown; some had not. From one year to the next, the sowing dates vary considerably.

A lot of necessary work

Ragi is a demanding crop. It needs a fair amount of nutrients, as mentioned previously, and a lot of work. There is the general soil preparation, to let the water infiltrate into the soil, which is usually done after the first rains in April or in May. Again, some will consider it very important to start the ploughing early, to allow a maximum infiltration of water into the soil. It will also mean that the intervals between ploughing are long, so that a mximum number of weed seeds germinate and can be destroyed. These farmers will also be meticulous about the preparations: the ploughings, clearing of waste weeds, adding manure early so that it is well incorporated and can continue breaking down in the soil, etc. Other farmers will not consider it makes all that much difference (annexe 6).

Compared with other crops, for ragi the ground must be kept very clean. The previous years' residues are collected up and burnt before the first ploughing. This is not done when the previous crop was groundnut, as these residues are considered to be beneficial for the ragi. On the other hand, the castor and sorghum stalks that are left in the fields after the cows have roamed them for a few months presumably require a long time to break down in the soil if they were turned in during the ploughing; and they might well create a nitrogen take-up from the soil after they were first incorporated, due to their high-lignin content - that much less nitrogen for the young ragi plants.

During the soil preparation, weeds will be ploughed over and collected up at least 2 times before sowing and often more. The crop has to be thinned twice to allow good development and tillering of the young plants. Next comes a banking, to weed between the rows, and to pile the soil around the base of the plants. It will also help reduce water loss by evaporation. The banking is complemented by a full weeding along the rows, around one month after sowing. There is then a gap, with little work, other than fertiliser application. Harvesting will be the next big work period, with the various crops being ready one after the other (Figure 35).

The implements used for the different soil preparation activities are described in annexe 3. Full details of the operations carried out for this cropping system are presented in annexe 6.

The work calendar can be shifted one way or other depending on the date of sowing. On Figure 35, the date chosen is a reasonably early one, at the beginning of July (annexe 6). There is a common practice of forming teams to carry out the work and especially the sowing, where the preparation of the soil, sowing and covering of the seeds must be done on the same day. In this way, a farmer will work with his neighbours to sow his fields in one or two days, before returning the favour by working in theirs on the following days. From the quantity of work that he and his family must carry out, it is as if the task was spread over a longer period (annexe 6). It must also be remembered that many tasks are gender divided. All this has been considered for the determination of the work peaks (annexe 6).

The weeding is the period where the need for external work first appears. Without relying on paid labourers, one woman can weed up to an average of 2 acres on her own, which represents 2 weeks of continuous work. If her husband or her children help her out, it can be increased. As can be seen on Figure 35, 4 acres will require extra labour at harvesting time as well. Just over 3 acres of ragi and intercrops can therefore be dealt with by a family with 2 active members, as long as a little help is available for the woman to cope with the weeding. For larger surfaces, external labour will be required. Farmers with low incomes will reduce the external labour requirements to a minimum. Those able to generate sufficient incomes, mainly of higher castes, will gladly pay labourers for tasks such as weeding and harvesting. The labourers are nearly always of lower castes (§ 2.3.1).

2.4.2.2 A variety of cropping systems despite such widespread ragi fields

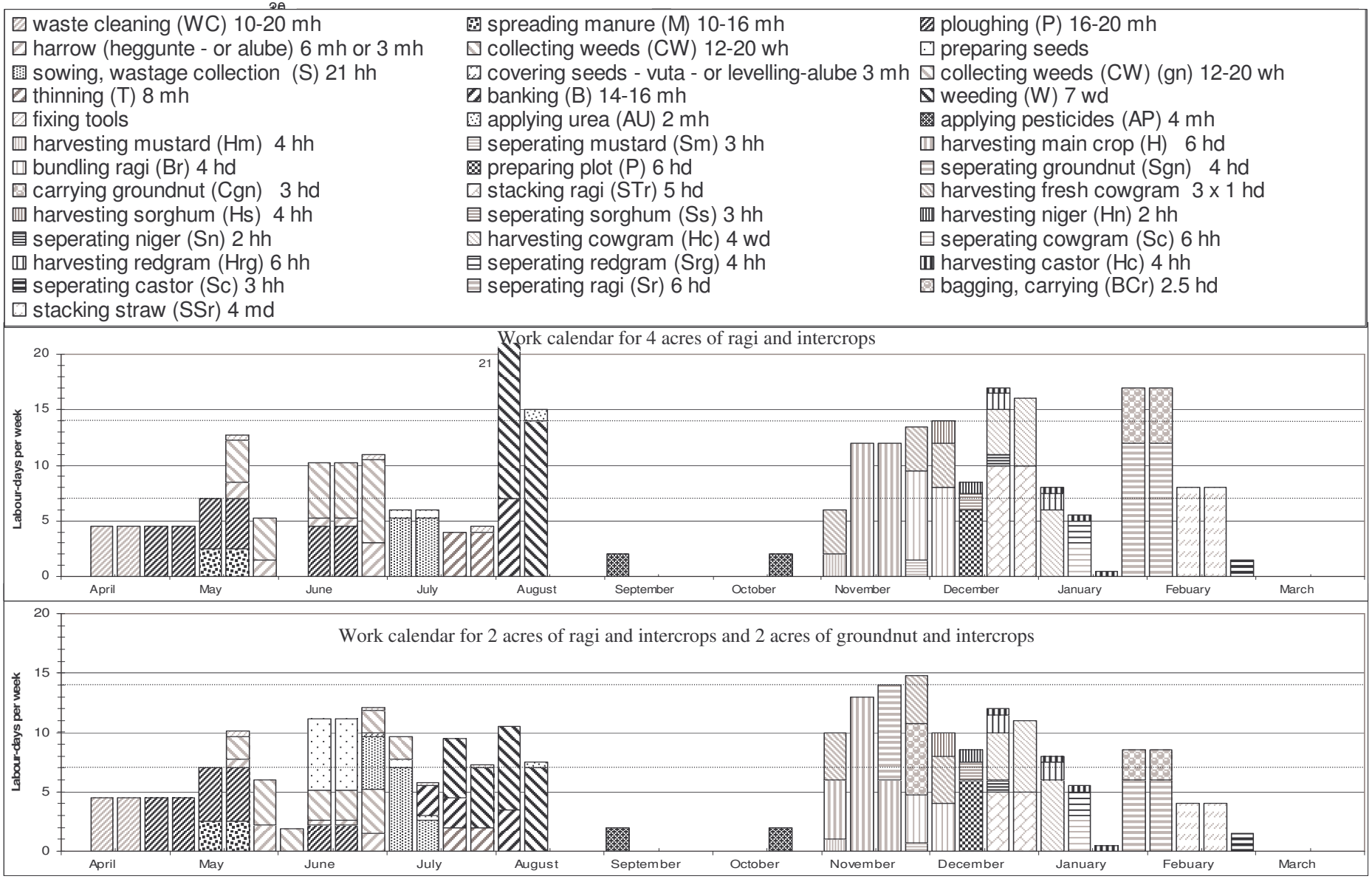
Ragi and intercrops dominate the fields. In some areas groundnut has taken on a lot of importance. But both of these crops can enter into a number of rotations, or be present alongside quite a variety of other cropping systems, that present advantages in terms of reduced labour or reduced inputs.

The increase and decrease of groundnut in the rotations - CS1 and CS2

Groundnut is one of the other main dry-land crops that is grown. Previously a creeping variety that produced low yields used exclusively for the family's own consumption was sown. With the introduction of modern hybrid varieties, the surface cultivated with groundnut increased significantly around 10 or 15 years ago. A double explanation is proposed: the increase in yield obtained with the new varieties and the price of groundnut made it an economically interesting crop to grow (§ 2.2.2.3); the chemicals and new varieties of ragi had by then been introduced, so that from the same surface, farmers who had struggled to grow enough ragi for their families and animals now had an excess, and could sow some of their land with other crops.

Groundnut is usually combined in a similar fashion to ragi, with the mixed line of crops. No mustard is included, but niger is still regularly sown around the edges of the field. As to the crops in the inter-row, they can have very different spacings, raging from 1 or 2 m, similar to within the ragi fields, to 4 m or more in some cases. A few farmers do not include mixed rows at all. Some combinations of intercrops with groundnut were also considered negative by certain farmers: cow-gram, because of its creeping nature that tends to invade the groundnut plants next to it; castor, because of the shade the tall plant creates. Most farmers however sow both of these in the mixed rows, and sometimes with high levels of seeds (annexe 6).

Figure 35: Work calendars for ragi and intercrops and groundnut and intercrops



The groundnut crop is never grown two consecutive years in the same field, but is always interspersed with at least one other crop, usually ragi. The groundnut crop apparently does not grow as well if sown for a second year running on the same field, whereas ragi grows well after groundnut. This seems coherent with experiments reported by Van der Tas (1986), where ragi yields were better in fields sown with a legume crop the previous year.

Two main cropping systems of the form ragi $_n$ / groundnut $_1$, have been selected, where n is the number of consecutive years of ragi. In some cases, the rotation will be one year of each: ragi $_1$ / groundnut $_1$. At the other extreme, on some fields ragi will be grown every year. In between, all possibilities exist, but usually there is no set pattern. Hence, a cropping system of ragi $_5$ / groundnut $_1$ has been chosen (**CS1**), which represents a situation where only a small amount of groundnut is sown (Figure 35). The work calendar for 4 acres of CS1 is similar to the one for ragi only. The other selected cropping system is ragi $_1$ / groundnut $_1$ (**CS2**).

The choice of a rotation of both ragi and groundnut crops means that a larger surface can be cultivated without requiring external labour (Figure 35). This is because many of the tasks for the 2 crops do not quite overlap: not only because the operations after sowing are slightly different, but because the farmers sow the 2 crops at a week or more interval. Four acres can then be grown with hardly any need for external labour. In fact, even with a total of 5 acres, only around 10 days of paid labour are required, mainly for the harvesting activities. If 4 acres of solely ragi and intercrops are grown, around 20 extra days of labouring are needed.

Up until recently, many farmers were sowing half of their land with groundnut. Today this remains true in several of the villages. But in others, repeated low yields for the last few years, have meant that many have reverted back to growing just enough for the house consumption and next year's seed. The reasons for obtaining just a few, small, shrivelled nuts, and the duration over which the decrease has occurred are difficult to determine: climatic variations are one possibility; a decrease in soil fertility due to high exports and insufficient organic matter inputs over several years is another (§ 2.4.6.3). Still other farmers, with land far from the village, have never really grown much groundnut, because of large losses due to wild boar. Farmers then grow more ragi, or resort to larger areas of other dry-land crops.

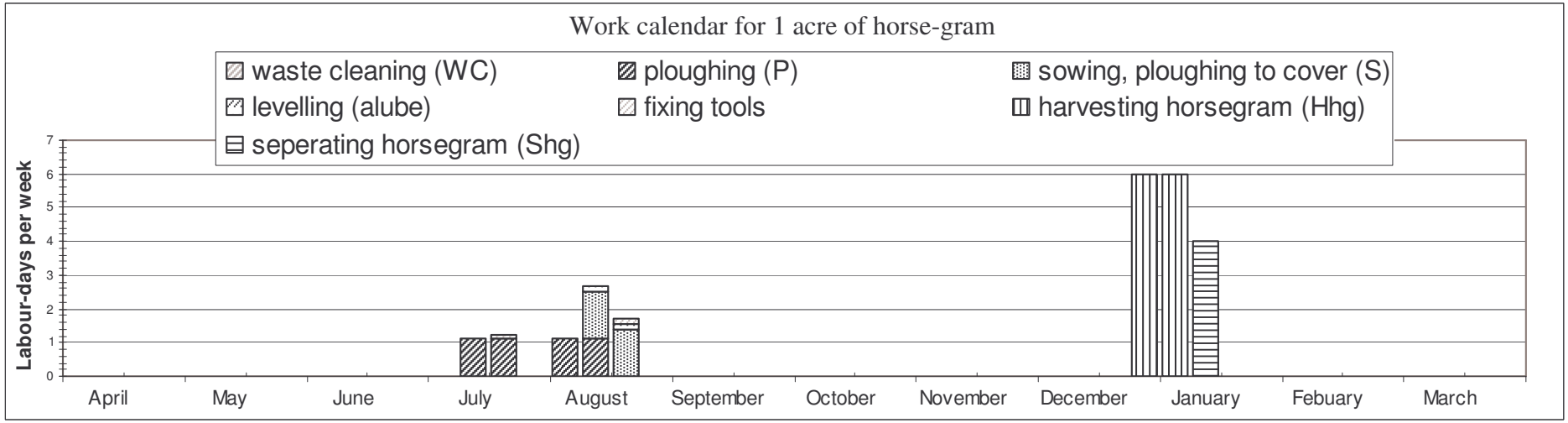
Rainy season vegetables

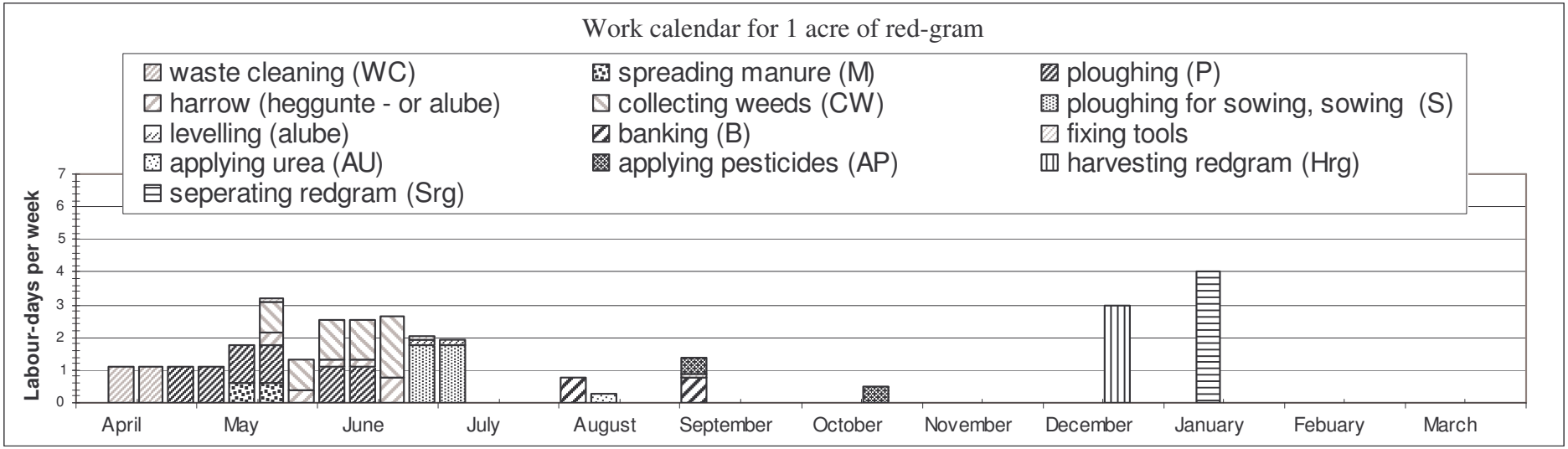
Many people grow vegetables, including aubergines, tomatoes and chillies, mainly for their own consumption, during the rainy season in small plots next to the main fields. Pumpkins and relatives, and various green leafy vegetables are also grown. The tomatoes and chillies are sown near the house and transplanted at around 3 weeks old. As the start of the rainy season is very uncertain, if it is still dry when they are ready to be transplanted, they will have to be hand watered. In July 2006; the late rains caused the owner of one such plot to walk the 30 min to reach her field, twice a week, to water the chilli plants by carrying buckets from the stream. Some are luckier, with space near the house, or even a tap in the garden.

A few other dry-land crops on smaller surfaces - CS3 and CS4

Horse gram (*Macrotyloma uniflorum*) is grown in separate fields. One of the traditional crops, it can be in rotation with ragi or with one of the other dry-land crops. However, it is grown on poorer soils, being very undemanding; or on land close to the forest, as it is not eaten by wild animals. It is therefore not included in rotations on better land and is sometimes grown year after year in the same fields (**CS3**). There is very little work involved for the soil preparation, and no thinning or weeding (Figure 36). Only the harvesting takes any significant time. Moreover, the ploughings and sowing are done after the ragi sowing and thinning, when there is little other work in the dry-land fields. The harvest is also done later than the other crops.

Figure 36: Work calendars for horse-gram and red-gram





Red gram can also be grown separately (§ 2.4.2). The soil preparation is the same as for ragi and groundnut. The sowing is done by ploughing, placing the seeds in the furrow and ploughing again to cover the seeds. It is sown around the same time as groundnut. The year to year successions are of all kinds, and it can be grown year-in year-out in the same field (**CS4**). The total workload is considerably reduced, less than half of that necessary for ragi and inter-crops, as weeding is not required and there is just one crop to harvest (Figure 36). For farmers with plenty of land, who pay labourers for a large part of their work, this is an attraction.

Minor millets (in this area, mainly kodo millet - *Paspalum scrobiculatum*, little millet - *Panicum sumatrense*, and more rarely foxtail millet - *Setaria italica*) are now hardly ever grown, as explained previously (§ 2.2.2.3). Due to this, they have not been studied here.

Sweetcorn (*Zea mays*) is being grown on a larger scale, but is still mainly found in the lower part of the valley. It is a recent introduction, used for fodder or sold. The price is apparently attractive, but the return obviously depends on the yield obtained. It has not been studied here.

Earling season cropping possibilities - sequential cropping - CS5

The sowing of the main crops does not start until mid-June or later, as the end of May and early June have very irregular rainfall (§ 2.1.1) and can be very dry. However, the rains in April and May, although they come as heavy showers, often with long gaps in between, can be sufficient to grow a drought-resistant short-season crop, such as sesame (*Sesamum indicum*), before the main ragi crop (**CS5**). One problem though is the free-roaming of the animals in this season (§ 2.4.3). It is not prohibitive, but does mean some crop loss.

This is another of the crops which requires very little work: the land is ploughed a couple of times, the seeds sown, then covered with a quick passage of the *alube* implement (annexe 3); sometimes residue weeds are collected up after the second ploughing, and it can be necessary to thin the crop. The harvesting is the main work. Just over one acre could be harvested by a family with 2 active members (Figure 37), but even that little, which should preferably be harvested all in one go, is usually done with the help of external labour. Once harvested, a rapid threshing plot will be made and after a week or so of drying, the seeds will be separated from the plants. This takes 3 days, unless there are very large quantities (annexe 6).

The work for implanting the main crop must then be done very quickly and extra labour can be required. There might also be an impact on the ragi yields obtained, due to a slightly later planting of ragi, extra nutrient exports from the field, but also by the fact that the soil is covered during the heavy April and May showers. These aspects would need studying.

Moreover, the rains are very uncertain at this time of year. Sesame does not need much water, but if it hardly rains at all, the few grains that form might not be worth collecting. The plants are then simply ploughed into the soil. Farmers are often prepared to risk a poor yield, as little labour is needed for implanting the crop and seeds are the only other input (annexe 6).

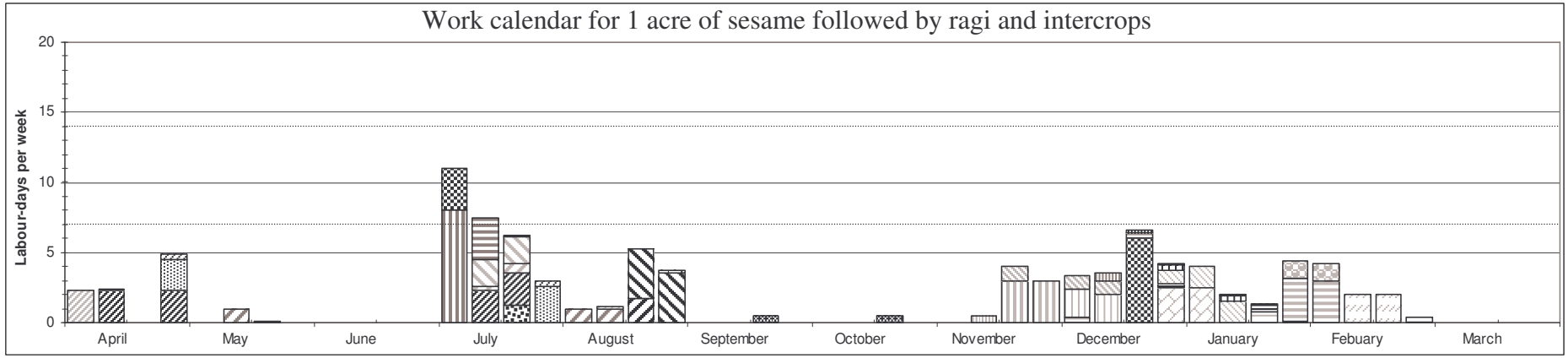
After a normal harvest, the plants are burnt. They could be incorporated into the soil, but at this stage, just before sowing, that might create a nitrogen uptake to break them down; this at a time when the young ragi plants need all the nitrogen they can get.

Dry-land plantations

Mango plantations exist on a small scale in the area. Some of the larger farmers, owning 4 or more acres, have set aside from half an acre, up to several acres, on which they have planted mango trees, at a density of around 60 trees per acre.

Figure 37: Work calendar for 1 acre of sesame followed by ragi and intercrops

waste cleaning (WC) 10-20 mh	spreading manure (M) 10-16 mh	ploughing (P) 16-20 mh
harrow (heggunte - or alube) 6 mh or 3 mh	collecting weeds (CW) 12-20 wh	preparing seeds
sowing, wastage collection (S) 21 hh	covering seeds - vuta - or levelling-alube 3 mh	collecting weeds (CW) (gn) 12-20 wh
thinning (T) 8 mh	banking (B) 14-16 mh	weeding (W) 7 wd
harvesting sesame (Hs) 8 hd	seperating sesame (Ss) 3 hd	fixing tools
applying urea (AU) 2 mh	applying pesticides (AP) 4 mh	harvesting mustard (Hm) 4 hh
seperating mustard (Sm) 3 hh	harvesting main crop (H) 6 hd	bundling ragi (Br) 4 hd
preparing plot (P) 6 hd	seperating groundnut (Sgn) 4 hd	carrying groundnut (Cgn) 3 hd
stacking ragi (STr) 5 hd	harvesting fresh cowgram 3 x 1 hd	harvesting sorghum (Hs) 4 hh
seperating sorghum (Ss) 3 hh	harvesting niger (Hn) 2 hh	seperating niger (Sn) 2 hh
harvesting cowgram (Hc) 4 wd	seperating cowgram (Sc) 6 hh	harvesting redgram (Hrg) 6 hh
seperating redgram (Srg) 4 hh	harvesting castor (Hc) 4 hh	seperating castor (Sc) 3 hh
seperating ragi (Sr) 6 hd	bagging, carrying (BCr) 2.5 hd	stacking straw (SSr) 4 md



The initial investment must be born for 5 or more years, before the trees really start fruiting, which excludes many of the smaller farmers. Crops can continue to be sown under the trees for at least 10 years, which limits the land investment that it represents at first. Once productive, the trees generate income with barely any labour required. The land must be ploughed a couple of times a year, to keep it clear, and plots dug around the trees to help the water infiltrate close to the roots, while the trees are still young. All of this represents barely 10 days of work per acre and per year. The harvesting is often done by an outside contractor who negotiates a price for the whole crop. A few farmers organise the harvesting themselves. That is obviously extra work.

This cropping system is not detailed here, as it represents an extra source of income generation for larger farmers only. Those with insufficient land do not have such cropping systems; the mango plantations remain few and far between.

Coconut plantations can be part of irrigated cropping systems or on non irrigated land. Usually they are planted on bunds surrounding other irrigated crops. As such, they receive few inputs: they benefit from the water and fertilisers applied to the other crops (paddy, fodder grasses, or more rarely banana or mulberry) and require very little labour. They can also be on previously irrigated land, by the streams, where the first diesel pumps were installed. Sometimes they were watered by hand as young plants. Most of these plantations are small, with some 20 to 30 plants. Many of them are neglected today, because a disease affecting most of the trees in the area has seriously reduced their productivity of good quality fruit, and because the owners of such plantations have other income generating activities. Their management is not presented in detail here either.

2.4.2.3 Enough land to choose or just enough to cope?

The cropping possibilities of the area cannot be reduced to ragi and intercrops. However, depending on the available surface of land and available money, the farmer has more or less choice (Figure 38). First and foremost, the farmer must grow enough ragi to feed his family and his animals. Since the introduction of high-yielding varieties and chemical fertilisers, most families grow more than enough for their own food. Indeed, even with a low yield of 5 q / acre (annexe 6), barely more than 1 acre is necessary to cover the requirements of a family of 4 (annexe 4).

For the cattle it is a different matter. On a good year, 1 acre of ragi can produce the necessary straw for 2 cows. On a poor year, 2 acres can be insufficient (annexes 6 and 7, § 2.4.3.2). To be on the safe side, 1 acre of ragi therefore needs to be grown per cow: on a good year, some can then be put aside to cover a bad year.

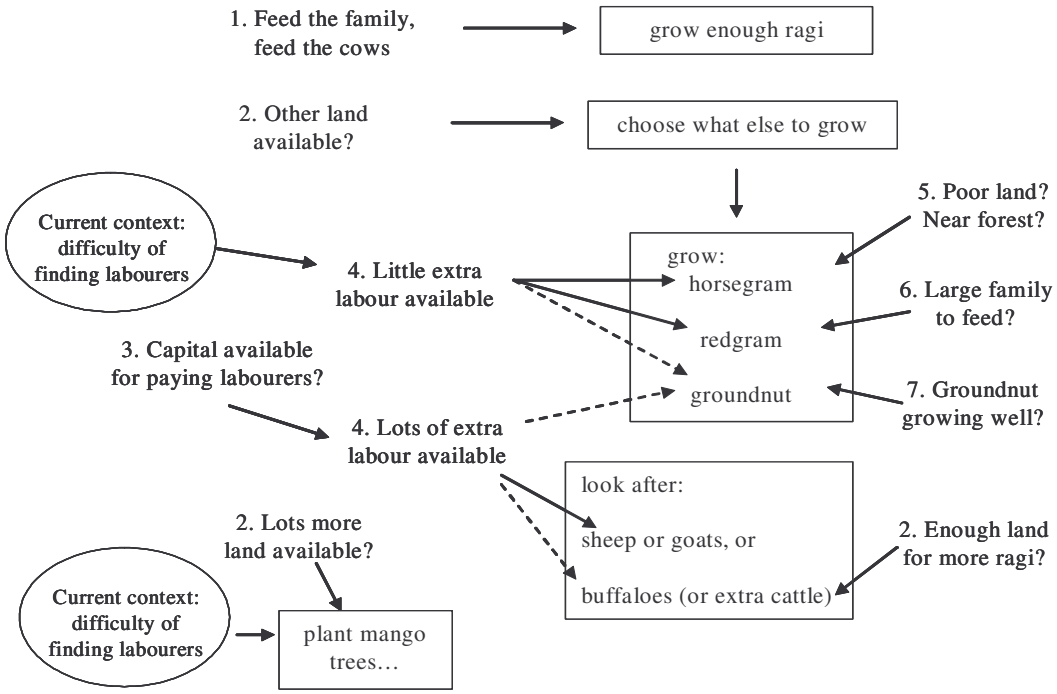
This does not leave much possibility for other choices for the smaller landholders. When the groundnut was growing well, some very small farmers did function by selling groundnut and buying straw, but with the poor groundnut crops, that has become very risky. It can also be very difficult finding straw to buy and can become costly on years where ragi yields have been very low.

Farmers with more than 2 acres, unless they have more than 2 cows or land of very poor quality, can decide what to grow on the rest of their land. Groundnut is a frequent crop because of the workload that is slightly offset, but less so over the last few years, with the lower yields (§ 2.4.2.2).

Red-gram and horse-gram are used by farmers who have more land or less labour available (2.4.5). These farmers can also choose what to grow on which fields, placing horse-gram for

example on poorer soil, choosing fields closer to the village for groundnut that will be less susceptible to attacks from wild boar, etc. For those with still more land, some can be put over to plantations requiring very little work such as mango, or tests can be made with crops like sweetcorn.

Figure 38: Enough land to choose? Some factors affecting farmers' choice of dry-land crops and livestock



So land surface is very important, but it must not be forgotten that land quality has a very large influence. The yields obtained for ragi and its intercrops vary immensely. The farming practices of the area have always taken into consideration that the quality of the land needs maintaining. Indeed, the climatic conditions are not always the most favourable, with high temperatures that favour a rapid turn-over of the organic matter, and very heavy showers, creating high risks of soil erosion.

2.4.2.4 Old and new biological resource management

The soil itself presents a certain number of constraints. It has a fair potential, but must be treated with care (§ 2.1.3.5). Recent changes might require concern.

Bunds and terraces to limit soil erosion and feed the cows

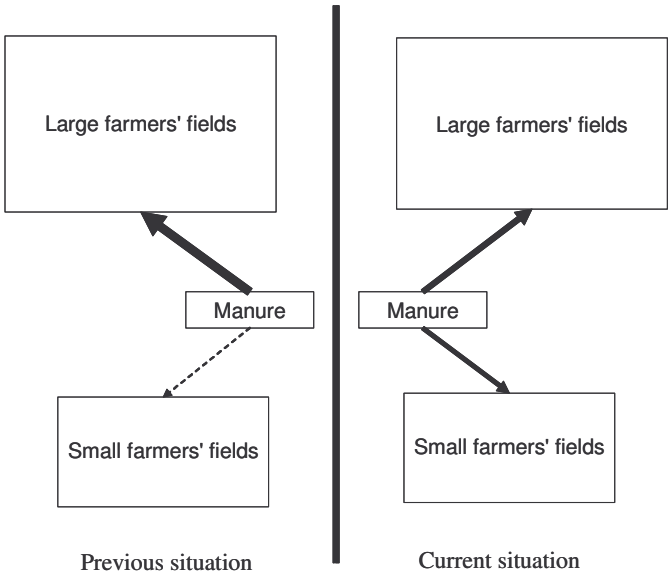
To deal with the water run-off and soil erosion that have always been a problem (§ 2.1.3.4) on the hilly land of the area, terraces and bunds are systematically constructed. The terraces between the little fields were first made when the land was cleared, to create a level area. They are regularly maintained to slow down the water and limit the loss of soil. Even so, soil erosion remains important, especially on the steeper slopes. The bunds are also kept clear of thorny bushes and trees, which is often a long job carried out before the ploughing starts, so that they can provide much needed grass for the cattle (§ 2.4.3.2).

From feeding the soil to feeding the plant

As to the management of the fertility of the soil, up until approximately 15 or 20 years ago, no chemical fertilisers were used in this area. The elements exported from the soil by the crops were compensated for by application of farmyard manure, by those who had animals. The manure was prepared simply, by digging a pit and daily piling in the cow or other animal

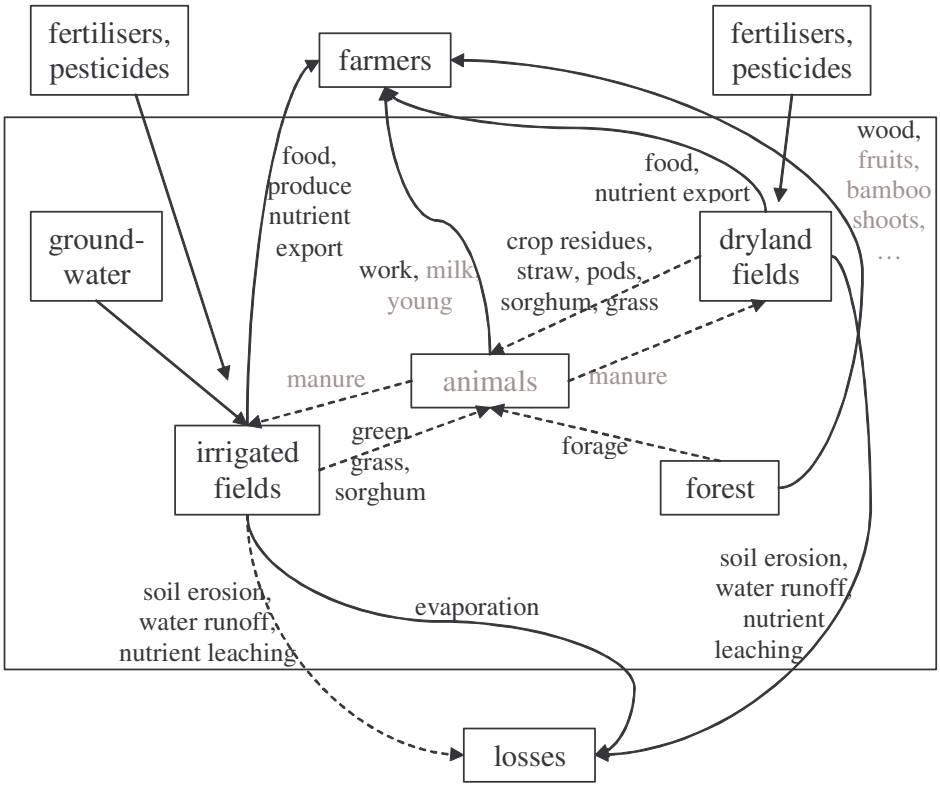
dung along with the refuse straw. Some farmers would add green leaf material. Today, many of the manure heaps are made above ground and the practice of adding green matter such as leaves has stopped altogether. There is doubt as to whether the organic matter thus obtained is of good quality.

Figure 39: Changes in available farmyard manure



The decrease in number of animals owned by the larger farmers means that their land often receives less organic manure than it did 30 or 40 years ago. For some of the smaller farmers, who had no animals previously, the change has been the opposite (Figure 39). It is difficult to get a clear picture as to the global balance of animal numbers. It appears that total numbers have decreased. Today, the average quantity of farmyard manure that the farmers can apply is approximately 2 tons per acre (1 tractor load), but it can vary by at least a factor 2, up or down. Those with many animals, or irrigated crops producing large quantities of vegetative growth, or those who can afford to buy manure, often apply 2 tractor loads per acre, or more if it is on irrigated crops (annexe 6 and 8).

Figure 40: Modification in the use of resources - fewer animals, more external inputs



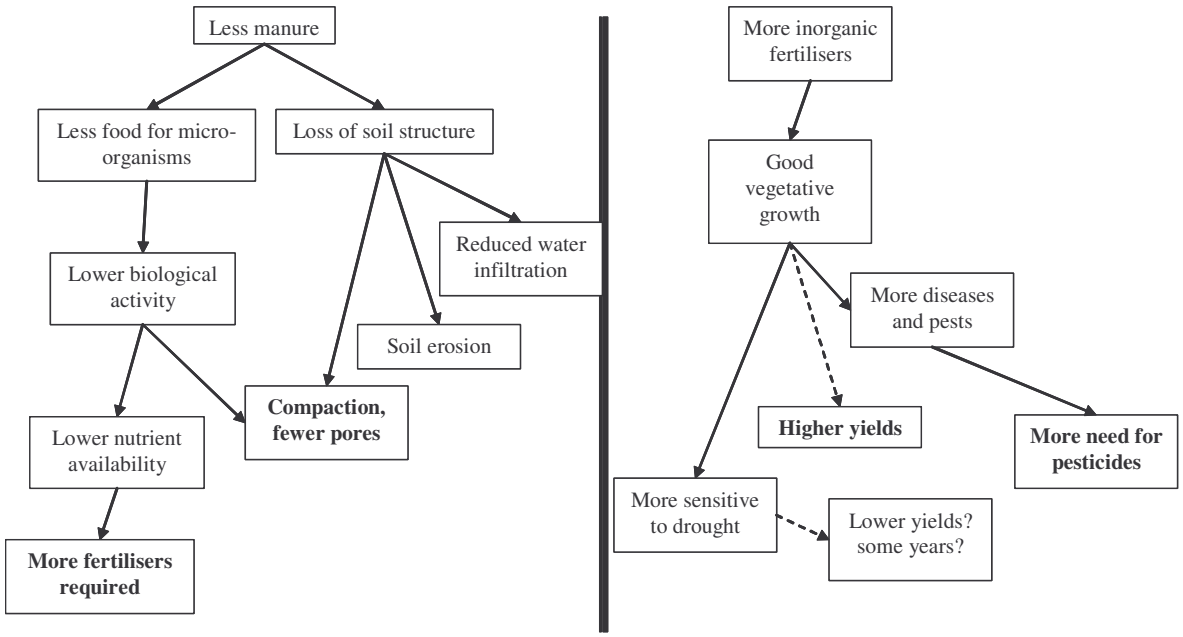
The reduced quantity of organic manure produced by many of the farmers has been replaced by the use of chemical fertilisers (Figure 40). However, the levels applied for the last 15 years have remained low (annexe 6), with less then 10 kg / acre of equivalent N applied by the

majority of farmers. Di-ammonium phosphate (dap) is mixed with the seed at sowing time and urea added mid-way through the growth, in approximately similar quantities of 10 to 15 kg / acre, although the doses of each can reach 25 kg / acre (barely over 40 kg / ha of N).

Consequences of this change in mode of fertilisation are firstly the nourishment of the plant instead of the soil. This can lead to problems linked with the quality of the soil (Figure 41). Some farmers do indeed report a compaction of the soil and higher levels of fertilisers required year after year. If not all farmers agree, neither have all farmers seen their number of animals decrease and some continue to apply large quantities of manure. Those who think that the quality of their soil has suffered have all reduced the amount of organic matter they apply to their fields. Increases in soil erosion and decreases in water infiltration are more difficult to establish, but are likely to be consequences of the reduced quantities of organic matter.

All the farmers saw important increases in yields with the onset of the use of chemical fertilisers. But nearly all of them also saw the incidences of pests increase, on cow-gram and red-gram notably (Figure 41). The odd farmer still does not need to spray his crops, but most farmers have to apply pesticides twice yearly (annexe 6). The products used can be particularly noxious. When they first arrived, farmers did not know about potential health risks associated with them. A few cases of health consequences linked to the pesticides were mentioned during interviews with the farmers, especially skin problems. But most of the effects are long-term ones and therefore difficult to identify.

Figure 41: Changes in fertilisation practices and their consequences



On red-gram, the fertiliser doses are similar, sometimes a little higher. On groundnut, only dap is applied. Many farmers have decided not to apply any at all, because they cannot afford it or because they think it might be responsible for the low yields obtained the last few years. This latter opinion was explained by an excessive development of the vegetative parts of the plant at the expense of the grains. Farmers not applying dap then rely on farmyard manure if they have enough. However, farmers with too little manure tend to apply it in priority to ragi, and not to the fields that will receive groundnut that particular year.

High-yielding varieties for the main crops

The varieties of ragi used are all high-yielding varieties today, mainly Indaf 5 and GPU 28. The groundnut sown is also one of 2 high-yielding varieties: one white preferred for the house consumption; one red chosen if the produce is going to be sold, as its higher oil content means it fetches a higher price. Some of the red-gram is a hybrid variety, although many farmers continue to sow local varieties. Most of the other dry-land crops are local varieties.

Farmers continue to produce their own seed from one year to the next. The high-yielding varieties are replaced every 2 years in the most frequent scenario, but many farmers only purchase new seed every 4, 5 or more years. Opinions are different as to whether yields decrease after several years of use of the same seeds.

Organic farming practices in the area

There are a few farmers farming more or less organically by default: those who cannot really afford the external inputs often do not apply any, on some crops at least, but have otherwise identical practices to the other farmers. They do not compensate for the lack of external inputs by other means and usually obtain lower yields.

The rest of the organic farmers in the area are mainly from Veereianadoddi and Aralagadakalu, with just a couple in Bilidalee and Kolgondanahalli. They have abandoned the use of chemical fertilisers and pesticides following Green Foundation's suggestions and awareness and training schemes. As such, they have similar practices, even if all have not adopted every idea.

One of the aspects of organic agriculture, that Green Foundation is working on, is making sure that the material recycled is done so in the best possible way. For example, not leaving the compost material to dry out in the sun, avoiding the leaching of important nutrients and balancing the composition of the compost can improve the quality of the material returned to the soil. These can be achieved by careful layout of the compost pit, the choice of what to add to the heap and how to incorporate the manure into the soil. Amongst the larger landowners, some of the care in choice of materials and location of the heap, that would have been taken previously, had nearly disappeared before Green Foundation's arrival.

Many of the organic farmers, encouraged by Green Foundation, have initiated the production of good quality compost, such as by the basket method, where the circular wooden fencing allows air to circulate. Most of the families have set-up individual vermicompost units and learnt about its production with Green Foundation’s support. The vermicompost, composed of fresh cow dung and lots of green vegetable matter, kept humid, is obtained rapidly: in just 2 months very rich, fine soil is produced thanks to the worms' pre-digestion.

This production of vermi-compost is one of the most widely adopted of the ideas for individual practices. However, some farmers do not have room for such a unit in their back garden. Others have encountered problems with rats eating the worms, or with a lack of readily available vegetable material to use for the compost. Some are not all that enthusiastic about its production, as they are not sure that it will have an effect on the crops, and do not want to spend extra energy on carrying water to the pit. These difficulties tend to concern the lower-caste families.

The higher-caste families often have a tap in their back garden, as well as irrigated crops producing plenty of vegetable matter. They are more actively engaged in the process, and obtain greater quantities of vermicompost on the whole. They apply it to their dry-land crops, alongside traditional manure or good quality basket compost as do the lower-caste families,

although this new practise is a very recent one for many of them. Moreover, the quantities applied often remain low: most of the lower-caste families are producing small quantities; the higher-caste families often have irrigated crops and use most of their vermicompost on these, or commercialise it as a high added-value product.

Within organic farming, there are different schools of thought, as to what is best: such rich compost? or fresh organic matter used as mulch, to stimulate the organic activity in the soil, as well as protect the soil from erosion and keep in moisture? Green Foundation is encouraging both. The mulching is so far reserved for the irrigated crops, because those without such crops do not have much vegetable matter available, and those with irrigation give priority to these high productivity crops.

Most farmers in the village have stopped the application of chemical fertilisers. Those who have enough manure and vegetable matter to do so, have increased the restitution of organic matter to compensate. The smaller land and animal owners have difficulties achieving this.

Some farmers have also started producing an alternative urea, by collecting cow urine in a sand-filled pit and later drying the sand, before applying it to the fields, for a boost of easily available nitrogen. Again, this is too recent a practise to know what the impact is.

Awareness on the potential hazards of various pesticides has been given. As a consequence, farmers have taken up the production of bio pesticides, although thorough tests still need to be carried out in the village, to determine the effectiveness of different preparations, based on neem, garlic, chilli, etc.

The organic farmers in the village are also growing different non-hybrid varieties of ragi. Green Foundation's suggestions include Pitchkadi ragi, Bili Mundaga, Karikadi ragi... There have been too few years and too many different varieties tried for any results on the different varieties to be clear.

2.4.3 Livestock systems: decreasing use of local forage resources

The food for the animals is a combination of what they can obtain by grazing and some supplements fed to them in the morning or evening. Most of the livestock systems of the area are very low external input ones, with the supplements coming from the farm itself (Figure 40). However, they require a large surface area per animal, of common land. Indeed, the goats, sheep, Hallikar zebus and buffaloes all rely on grazing the vegetation found in the forest and the fields after harvesting. Only the cross-bred cows make little use of the local resources and depend primarily on purchased concentrates.

The work for any of the animals is a daily routine: cleaning out the shed, collecting up the dung and refuse straw and taking it to the manure heap, milking the cows in the morning and again at night, fetching food for the cattle, herding the animals while they are out grazing, or taking and fetching them at periods when they can be tied in a field. The daily work averages a couple of hours for all of the day-in day-out tasks (annexe 7) and is done on top of the other work necessary for the cropping systems for example. When the animals have to be watched, it is a whole day's work, of usually 7 hours on top of the routine work.

The total number of animals has decreased. The main factor advanced is the difficulty of finding labourers for looking after the animals. The larger landowners used to rely upon this labour. The heavy decrease in their numbers of animals has only partially been compensated for by the increase in numbers owned by many of the smaller farmers since they have had a little more access to land and the necessary capital.

2.4.3.1 Consequences of free-roaming regulations on resource use and crop management

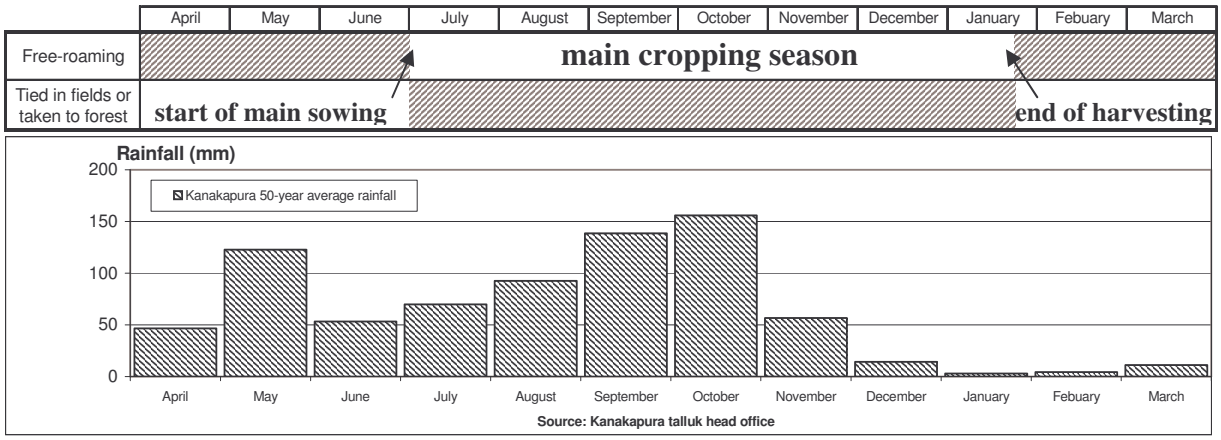
From the end of the harvesting to the sowing of the next main crops, the animals are free to roam the fields. There they graze the growing weeds, or eat the crop residues. The zebus and buffaloes will go unwatched. The goats and sheep will still require a shepherd.

After sowing, the animals must be watched by their owner. They can feed off of vegetation around the edges of fields, or on grass in fields or scrub land set aside, or they can be taken off to the forest when that supply is insufficient (Figure 42). Different types of animal having different requirements, they will be more or less able to cover their nutritional needs by food found in the forest. They will be taken there for various periods of time.

There is no set regulation for the dates at which free-roaming starts and stops. By mid-January, at the Sankranti festival, nearly all of the crops have been harvested, except sometimes castor, which must then be dealt with quickly, to prevent it being knocked over by the cattle. The cattle are left loose during the day. However, if the harvest is a late one for climatic reasons, the start of the free-roaming will be prolonged by consensus.

The end of the free-roaming, at sowing time, works in the same manner: when enough people have sown, usually at the end of June or in July, the animals are no longer allowed to roam the fields. In some villages, most of the farmers will sow much earlier than in other villages and the free-roaming stops accordingly.

Figure 42: Tolerated free-roaming period for the animals



This collective use of the open dry-land fields means that the animals can make the most of the resources there (Figure 42). It also has the advantage that the cattle do not need to be watched and so it frees up labour for other activities. However, it has one major drawback: it is not possible to sow when one wants; if one sows much earlier than everyone else, all the young plants will be eaten by the domestic animals. It is not uncommon to see, in a ragi or groundnut field sown amongst the earlier ones, a goat walk along a row of intercrops and munch the tops of all the little plants. The herders only really take sufficient notice and pay particular care to the whereabouts of their animals when most of the fields are full of young plants.

This problem occurs with sesame: few farmers sow it, so that there is no restriction on the free-roaming; those who do sow it therefore have the animals trampling all over their crop. Fortunately, the animals are not that fond of sesame plants. Even so, many farmers, whose land is near one of the well-used cattle tracks for example, or too far away to be easily watched, find themselves with important losses due to the passage of the animals.

2.4.3.2 Hallikars or tractors? - LS1

The Hallikar cow, a zebu breed (Bos indicus), is one developed for mechanical work, not for milk (Chopra, 1997). They are specific to the area around Mysore, in southern Karnataka (Embryoplus). Strong animals, they are used as traction power for the agricultural work: most of the ploughing, harrowing, thinning, banking, and threshing still depends on the Hallikars.

Tractors for transport and Hallikars for ploughing

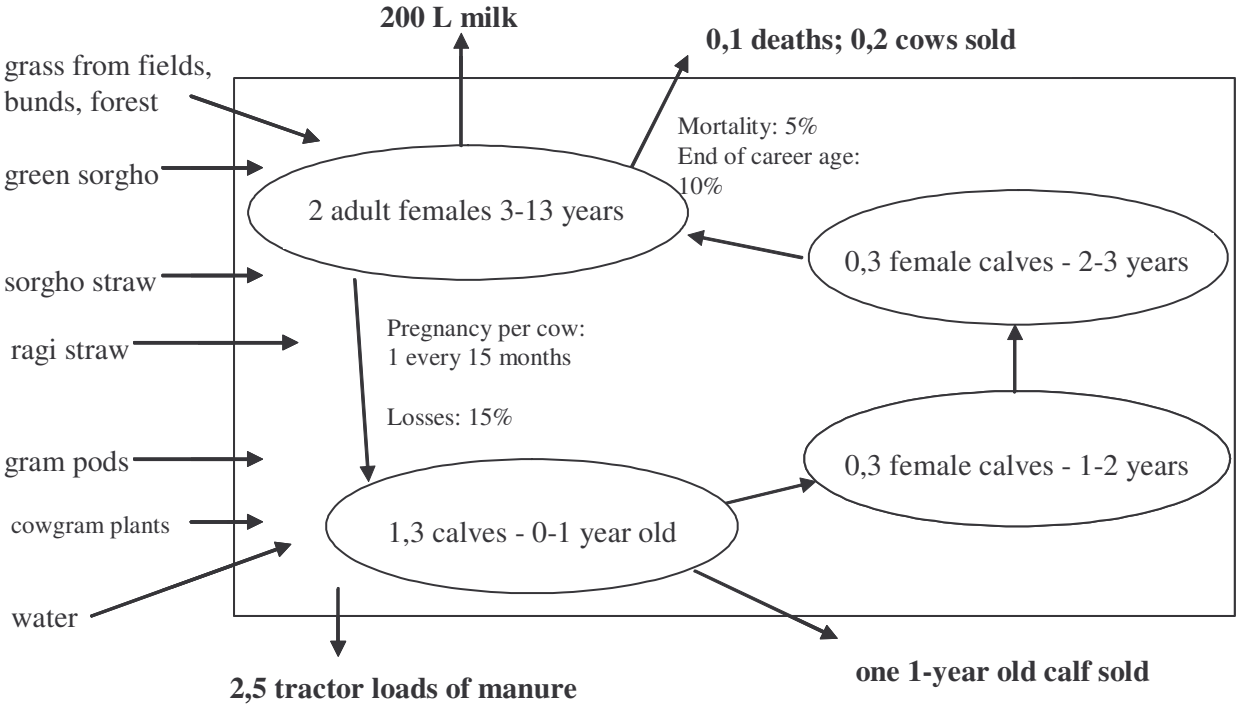
Despite some farmers still using bullocks for pulling a cart, the transport work is now often done by tractor. Some of the farmers have also been resorting to the tractor for ploughing since about 5 years ago. It is much quicker, and it is not always easy to find labourers available to plough one's land with the cows when needed. Many larger farmers relying on external labour for their ploughing now have it done by tractor for this reason.

On the other hand, it is expensive. Moreover, all the farmers agree that it is not very effective: the tractor is not equipped with a plough, but with a kind of harrow, with long incurved teeth, widely spread compared with the width of a plough. The teeth do pull out the weeds in their path, but in between, the weeds are still firmly rooted and just get covered with a little soil. They are difficult to remove by hand afterwards, making this collecting up of organic matter much longer than usual (annexe 6). Also, the soil is not turned over, so that the development of these weeds is not stopped and they grow back; the weeding task is much lengthened.

All in all, farmers consider that the cow-drawn plough is much better for allowing crop development and for reducing the time needed for weeding. Most of them still use cows. However, with people looking to better returns than dry-land farming, it is possible that the Hallikar numbers drop further as the tractor takes over more and more of their work.

Numbers of cows and bullocks

Figure 43: Average population data for a "herd" with 2 adult female Hallikars



At the time when many of the lower casts did not have their own land or animals, and the large landowners had lots, most of the implements were drawn by bullocks. The larger

landowners still use bullocks as opposed to cows. The ploughing and other operations are faster. However, this means keeping additional cows for reproductive purposes. This in turn requires enough land for producing straw. One can buy young males when the others get old, but that means both enough income to purchase new animals and to do without the money generated by selling one's own calves. Either way, keeping bullocks is a little of a luxury.

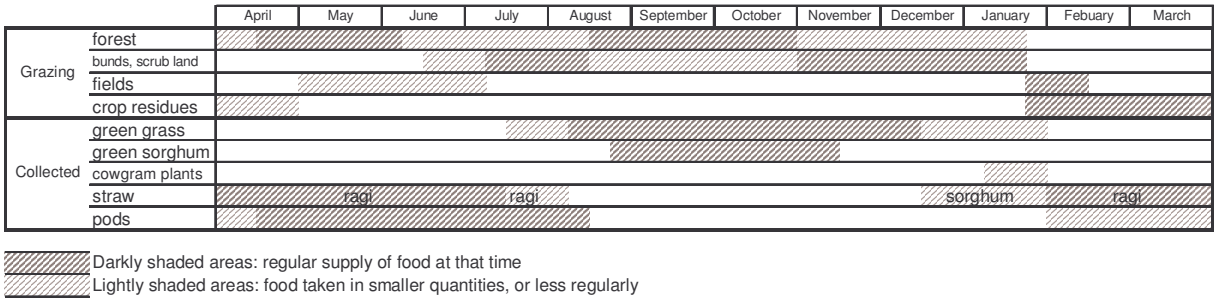
Although some larger farmers still have up to 20 adult female Hallikars and the poorest may have only 1, or none at all, most farmers have 2 cows used for working the fields. This number is chosen to illustrate the needs and benefits that farmers expect to obtain from their Hallikars (Figure 43).

Information on reproductive parameters, mortality rates and their reasons are given in annexe 7. The small number of animals in many a herd mean that the ordinary statistical variability can have severe consequences for more marginal farmers. The death of their one or one other cow can be seen as one of the risks they have to face.

Straw and fodder to complement the grazing

The Hallikars cannot get enough food directly from grazing. In the morning and evening they are distributed complementary food, which is all produce from the farm. At times of the year when they are used for traction work, this is very important, as they require extra energy, but they cannot graze while they work. Rich food such as the pods from the pulses is then used. The main complementary food in terms of volume required, is straw throughout the dry part of the year, and green material, such as sorghum and grass, in the rainy season (Figure 44). Farmers must have enough land to provide this supplementary food. The sorghum they can sow more or less of, mixed in with the row intercrops, to cover their cattle's needs.

Figure 44: Sources of food for the Hallikars throughout the year



The grass comes from bunds only, in the case of small landholding families; farmers with more land might set aside a field that is not very productive for ragi, or a part of one, and let the grass grow there to be grazed or cut for the cattle. That leaves the straw. This is required at a time of year when grass is in short supply. As such it is a very important part of the cows' food, despite it being poor nutritionally and not being able to cover the cows' requirements if it is not supplemented by some grass at least (annexe 7).

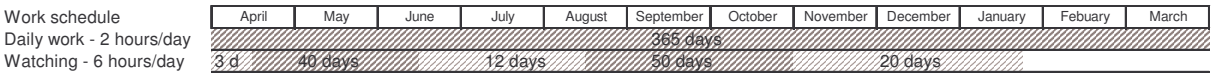
Estimations show that with a good ragi and straw yield, enough straw can be produced from 1 acre of ragi and intercrops to cover the needs of 2 cows and their young (annexes 6 and 7). However, on years when the rains are a problem, the straw yield can drop considerably. To be sure of having enough straw, approximately 1 cow can be kept per acre of ragi grown. It is possible to purchase straw, but after a poor harvest, many a farmer will be looking to buy straw for their animals, and few will be in a position to sell any: the price rises rapidly. Most farmers calculate the surface of ragi to be grown so that it guarantees them enough straw.

The families with irrigated land usually grow fodder, such as elephant grass. This is available throughout the year and can considerably decrease the quantity of straw that they require.

Juggling with the herding

Most families have Hallikars. Yet they do not necessarily have someone free to watch them all day throughout the whole cropping season. They have to use the patches of grassy common land or juggle with the grazing resources on their own land: a small part of a field where the grass is left to grow, or the bunds between the fields, which are a precious resource.

Figure 45: The Hallikar yearly work schedule



Total work time	185	days/year	including herding
	91	days/year	if there is no herding (more land set aside, or hybrid grass, or organistion with neighbours)

For example, in the cropping season, the limited grass on the bunds is used while people are busy sowing, banking and weeding, then again during harvesting. Indeed, in June-July and November-December, there is little spare time for watching the animals: they will only be led to the forest on days when there is no work for the cows or their owners (Figure 45).

In between, people who have no access to irrigation usually take the animals off to the forest. So this whole day's work is carried out when there are not too many other pressing tasks. Alternatives include taking the cows to the forest and leaving them there for the day, before collecting them in the evening, like the buffaloes. Several neighbours can also organise themselves, so that one of them watches the others' cows as well.

Again, a distinction must be made with the families who have irrigated land. They usually have much busier work schedules and so are often not at all available for herding. But they also have cropping systems that can produce much more per acre, and so are able to set a little more land aside for grazing and for growing year round green fodder.

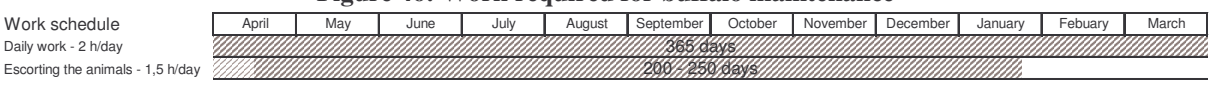
Little milk, but some manure

The Hallikars only produce very small quantities of milk. Sometimes, it only covers the calf's needs. Other cows produce 1 extra litre per day, very rarely 2. Their main use is the traction they provide. However, they also produce manure, not to be forgotten: 1 cow provides about 1 tractor load, usually just over 2 tons, of manure per year (annexe 7). The decreasing number of animals in the area means there is a decreasing quantity of farmyard manure available.

2.4.3.3 Sturdy buffaloes for milk - LS2

The buffaloes, a local breed, are not used for any of the agricultural work. They are kept because they produce much higher quantities of milk than the Hallikars. They can produce up to 5 or 6 L / day, but a more common quantity is 3 to 4 L / day (annexe 7). The reproductive parameters are similar to those for the Hallikars (annexe 7).

Figure 46: Work required for buffalo maintenance

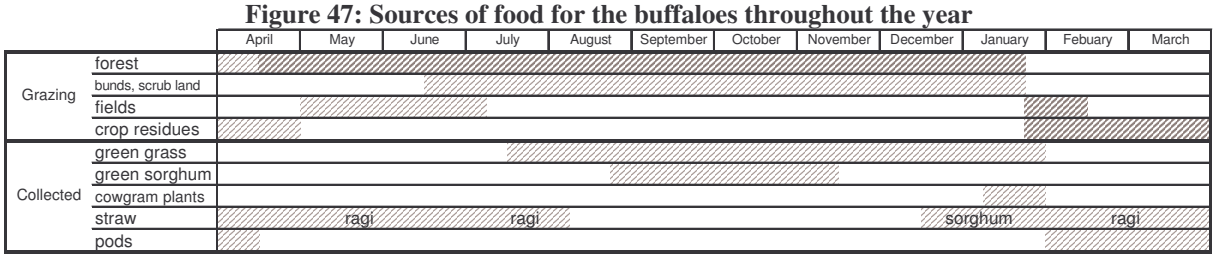


Total work time	133	h/year	including watching	with just buffaloes
	88	h/year	including watching	with cows and buffaloes (extra daily work, just 1 h/day instead of 2)

They require little herding work, as they can get most of their food from the forest. In the dry season, they are left to roam free until the sowing starts. After, they are taken off to the forest, but usually the owner will return, leaving them to fend for themselves in the day (Figure 47). Like the cows, they will be fed some extra straw or grass in the evenings (Figure 47,

annexe 7). Quantities of manure obtained and straw required have been considered to be the same as for the Hallikars, but this would require more detailed investigations to be sure.

Figure 47: Sources of food for the buffaloes throughout the year



2.4.3.4 Sheep and goats instead of savings - LS3 and LS4

The sheep and goats are land races. They are not milked, but the young are sold for meat.

Figure 48: Average population data for a flock of sheep with 10 adult females

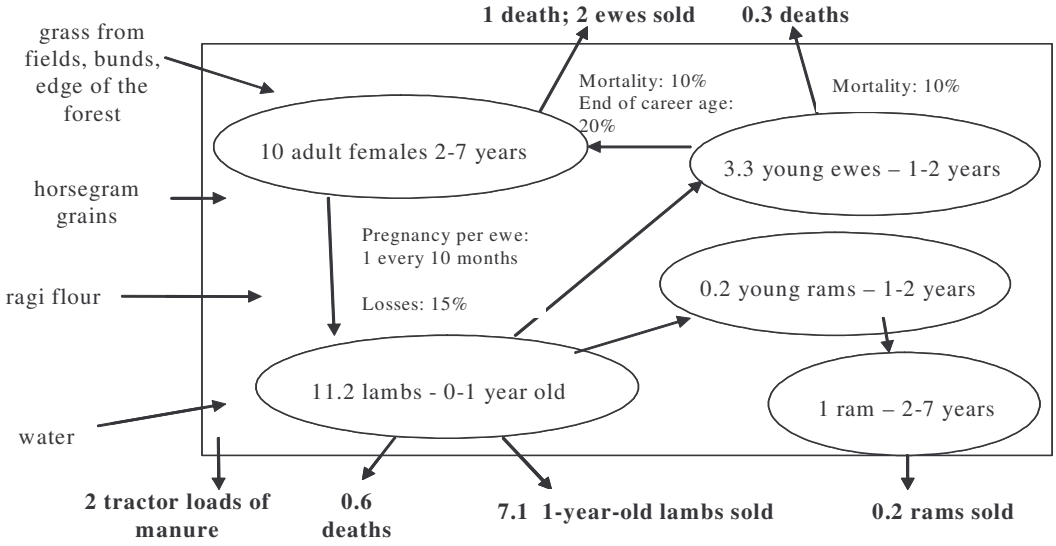
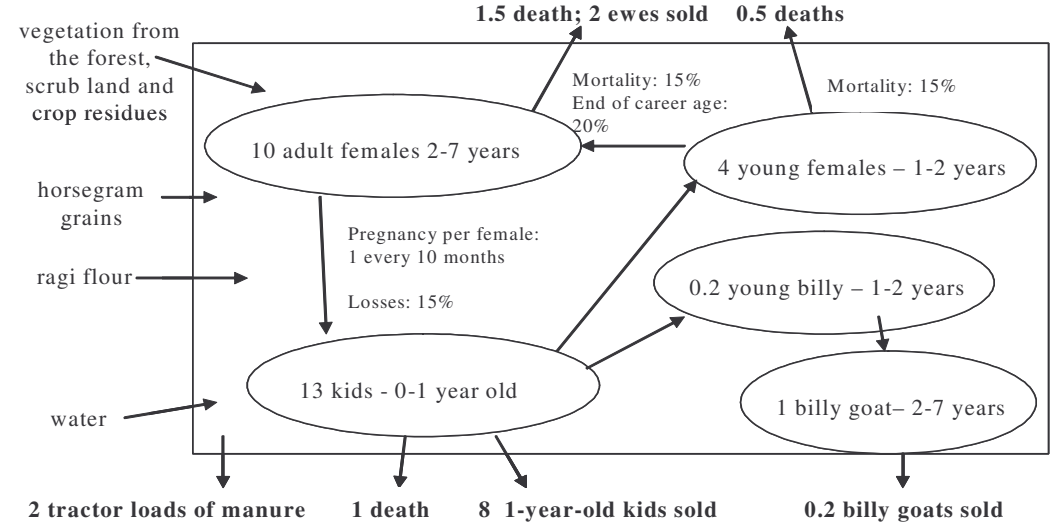


Figure 49: Average numbers of goats in a herd with 10 adult females



Regular income or source of credit

Some farmers have just a couple of sheep or goats, but the most common herd size is around 10 adult females, be it sheep or goats, as presented here (Figure 48 and Figure 49). The total

number of animals is then approximately 25. Proper mixed herds are very rare, because of the different nutritional requirements of the animals and the problems of watching over both at the same time. Some farmers will have just 2 or 3 goats in amongst their flock of sheep for example.

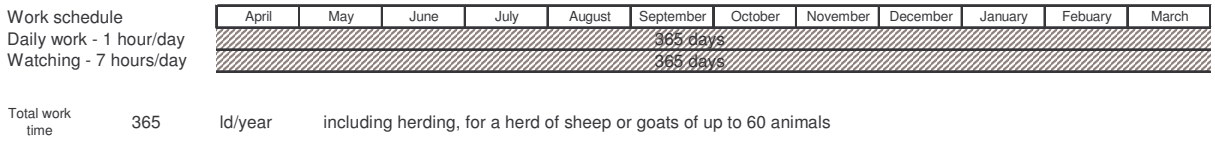
The income generated by these livestock systems has been evaluated by considering a herd with stable numbers (Figure 48 and Figure 49). However, this is rarely the case: significant numbers of farmers have acquired their animals recently and still have herds on the increase; for others, there have been drastic decreases in numbers, due to a disease present in the area since about 3 years ago (§ 2.4.6.2, annexe 7), or because the family required money and sold an important part of the flock. The income generated by the sale of half of the herd has also been determined (annexe 7). This is often how the herd functions: people build up their capital, selling just the young males and keeping the young females. When they need a large sum, they sell a big part of the herd (§ 2.2.1.3 and § 2.3.1). Sales also occur if the owners no longer have the necessary available labour to look after them.

A herding constraint…

The work for looking after a herd of sheep or goats is a full time job (Figure 50). The families who own the goats and sheep therefore fall into two categories. Firstly there are those who have enough able members compared to their land acreage for one of them to look after these animals. This is families with 3 or more active members and with a workload such that one of them does not have any real other responsibilities. They often do not have irrigated land for example. The other able members can be older children, grown-up sons (not the daughters as they are married very early), the man's parents, or one of his brothers… One person in the family is designated as principal herder.

The other group are families who cannot free up one member all year, because each of them has parts of the year when their work calendar is full. The purely dry-land farmers do however have long periods where the work level is low. The larger landowners in this category, with 3 or more active members, but none of whom are free all year, can have long histories of goat or sheep owning. Others are families who would previously have relied on labouring work to bring up their income level, but with this sheep or goat keeping activity can significantly cut down on the amount of outside labouring that they need to do. These are usually villagers with small areas of dry-land crops, with only 2 able adult members. They take it in turns to look after these animals: when there are gender specific tasks, such as weeding, the man can look after the goats while the woman is busy in the fields and vice-versa. However, this situation is complicated as there are times of the year when both are needed in the fields. Then the children are called upon to miss a few days of school, to go goat keeping for example.

Figure 50: Work requirements for a herd of sheep or goats



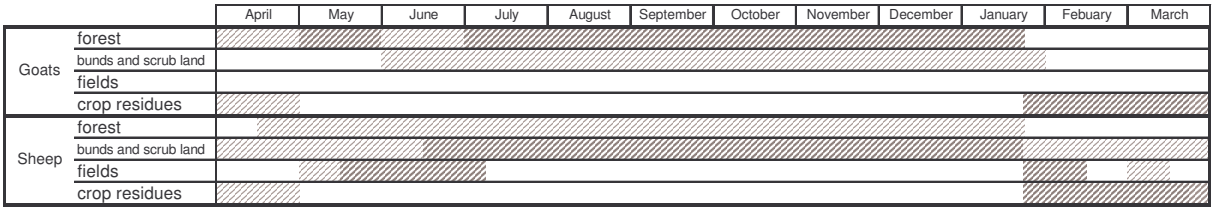
Total work time	365	ld/year	including herding, for a herd of sheep or goats of up to 60 animals

Still another category of sheep or goat owners pay a herder. These are only a small group today, as the people volunteering for such work are few and far between, due to the low yearly salary of between Rs. 5 000 and Rs. 10 000. For the owners, the herd must be big enough to make it worthwhile paying somebody.

…but no need for land

The advantage of these animals is that they need no other food than the grazing material. A few farmers feed them some grains if they are very thin or not producing enough milk; exceptional are those who feed them such extras to fatten them up faster. Therefore even landless farmers can keep sheep or goats.

Figure 51: Sources of food for sheep and goats



The choice between sheep or goats, is made according to who is going to be the herder. The goats are more interesting financially, simply because of their higher prolificity (annexe 7, Figure 48 and Figure 49). But they require being taken to the forest for large parts of the year, whereas the sheep are content to graze on grass around fields or on scrap land (Figure 51). If the herder is a woman, or is too old to trek off daily to the forest, sheep are preferred.

2.4.3.5 High milk producing cows for easy income - LS5

High milk producing cows have been present in this zone for about 10 years. They appeared as a few dairies started being set up, but only in the larger villages at either end of the area. Approximately 6 years ago, several new dairies opened and the number of cows in those particular villages increased fast. 3 years ago the same happened in another few villages. There the number of high milk producing cows is still increasing.

The high milk producing cows are cross-bred. Two main European dairy breeds are used, Jersey and Holstein-Friesian. These have been crossed with local zebu breeds. The introduction of the cows is too recent and their numbers still too limited for precise reproduction and mortality parameters to be determined, but they are similar to those of the other cattle (annexe 7).

High investment but high return

The daily milk that can be sold during the main part of the lactation is above 10 L for most of the cross-bred cows (annexe 7). This is much higher than the 3 or 4 L obtained from the buffaloes. The price of one cow is however expensive: the initial investment is around Rs. 15000 today. But the high return on the milk well compensates for this, even after deduction of the cost of the concentrates (annexe 7).

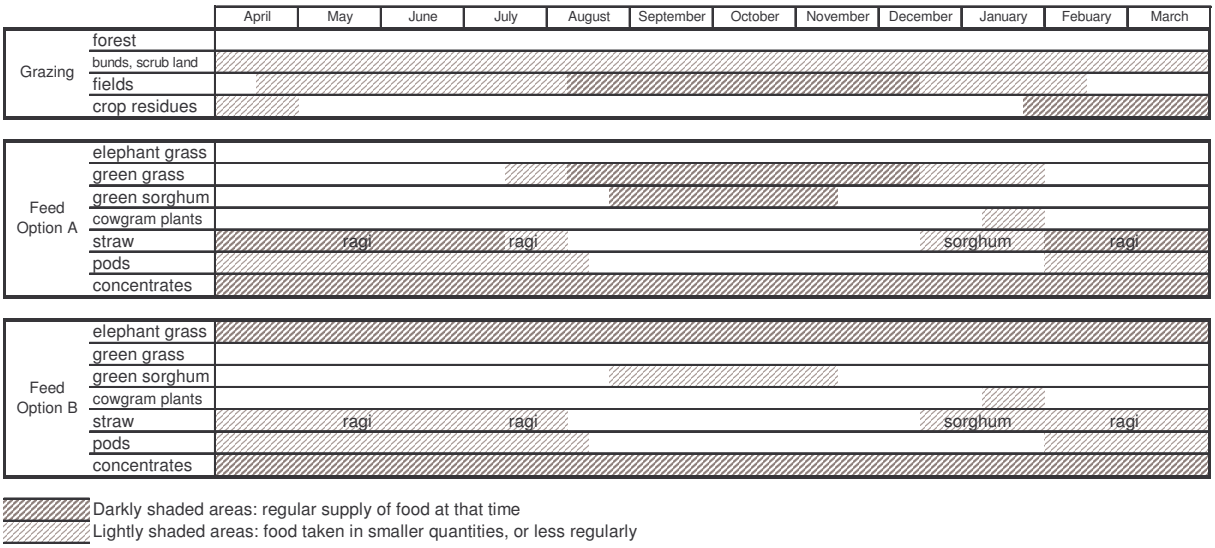
Most families owning such cows have only 1, a few have 2, despite it being an interesting investment. Some richer farmers have 6 or 7. The information presented here corresponds to just 1 such cow.

Less work but some land needed

The cross-bred cows do not like walking around, so are just tied in fields or on bunds. This reduces the necessary work to a couple of hours a day for the routine tasks.

It does however mean that the farmer must have some land to set-aside for them. They can be tied on common land at parts of the year, but this is not sufficient all year round. Moreover, despite their main intake coming from concentrates such as groundnut cake and sweetcorn or wheat flour, some straw is needed, unless the farmer has year-round green fodder from irrigated land.

Figure 52: Food sources for the cross-bred cows



Two different situations are presented for their food source (Figure 52). In the first situation (A), the farmer has no irrigated land and like the Hallikars, the cross-bred cow will depend on straw throughout the dry season, and green grass or sorghum in the wet season, for the bulk of its morning and evening food. In the other situation (B), irrigated land is available for producing fodder and straw is hardly used: a green fodder grass, such as elephant grass is used throughout the year, or at least throughout the dry season. The amount of straw required works out similar to that for a Hallikar, in the case where green fodder is not available all year round. Because these cows cannot be taken off to the forest, they need approximately 1 acre of land set-aside as grass land. This is only a very rough estimate, as it was difficult obtaining precise estimations from farmers, but it means a lack of land excludes many farmers from purchasing one of the animals, even should they want to risk a loan for that purpose.

2.4.3.6 Choosing the right animals: labour and fodder constraints

The daily routine work for looking after the animals can be arranged around the family's other tasks. The herding on the other hand requires one person for a whole day. The number of days when it is necessary will depend on the type of animal, so that the main difference in work requirements between the animals stems from the herding. For sheep and goats it is 365 days a year, so that a family can only keep these animals if they have the equivalent of one person free for watching them all year round. At the other extreme, the cross-bred cows are always tied in fields or on bunds and do not need watching. The Hallikars and buffaloes will present differences from one family to the next, in the extent to which they are: watched in the forest; taken to the forest and left there for the day; or tied in fields or on bunds, to avoid any herding work at times when such labour is not available within the family. There are usually ways to fit the labour required into a family's schedule, even when it is a very busy one.

The food for the animals can also impose a minimum amount of land needed. The sheep and goats need none, getting all their food from grazing in the day. The cows and buffaloes need a minimum amount of straw for half of the year and extra green material the rest of the time,

therefore a minimum of approximately 1 acre of ragi per animal. A main part of the cross-bred cows' intake is purchased concentrates. But they also require approximately 1 acre of ragi being grown per animal to provide straw and green material, as well as around 1 acre of land being set aside as grass land. The straw can be reduced for farmers owning irrigated land and growing fodder such as elephant grass.

2.4.3.7 Increasing outside inputs and decreasing use of the forest

The overall trend in the area is a decrease of the local breeds of animals and an increase in the number of cross-bred cows. From an economic perspective, this is discussed in § 2.4.5. From a resource perspective, this could maintain part of the farmyard manure produced. However it means a shift from the use of forest forage resources, to an increase in use of concentrates bought in from the exterior as a replacement source of organic matter. It also leads to an increase in land set-aside for grazing. There are consequences on the total productivity of the land, which can be compared with those for the other livestock systems (§ 2.4.5.2).

2.4.4 Much desired water

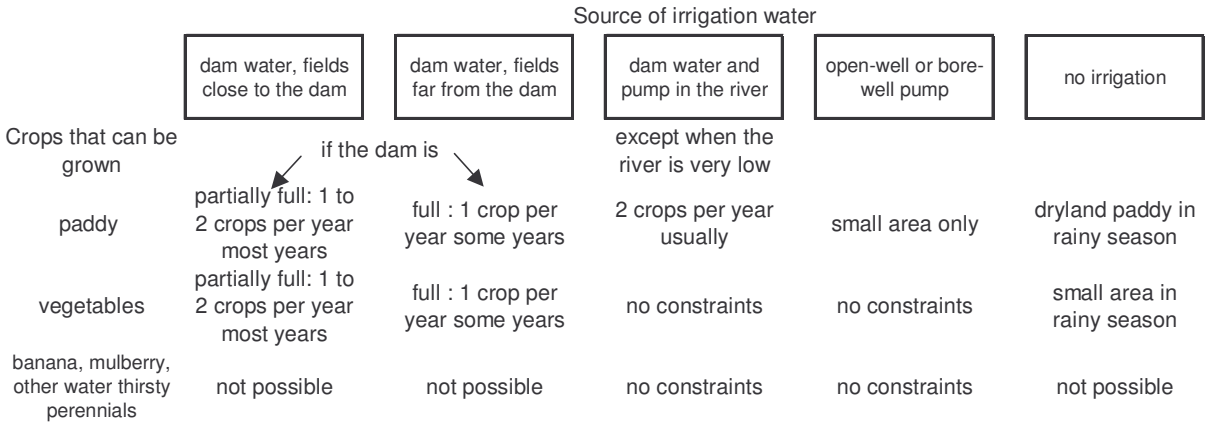
With access to water, a farmer's range of options increases considerably, some of which are examined here. In the area studied, the water for the irrigated crops comes from 3 different sources: directly from the dam, via the irrigation canals, and controlled by a government official; from open-wells or the river, with the help of a private pump set; from private bore-wells installed with a pump. All do not open up equal opportunities of crop choice.

2.4.4.1 Water sources and cropping possibilities

Farmers in the dam irrigated area with pumps installed in the river are in the most enviable situation. They have access to water all the time. They can grow 2 irrigated crops a year, of paddy for example, which is often transplanted on significant parts of their irrigated land. On the remainder, they usually grow perennial crops such as mulberry, banana, coconut, fodder grasses or flowering bushes (Figure 53).

With a pump installed in an open-well, farmers in other parts of the zone are in a similar situation, as to the crops that they grow. Paddy is however rare. It is sometimes sown on small surfaces, but there current is only available for half the day. This makes the total quantity of water insufficient to grow a large area of paddy as well as other perennial crops, which cover most of the irrigated land. The principal ones are mulberry, banana and vegetables. The vegetables are very diverse and would require a long study in themselves. Therefore these cropping systems are not presented here.

Figure 53: Cropping choice constraints imposed by the source of the irrigation water available to farmers



Moreover, the level of the water can drop significantly after several years of use, as has happened in some cases over the last 10 or 20 years. Depending on their localisation, some farmers have had to give up this source of irrigation. Those who have no suitable spots for open-wells, or whose open-wells have dried up, have been resorting to digging bore-wells. This started approximately 15 years ago and is a gamble: finding water or not finding water.

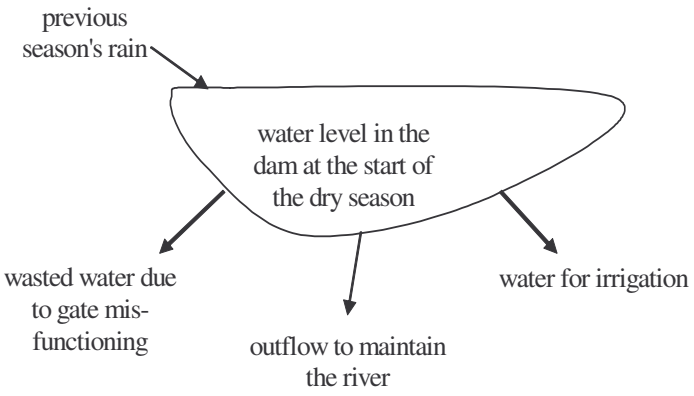
The farmers with access to dam irrigated land cannot grow irrigated crops every year. It depends on how full the dam is at the end of the previous year's rainy season (Figure 54) and how close the farmer's fields are to the dam (Figure 53). Just below the dam, farmers can often grow 2 irrigated crops a year. Further away, 2006 was the first year within the last 4 years where the farmers could grow paddy at all. Neither can the farmers relying on dam water grow perennial crops that need water every year and throughout the whole year (Figure 53). They grow principally paddy, and sometimes a little sweetcorn or vegetables as well.

The management of the dam water

The dam water is distributed to all farmers with land in the irrigated zone, for a limited period: while there is water behind the dam, and once the officials have decided to open the gate. It created a divide between those with land in the irrigated area and those with land outside and those with more land get more water. However, for those within the irrigated zone, the only investment was the labour to construct the bunds and it has benefited some more marginal farmers as well.

This water source is not a very certain one. Rainfall will obviously determine the possibility or not of having access to dam water for irrigation and the number of irrigated crops that can be grown. Some years more is available than others. Another factor is the quantity of water wasted (Figure 54). This factor should be able to be controlled.

Figure 54: Factors determining the available quantity of dam water



The dam was designed to irrigate a much larger area than the actual one, but not all the necessary canals have been constructed. Once full, the capacity of the dam is sufficient to allow the farmers of the irrigated zone to grow 2 successive irrigated crops. But even after a good rainy season, and with the limited area to irrigate, the dam cannot provide the necessary water for that: a large proportion of the water is wasted due to one of the gates, which once opened cannot be closed again. In January 2006, the water level was very high, after the exceptionally abundant rainfall in the later part of 2005. Much more water than needed flew out during the first cropping season. By June 2006, the dam was virtually empty. Without important early kharif season rainfall, no more irrigated crops could be grown in 2006, even close to the dam. The current state of functioning of the gates is not satisfactory: after the sums invested for the construction of the dam, it highlights the government's incompetence at managing this valuable resource.

For farmers without a pump, the presence of dam water is very uncertain and the paddy growing seasons have been few and far between. On many years, they are in the same situation as the dry-land farmers. Priority has therefore been given to pump irrigated crops, to

examine the difference between farmers with access to these and those relying on dry-land crops. As a consequence, the information relating to paddy has been left aside in this report.

2.4.4.2 The unregulated groundwater and river water

Installing one's pump, be it to use water from the river or from a well, has been encouraged by the government: for many years, no charge was imposed for the access to the water used and even the electricity for the pumps was free. Efforts were made to make electricity available for more hours per day. Recently there were subsidies that covered half of the price of the electrical connection to the mains. The beneficiaries are mostly farmers who had initial capital, as the pump, connection to the electricity mains and fencing represent a large investment. If a well must be dug, the cost is considerably increased, and even more so if it is a bore-well (annexe 8). Those who have a pump are nearly all larger landowners, and most belong to the higher castes.

Today there is a small "water" tax: an electricity bill that is proportional to the power of the pump installed. But there is no collective mechanism for the regulation of the use of the groundwater or the river water. Those who have a pump with access to water can use the water as they see fit. Those without either of these must continue as dry-land farmers.

There is no knowledge as to how much groundwater is present, to how long farmers might be able to exploit this resource for, nor the consequences of an eventual decrease in the water-table level. As explained above, some open-wells have dried up. Serious thought as to the future of this resource, and possible ideas of more efficient and fairer use of it are required. In this respect Green Foundation's work on water conservation is important. Other measures are required to imagine ways of extending the cropping possibilities and to make them accessible to all categories of farmers and not just those with initial capital.

2.4.4.3 Growing mulberry to rear silkworms: a bi-monthly income - CS6

There has been a fair tradition of producing silk in the area: mulberry has been grown there for at least 50 years. The mulberry species initially grown was left to develop as a tree, with small leaves, the picking of which required a still greater length of time than today. Sufficient leaf growth was only produced during the wet season, enabling some 2 or 3 batches of worms to be reared per year.

The development of open-wells and then bore-wells has meant that leaves can be produced throughout the whole year and new varieties of the *Morus indica* species have been introduced. These include S36 and more recently V1. They have been developed to produce bigger leaves faster, and be resistant to certain diseases (Datta). There are still many plants of the M5 variety in the area. All are grown as bushes and are cut back to the ground regularly. Since the introduction of these fast growing varieties, the quantity cultivated in the area has increased, although not all villages are concerned to the same degree.

The work required is the maintenance of the mulberry bushes throughout the year and the care and feeding of the worms for the duration of each batch. The number reared are counted in worm units: 1 worm unit is the number of worms that 1 female lays in one go. It corresponds to approximately 400 worms (Krishiworld).

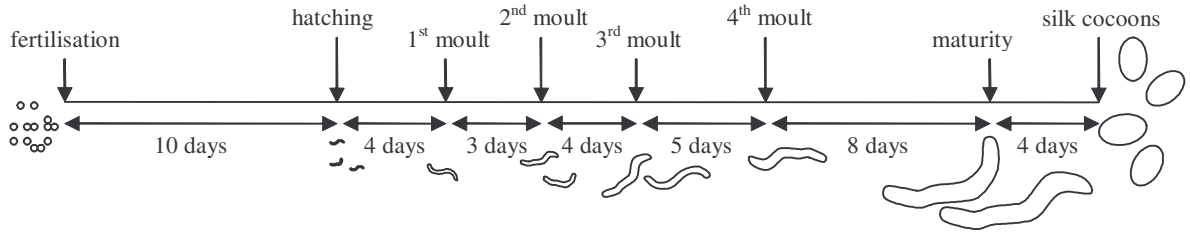
The 28-day silkworm cycle

The silkworms (*Bombyx mori*) are not bred by the farmers, but are purchased from Kanakapura, either as eggs, or, for a higher price, just after hatching. All the farmers around Kanakapura use the same type: they are a hybrid species of the "bivoltine" worm. Further

north, the climatic conditions are suitable for the rearing of pure race bivoltines that are used for egg-production in very controlled conditions.

The worms are very delicate and require being kept in a very clean environment and away from ants or mice or birds. The yields can vary greatly, depending on factors such as temperature changes, or various other health problems (annexe 8).

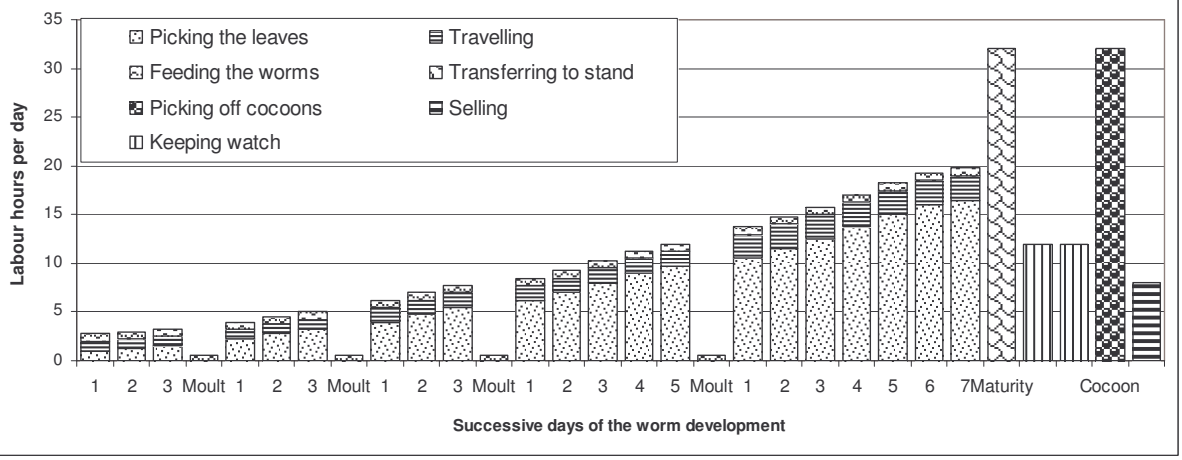
Figure 55: The silkworm life cycle



From hatching until the silk is spun, the cycle is 28-30 days long (Figure 55). As the worms grow, they need to be fed more and more mulberry leaves. On the days where they moult, they stop eating. Once they reach maturity, they are transferred from their protected interior racks, onto stands that will be placed outside. This is when they start spinning their silk cocoon. They do not need feeding any more for those last 4 days.

Up until that point, the feeding is done in 3 meals. The leaves must be very fresh, so that they are picked in 2 lots, daily. therefore, as the cycle progresses, the work required increases (Figure 56). It is very uneven. With 2 active members, the number of worms reared is usually between 50 and 100. For 100 worm units, 3 people are needed for picing the leaves for at least the last 4 days during which the worms need feeding, at the end of the cycle (Figure 56).

Figure 56: Monthly work calendar for the rearing of the 100 silkworm units



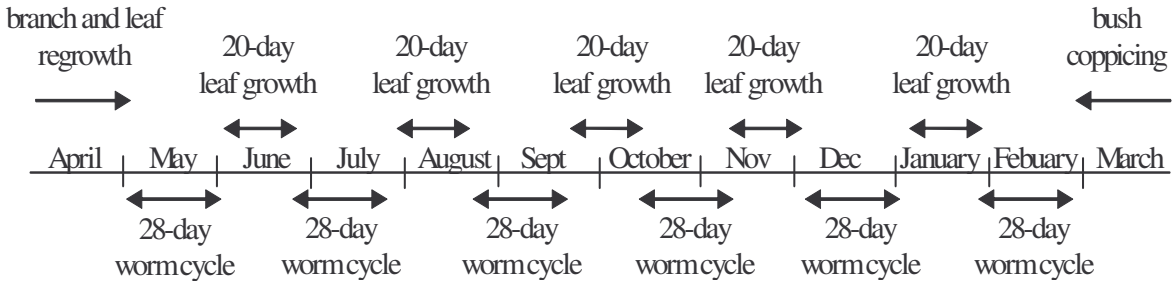
Four people will be required on the day when most worms reach maturity, at the end of the cycle, as they must be transferred to the stand as they mature. This means picking off selectively the worms that are ready to start spinning and is therefore a long job. On the last day, the cocoons are taken from the stands and quickly cleaned of any dirt. This again requires approximately 4 people. They will then rapidly be taken to the cocoon market in Kanakapura to be sold.

Other than in families with many active members, labourers are usually taken on for a few days. It is sometimes done as an exchange of labour between families who will not be rearing a batch at quite the same time.

Six batches of silk cocoons a year

After one silkworm cycle, all of the leaves have been picked from the mulberry bushes. It takes approximately 3 weeks for the leaves to grow back sufficiently to be able to start a new batch. One-day-old worms are purchased once the leaves are ready, or else, eggs can be bought some 8-10 days before, so that they hatch around this time. In this way, as can be seen on Figure 57, the family can produce around 6 batches of silk per year and bring in income every other month. Families estimate that 2 or 3 of these batches per year give poor yields, the others being good or reasonable.

Figure 57: Yearly management of the silk production



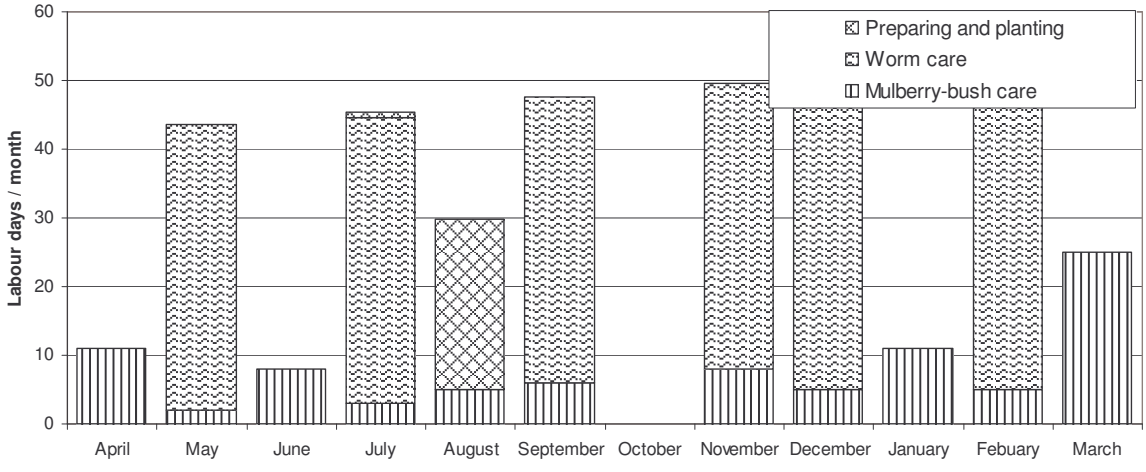
Once every year, or every 2 years, the branches must be cut back to the ground. At this period, manure is spread around the plants and the field is ploughed to aerate the soil, turn in the weeds and bank the soil around the base of the plants to cover the manure. Next, the earth is dug and banked to make plots for the irrigation. This also requires very small channels to divert the water to each plot successively so as to inundate them in turn (§ 2.4.4.4).

The maintenance of the bushes involves weekly watering, weeding once every 2 months when the weeds grow quickly, after the leaves have been removed, and applying urea every 2 months to speed up the growth of the leaves (annexe 8).

Small labour intensive irrigated area

The number of plants required depends on the variety of mulberry plant. For the newest varieties, such as V1, 1000 plants are nearly sufficient for 100 worm units. For older varieties, over 1500 plants are usually needed. This is what has been considered here, as it is still the most frequent situation in the area. This means a necessary 0.4 acres of irrigated land planted with the bushes. The yearly work for this number of worms appears to be manageable by a family with 2 active members (Figure 58), but there is in fact extra labour needed at the end of each worm cycle as explained previously.

Figure 58: Yearly work calendar for mulberry growing and silkworm rearing for 100 worm units



The maximum surface of mulberry that can be farmed by 2 active members is therefore very small. With a little external labour at the end of each cycle, they can manage up to about 0.5 acres, enough for 100 to 120 worms. Many families with irrigated land can afford to pay for labourers for tasks such as weeding or spreading manure. Most though do a large part of the picking of the leaves themselves, and only look for external labour when the workload becomes too much. For mulberry, rare are those functioning on a managerial basis of paying for all of the work to be done by labourers.

The small area that can be looked after by one family means that for farmers with irrigated land, it can be an interesting investment to plant a larger area of mulberry and lease it to neighbouring families. This is a common practise in some villages. There are therefore quite a few families rearing silk worms, who do not have access to irrigation and cannot afford to invest personally in the digging of a bore-well. The price for this land planted with mulberry bushes can vary considerably from one land owner to the next.

2.4.4.4 One crop a year of bananas - CS7

Banana plants produce fruit every year. With the practice of planting them all at the same time, the farmers obtain all of their produce in one go, once a year. At least one farmer has chosen to cut his bananas back at slightly different dates, so as to spread his crop throughout half of the year, and obtain a regular income.

This crop has only developed very recently, over the last 5 or 10 years. It requires a fairly large plot of land sheltered from the wind and, as for mulberry, irrigated with a pump, so that water is available all year round. A common quantity is 1000 plants. This takes up approximately 1 acre of irrigated land. Two main varieties are found: Elaki, producing small fruits much appreciated for their taste and Pach, which has large fruits. Elaki are by far the most common and the data relating to yields concern these bananas.

Frequent problems for banana plants

The non-organic farmers all apply large quantities of chemical fertilisers and usually at least some farmyard manure. They claim that the banana plants should give 3 crops before the plants need replacing. In practise, the average in the area is much less. There have been several cases of large parts of plantations being knocked over by the wind. Many farmers have also had to rip out most of their plants because they were affected by diseases, or had simply exhausted themselves producing too many fruit the first year and were no longer productive the second year. In the case of diseases, no products are applied. A few farmers use preventive fungicides when they plant the saplings. But even that remains rare and seems to concern mainly the larger farmers, functioning on a managerial mode.

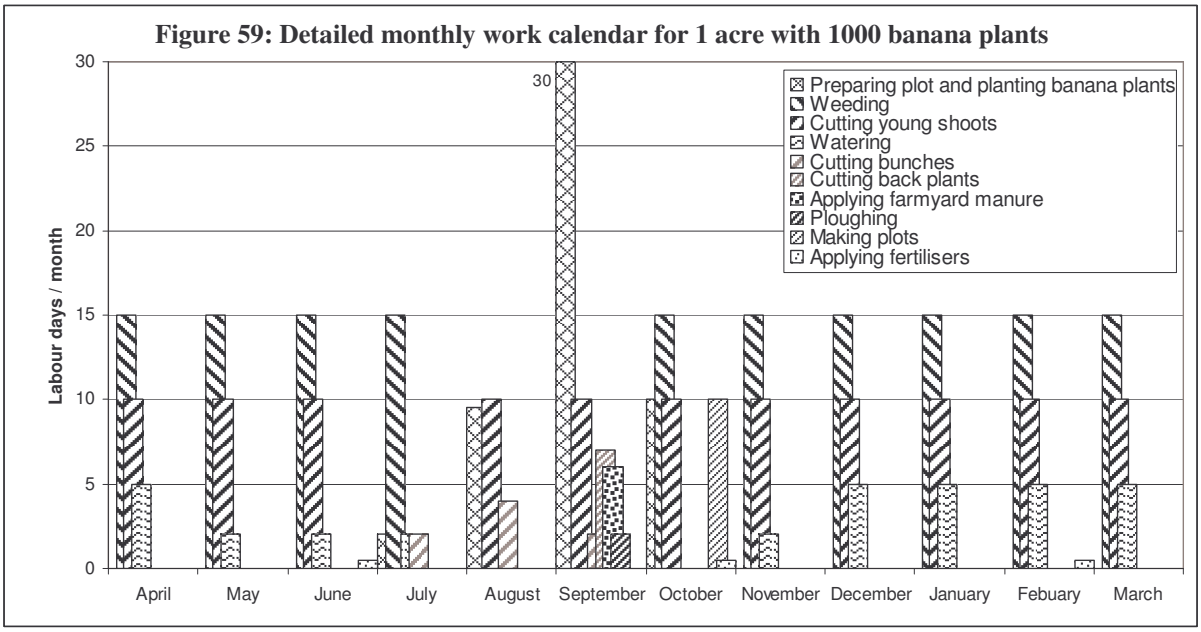
After ripping out the previous plants, several farmers were replanting banana plants in the same fields, because of the limited extent of their irrigated land and not knowing it could cause health problems for the plants. However, whether this is a frequent practise could not be verified, as many of the plantations are very recent.

An even distribution of the yearly work

The work calendars (Figure 59 and Figure 60) show both the work necessary for planting new plants, as well as that for maintaining them. Ripping out old or diseased plants must be added on top. It is not excessive if it is only done every 3 years, but obviously increases if the plants must be changed more frequently. This is true for preparing the plot and planting too.

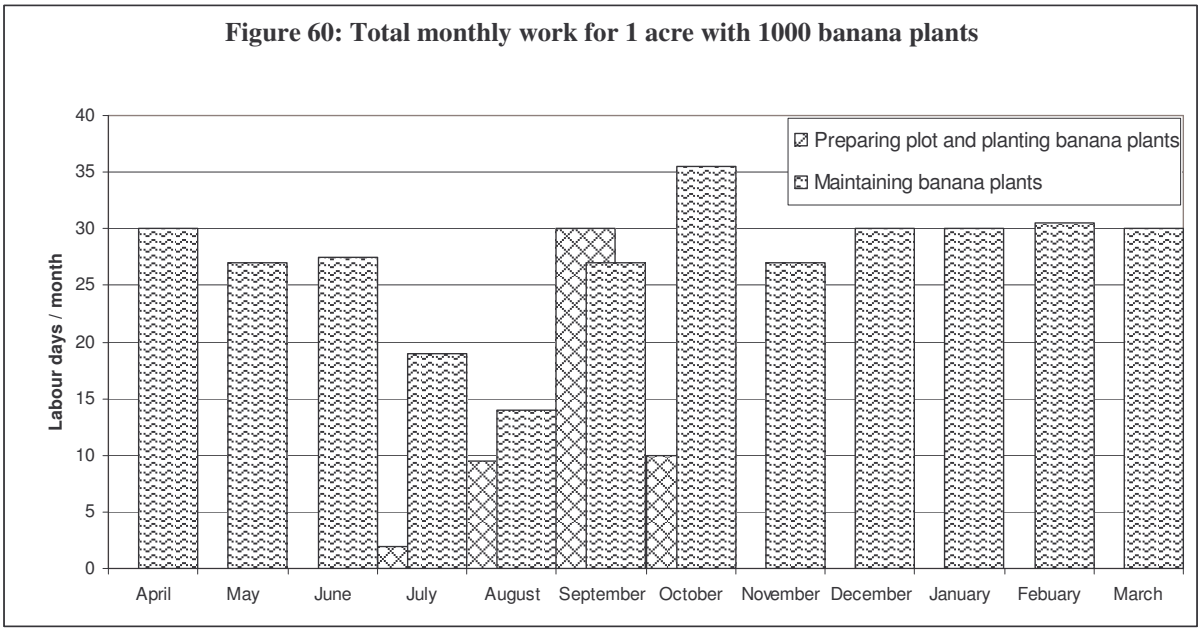
As with the other irrigated crops in the area, including mulberry, the water is distributed to the plants by digging small plots and channels in the ground. Earth is then moved to open and block the little channels and fill each plot successively. Someone's presence is therefore required for the whole duration of the irrigation (annexe 8). The necessary time throughout the year varies, as the frequency of the irrigation depends on the rainfall. During the wet season, it is very rare to have to give the plants extra water.

Figure 59: Detailed monthly work calendar for 1 acre with 1000 banana plants



The preparation and planting work aside, there are no real peaks in the work distribution, as many of the tasks, such as the weeding, are monthly ones (annexe 8). With 1 acre of banana plants, the monthly work calendar for 2 active members is not full (Figure 60). But a family will also be continuing with their dry-land crops. As the work for the bananas is very constant throughout the year, if the family does not want to be employing full time labourers, they would find it difficult to grow much more than this 1 acre of bananas (§ 2.5.4). The crop also presents high risk of failure, so it is best not investing all of one's labour and capital into it.

Figure 60: Total monthly work for 1 acre with 1000 banana plants



With the situation as it is, the families who cannot employ much full time labour can fit the banana work around the jobs for other crops, as the tasks in the banana plantations often do

not have a precise date at which they need to be done. For many families though, with irrigated land, they can afford to pay labourers, and have the most tedious and repetitive jobs, such as the weeding, done by them. Some farmers are in a managerial logic and pay for all of the work to be done by external labourers. This is also true for the larger surfaces of vegetable crops. It is much less true for the rearing of silkworms, where the use of labourers is usually reserved for weeding, spreading manure, high work peaks such as planting, and picking leaves during the busiest last stage.

2.4.4.5 Comparing organic and non-organic practices on irrigated crops

Most of the organic farmers are in Veereianadoddi and Aralagadakalu. Here, the irrigated crops are principally bananas and mulberry. Vegetables are grown in these villages, but on smaller surfaces than in some of the others.

Inputs: organic manure and chemical fertilisers

The non-organic farmers of the area use much higher levels of farmyard manure and chemical fertilisers, principally urea, on their irrigated crops than on their dry-land ones (annexe 8). The manure can be added at the time of planting for bananas, although some farmers claim that such this favours the development of worms and so is damageable to the roots. They prefer to apply the manure around the base of the plant later, as is done with mulberry. The majority of farmers do not use other chemical products on these crops: lime and another powder are used for the silkworms, but nothing is applied to the bushes; a few farmers apply some fungicide when planting the banana plants, but most apply nothing besides the fertilisers and manure.

A couple of organic farmers were identified who had not been influenced by Green Foundation. Both were cultivating bananas organically, but one because he could not afford to apply chemical fertilisers and the other because he had plenty of farmyard manure and did not judge it necessary to apply extra inorganic fertilisers.

The other organic farmers with irrigated crops are farmers participating in Green Foundation's activities. They have stopped the application of any chemical fertilisers and increased the quantity of organic matter returned to the soil, and many are using preparations such as *jeevamrutha*, as a general plant tonic.

Most cannot increase the amount of manure applied, as they have a limited quantity and cannot all afford to purchase more. Those who can often buy extra manure. The others can use the important quantities of vegetable matter produced by the irrigated crops. This is either integrated into the production of good quality basket compost or vermicompost (§ 2.4.2.4), or used as mulch directly under the crops. Green manure attempts have also started, with crops such as velvet bean planted under the bananas. Crop association, in particular tomatoes under bananas, or in between new mulberry bushes, was practised before Green Foundation's arrival, but has been encouraged.

Small changes in the workload

Organic farming requires mulching, making well-managed compost and other preparations and the application of these different products. The mulching, in the case of bananas for example, means that the leaves are left on the ground, rather than being carried to a compost heap, so that the quantity of work is actually less. With mulberry, the remnant waste, after the worms have eaten their share, has to be carried back to the field if it is wanted as mulching material. There is therefore specific work associated with it, but only about 3 md / acre. As to the preparation and the application of different composts, there is a small amount of

supplementary work. For example, the animal dejections are collected up daily anyway and taken to a manure heap; with vermicompost, they are taken to the vermicompost pit, which is often closer to the house; extra work will be needed, to water this compost, and collect green matter to add to the compost, but it is not a large quantity and can be managed by the families willing to do so.

2.4.5 Deciding which crops and which animals

As explained up until now, farmers have more or less choice as to which crops they can grow and which animals they can rear: for that, the land, labour and capital that they detain, as well as access to water or not, are essential factors (§ 2.4.2, 2.4.3, 2.4.4). Amongst the choices that are left to them, the productivity of the different systems will play an important part: productivity of the land for those with little of it; productivity of the work for those with "enough" land, or those able to grow crops with a high land productivity. These are examined now, for the different crop and livestock systems studied. They depend on the yields obtained, the price of outputs and the cost of inputs, all of which are sometimes very variable.

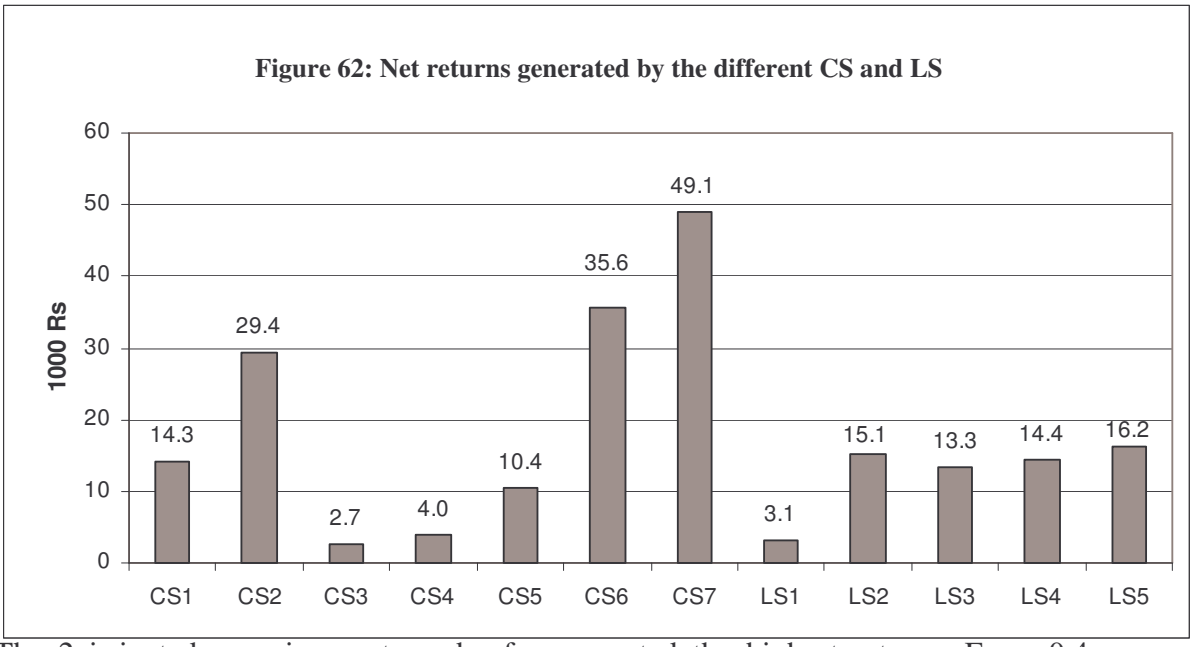
Figure 61: Description of the crop and livestock systems studied

Description	CS1	CS2	CS3	CS4	CS5	CS6	CS7	LS1	LS2	LS3	LS4	LS5
Main crops or animals	Ragi intercrops	Ragi Groundnut intercrops	Horsegram	Redgram	Sesame Ragi intercrops	Mulberry	Banana	Hallikars	Buffaloes	Sheep	Goats	Cows cross-bred
Other crops	Groundnut intercrops				Groundnut intercrops							
Rotation	Rg5 - Gn1	Rg1 - Gn1	various	various	S/Rg5 - Gn1							
Land surface	2	4	1	1	1	0.4	1					
N° of animals								2	2	10	10	1
Initial investment	3588	3588			3588	116820	119260	10000	10000	12000	12000	15000
Total work (days)	148	265	24	32	92	338	328	185	133	365	365	91

2.4.5.1 Net return of the whole cropping and livestock systems

The sizes of the cropping and livestock systems chosen correspond to those frequently observed amongst the farmers (Figure 61). A comparison of the different returns generated by them give some insight into the relative importance of each one for farmers (Figure 62).

Figure 62: Net returns generated by the different CS and LS



The 2 irrigated cropping systems by far generated the highest returns. From 0.4 acres of mulberry or 1 acre of banana, the return is indeed higher than from CS2, which represents

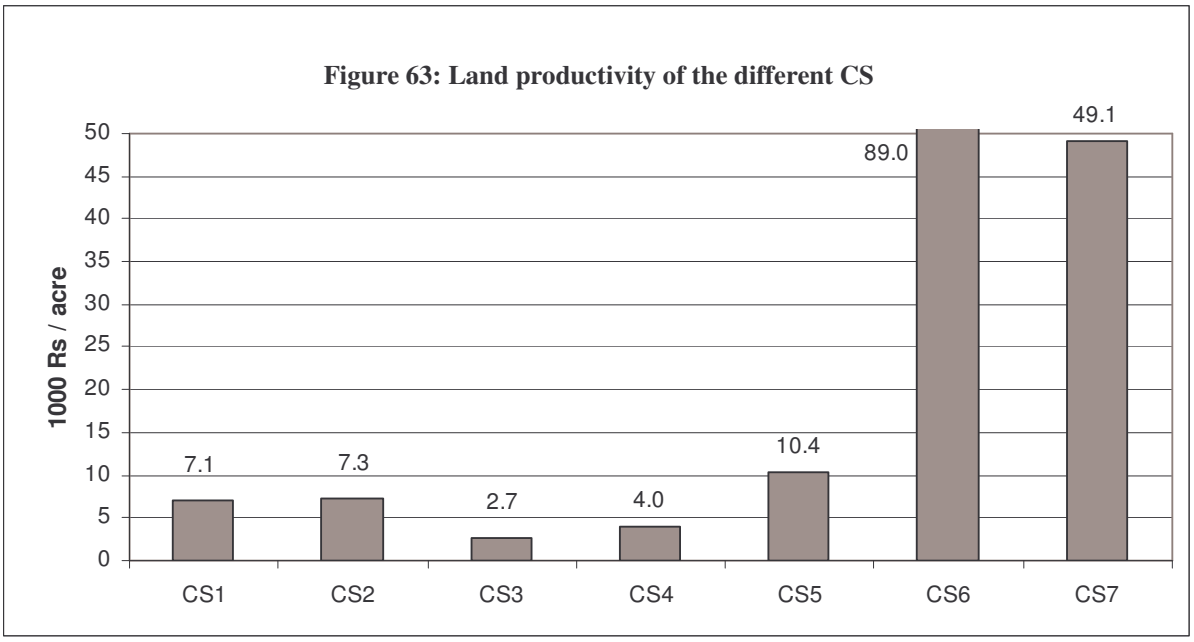
4 acres of ragi and groundnut. The areas sown with other dry-land crops are smaller (usually at most the 1 acre for CS3, CS4 and CS5) and therefore so are the returns generated.

As to the livestock systems, the Hallikars (LS1) produce very little net return: this confirms that they are not kept for that purpose, but as living "machines". If the "saved" cost of paying another farmer to do one's ploughing is taken into account, the net return is nearly doubled for a farmer with 2 acres. For the other livestock systems, it is interesting to note that the return that can be generated by the most common-sized system of each is very similar. Although per animal, the cross-bred cow generates a much higher return, this one animal brings in a comparable sum to the 10 goats or 2 buffaloes that other farmers regularly own. The return generated by any of these livestock systems is similar to that of 2 acres of the main dry-land cropping systems. This shows just how important the livestock systems can be.

2.4.5.2 Land productivity

The irrigated cropping systems generate a very high return per acre (Figure 63). In a situation where land is in short supply for many farmers, they are of particular interest. Indeed, "big" farmers in the zone are those owning 8 or 10 acres. Many farmers have 3 or 4 acres and significant numbers even less. This explains the hope of gaining access to water. Besides, the farmers with irrigated land will concentrate their energy and capital there, due to this high land productivity, at the detriment of their dry-land, relegated to second place. Access to irrigation can be classified as the main factor of differentiation between farmers today.

Figure 63: Land productivity of the different CS



For those who do not have access to water, the intercropping systems (CS1, CS2 and CS5) are much more productive than the mono-crop ones (CS3 and CS4). It is therefore not surprising that most of the land is sown with intercrops. CS2 with 50 % of groundnut and intercrops has only a slightly higher land productivity than CS1 containing only a small proportion of groundnut and intercrops, but this is discussed in detail in § 2.4.6.3.

The interest in growing sesame as an early season crop is also evident here: it can add nearly 50% extra return to the ragi and intercrop CS if the sesame yield is reasonable. No doubt the increasing trend in the number of farmers sowing it will continue, unless there are several years running with very bad conditions for its development.

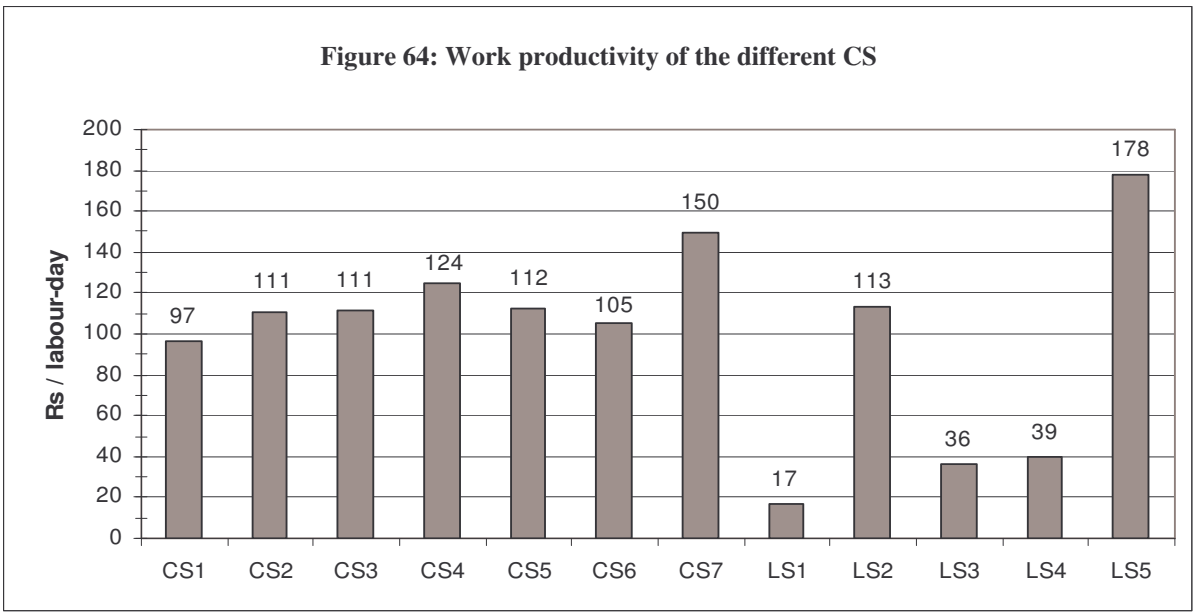
The land productivity of the different livestock systems has not been represented, as all of these systems depend not only on farm field land, but also on common land, including other farmers' fields in the dry season, and scrubland and forest land. Of a farmer's own land, the Hallikars and buffaloes require 2 acres of ragi to provide enough straw and sorghum for the 2 animals of an ordinary sized system (§ 2.4.3.2 and § 2.4.3.3). But these 2 acres also serve to produce ragi grain and other intercrops. Hence it is as if these livestock systems represent an extra return per acre: an extra Rs. 1500 / acre for the Hallikars and an extra Rs. 7500 / acre for the buffaloes. This means that the buffaloes can allow a total return of Rs. 14 500 / acre when combined with ragi and intercrops, higher than the return per acre with CS2: maybe growing groundnut is not so interesting after all, and farmers should be looking at growing a larger proportion of ragi to sustain more buffaloes.

For the cross-bred cow, 1 acre of ragi can provide enough straw and around 1 acre of land is required to be set aside as grass land (§ 2.4.3.5). From this 1 acre of CS1, 1 acre of grass and 1 cross-bred cow, the return is Rs. 23000, or Rs. 11500 / acre: much more than with just CS1 or CS2, but probably less than with the buffaloes; to verify this, a more precise determination of the required surfaces would be needed. The farmers with irrigated land have a higher total land productivity, so they do not have to worry so much about their dry-land productivity; also, they can produce green fodder all year round and so need less land set aside.

As to the sheep and goats, they require no land of one's own. In this area where access to the forest is no problem, they present an interesting way of using this resource. Moreover, they generate manure and so contribute to the lateral transfer of organic matter and nutrients from forest to farm land, as do the cows and buffaloes.

2.4.5.3 Work productivity

Figure 64: Work productivity of the different CS



The variation in the work productivity of the different crops (Figure 64) is much less than that of their land productivity. However, the work productivity of the cropping system based principally on ragi (CS1) is low. Thus farmers with more land tend to grow other crops once they have enough ragi to cover their needs. Red-gram is a case in point: the fact that farmers grow it as a separate crop can seem surprising when the land productivity is considered. But for farmers who are very busy, it is an attractive possibility of generating extra income with the limited days of labour that remain, or that they pay labourers to carry out. Farmers with

little land do not grow it separately. They sow mainly ragi, or ragi and groundnut. The introduction of groundnut increases the work productivity more than it does that of the land.

Horse-gram also has a reasonable work productivity but a very low land productivity. What with its ability to grow on poor soils with no fertiliser or manure, it means that it is grown on land too poor to give good ragi yields. Besides, the work fits in well with that for ragi.

Surprisingly, mulberry has a lower work productivity than most other crops. It is partly competing with silk coming in from other countries such as China, which can mean its prices stay relatively low. But its very high land productivity and regular income make it a particularly attractive crop, so that many farmers grow it locally anyhow. This too contributes to keeping the prices lower than they might otherwise be.

If the banana yield and price are fair, the work productivity of the crop is very good. The net return obtained is however very variable (§ 2.4.6).

The livestock systems have very different work productivities. The Hallikars generate little income, so that their work productivity is low. The sheep and goats require 365 days of herding; this makes their work productivity low too: at less than Rs. 40 per day, it is not much more than the yearly labouring wage. It must be remembered though, that this is for a herd of 10 adult females; one herder can keep many more animals than this, with little extra work (another trip to the manure heap and such). However there are probably greater risks of losing animals to predators if more goats are taken to the forest daily. For it to be worthwhile paying a year labourer to look after one's animals, one has to have a much larger herd.

Families with irrigated crops very rarely have sheep or goats. Indeed, the irrigated crops being labour intensive per acre, and their work productivity higher, it is better for such families to apply their workforce to these crops.

The cross-bred cows have a very good work productivity, unless one lives a long way away from the dairy and spends more than half an hour walking there and back in the morning and the same again at night. So with 1 acre of land set aside as grass land and the straw from 1 acre of ragi, one can generate the same return as from 2 acres of ragi (§ 2.4.5.2) with less work, which makes the cows particularly attractive.

The buffaloes go free-roaming and so require a little extra surveillance than the cross-bred cows. As a consequence, despite the work productivity of this livestock system being reasonable when compared to that of the cropping systems, it is lower than that of the cross-bred cow system. This could explain why their numbers are not increasing as fast as those of the cross-bred cows.

2.4.5.4 The costs of inputs and the necessary investments

In general, both the external inputs and the returns are much higher for the irrigated crops. As a percentage, the costs of inputs remain higher: 20-25% of the net return for the irrigated crops, as opposed to 10-15% for the main dry-land crops. For the dry-land crops, half of the cost is the external inputs: a little purchased seed (some years), fertilisers and pesticides. The other half is the cost of the manure and the tractor service for its transport (annexe 6).

It was sometimes difficult to verify the truth of the inputs that the farmers claimed to apply. A few farmers did not want to admit that they use less fertiliser than their neighbours or none at all, considering it to be a sign of poverty. On groundnut, this happened several times. Over the last few years, the low yields have not encouraged farmers to invest in inputs for this crop, as the return is far from guaranteed. Quite a few farmers are not applying any fertilisers at all on

groundnut, because they cannot afford to, or do not see it as worthwhile (§ 2.4.2.4). If the seeds are the farmer's own, the cost of the inputs drops to about half of its previous value.

So the costs of the inputs are fairly low. However, they are sufficient to make them inaccessible to the poorest families, or a source of debt for some. Although this situation was only exceptionally encountered during the interviews, its scarcity would require checking.

The cow-drawn implements are the main investments for the dry-land cropping systems. By sharing some of the more expensive tools, the cost can be reduced to less than Rs. 3600. Otherwise, they amount to Rs. 5400 (annexe 6). Many of them are inherited from the father.

The necessary investment for installing a pump is incomparable: a strict minimum of Rs. 60 000 is required to install a pump in the river; or to have a bore-well dug, the sum totals over Rs. 100 000 (annexe 8). These sums are totally prohibitive for most families.

Assuming the herds of animals are built up progressively, from 1 cow, or from 5 sheep or goats, the necessary initial investment is approximately: Rs. 9 000 for Hallikars or buffaloes; Rs. 12 000 for sheep or goats; Rs. 15 000 for cross-bred cows. Despite being much less than the necessary sums for gaining access to irrigation, they remain important, well above what most families can afford. They represent around half of the money that a family of four needs to live modestly. However, with access to a low-interest loan, they are sums that can be returned (§ 2.5.5.2). This explains why the SHG loans are often used for this purpose.

2.4.6 The hazards: variable productivities

All of the returns discussed until now are the ordinary returns generated in ordinary conditions. For many a farmer, most years are not ordinary years. Other farmers are never in ordinary situations. This creates a high-risk situation for many of them. The reasons behind the variation from one farmer to another and from one year to the next are examined.

2.4.6.1 Examples of the variability that farmers face and their reasons

- In 2005, October was particularly wet, with more than double the average monthly rainfall (§ 2.1.1). Yields were rarely more than half of their "ordinary" value. Then in 2006, virtually no rain fell in June or July. Those who had sown saw their seedlings dry out. Those who had not sown did not know if the very late filling of the grains, that would be a consequence, would happen at a time when there was any moisture left available (§ 2.4.2.1). Most farmers were hoping they might still get half of an "ordinary" yield.
- In 2004 and 2005, many a farmer lost at least half of their ragi and intercrops to the elephants; some lost it all.
- The last 3 years have seen large herds of goats and sheep reduced to less than twice their size by a disease that has been going around.
- A herder with just a few sheep can lose their ram and not be able to afford another; one year can go by with no new pregnancies…
- If the 5% mortality rate hits your one cow, it can be serious; if it is a cross-bred cow purchased with a Rs. 15 000 loan, at 4% monthly interest, it is worse.
- It is not uncommon for the wind or the elephants to knock over half of a farmer's banana plants; or for a disease to wipe out 3 quarters of them.

- The "ordinary" ragi yield is 8 q / acre; 5 q / acre is a low yield; but some farmers are pleased if the get 3 q / acre.

The returns obtained are therefore very variable from one farmer to another and from one year to the next. The reasons include: ordinary animal mortality in small herds and specific epidemics; varying yields; varying prices.

2.4.6.2 Animal mortality and its consequences

In a herd with 1 or 2 animals, such as is the case for many farmers' cows or buffaloes, ordinary animal mortality can have severe consequences if it hits one of the few animals owned. There are many different causes (§ 2.4.3), adding up to a mortality rate of approximately 10 %. A specific investigation would be required to see easier access to veterinary services or some training on certain animal health issues would help avoid some of the deaths. Farmers appeared to have good knowledge of their animals, as they did with their crops, but for some uncommon problems, support in giving a good diagnosis can be useful.

There has also been an epidemic touching both sheep and goats over the last 3 years. The illness has caused severe mortality in some herds. Medication is available from the vet, both curative and preventative. Not all of the farmers use the preventative medication, as some consider it to be very costly. Most call out the vet once the animals are ill. It can be too late.

The vet present in the area is available most of the time. There can be particularly busy periods. The main cause of not having him intervene though, seemed to be due to the cost that his services and any prescribed medication represent. For some farmers, it is too expensive. Other farmers prefer to use ayurvedic medicine anyhow.

It would also be useful looking at how to alleviate the consequences of these deaths for farmers in precarious situations. Developing low-interest loans is one example.

2.4.6.3 Yield variations

Factors affecting yields depend on the nature of the crop. Dry-land then irrigated cropping systems are examined. Specific investigations would have been required to establish definite correlations. Sufficient information was collected concerning the ragi and intercrop system, to enable some of the factors to be classified according to their importance. Trends for other cropping systems are discussed briefly.

The example of dry-land crops

From the interviews conducted, the factors affecting the yield of dry-land crops include:

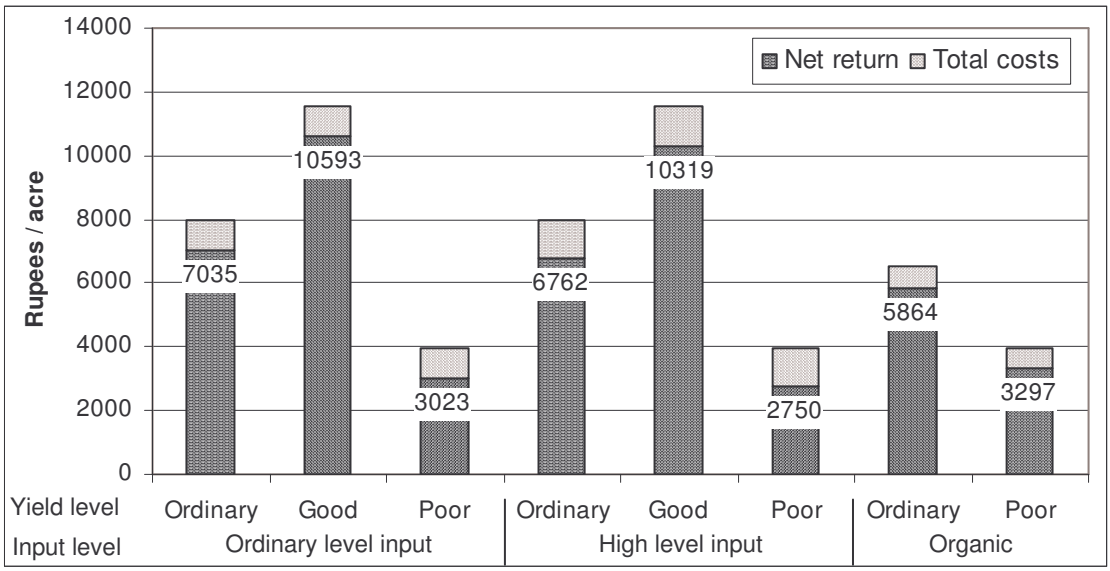
- the rainfall pattern, important in explaining differences from one year to the next;
- the quality of the soil, responsible for large differences between farmers;
- the quantity of organic manure applied;
- other types of organic fertilisation used, the soil coverage;
- the quantity of fertiliser applied;
- the density of seed sown, the variety and frequency of seed renewal
- the date of sowing in relation to that year's rainfall pattern;
- the previous crop, the mixture of intercrops and their proportions;

- the nature of the soil preparation and other work carried out;
- the quantity lost to wild or domestic animals, with elephants in particular being a serious cause of loss of produce, dramatically so for several farmers over the last 3 years;
- the quantity lost to pests or diseases (red-gram and cow-gram principally);

Ragi and intercrop yields

There are too many parameters for conclusions to be drawn with any certainty. However, for ragi and intercrops, over 20 interviews were conducted where technical operations and yields were questioned in detail. They were used to define different representative scenarios of the yields obtained and the costs incurred. Neither varieties, density and date of sowing, nature of the work carried out, precise crop combinations and sequencing, nor losses could be quantitatively linked to yields. However, possible correlations between yields and input levels, as well as the nature of the soil, were identified.

Figure 65: Production costs and net return for 1 acre of ragi and intercrops in different situations



The yields have been converted into gross returns, by using the average selling prices of the crops (annexe 6). There are very large differences in the results obtained by farmers. Four categories of yields were defined (Figure 65). The highest level is rare, with 12-13 q / acre of ragi and high yields of the intercrops. The ordinary level, at 8-9 q / acre of ragi, corresponds to what many farmers get on a reasonable year. The poor yields, with 5 q/ acre of ragi can arise in 2 different situations: farmers getting ordinary yields on some years, which drop to poor on a year when the climatic conditions put the plants under stress, or on a year when they lost a large proportion of their crops to the elephants; farmers always getting poor yields. The organic yields were very difficult to estimate. In the end, it was decided that the most representative situation is a low yield of ragi and ordinary yields for the intercrops (annexe 6).

Three different levels of chemical inputs have been distinguished: ordinary, high and organic (Figure 65). These correspond to what the farmers apply (annexe 6). An average level of farmyard manure has been chosen, although this too varies considerably. On an ordinary or high output level, the total cost of the inputs generally only represents a small percentage of the gross return obtained: 10%-15% (§ 2.4.5.4). If the yield obtained is low, the cost of the inputs can reach 25% of the gross return.

There is no apparent link between the level of chemical fertilisers applied and the yield obtained: some farmers applying a very small quantity obtain as high yields as the farmers applying a lot more; some of the farmers applying high levels are only getting "ordinary" yields or less (Figure 65). If this is confirmed, it means that a certain number of farmers are "wasting" fertilisers: they could be obtaining the same yields with less and the levels of fertilisers could be rapidly reduced for all of those in this situation.

The main factors differentiating farmers obtaining "ordinary" yields and those obtaining "good" yields appear to be the location of their fields and the quantity of manure applied. The farmers getting high yields all have fields on the upper flatter parts of the landscape, with fairly deep soils of the red or black type. They all apply chemical fertilisers, but some at the level defined as "ordinary" here, and some at the "high input" level. However, those with "good" yields" are those applying higher levels of manure per acre (1.5 to 2 tractors per acre or 3 to 5 tons per acre, instead of a scant 1 tractor load per acre). The importance of the farmyard manure or organic matter levels and the quality of the soil therefore needs to be tested.

Although it is a common acceptation that the level of organic matter is a central factor for the quality of the soil, in different locations and different soils its importance can vary. Soltner (2003) discusses a frequent result whereby the combination of mineral and organic fertilisers gives very good yields: many experiments conclude that the plant draws most of its food from reserves in the soil rather than from mineral fertilisers; but the plant can access these soil reserves better if it has a little supply of easily available nutrients close to its roots, such as mineral fertilisers provide. In that case, sand soaked in cow urine could be beneficial.

An alternative explanation, given the climate, could be the influence of the soil organic matter levels on the soil structure and porosity. Higher levels of soil organic matter help prevent the formation of surface crusts, allowing the water to infiltrate better, but they can also significantly increase the water holding capacity of the soil. To verify this, correlations between the soil organic matter levels and the yields obtained would have to be checked.

Poor yields are observed when the climatic conditions are not right, which occurs frequently (§ 2.1.1): the rainfall pattern is a very important factor. The other situation for poor yields is crops grown on poor quality land: fairly steep, with the soil composed of a very thin, pale A horizon above a C horizon (§ 2.1.3). Such soil is more like rock in the stage of weathering than real soil. Also, the farmers concerned often have few animals and thus only apply small quantities of farmyard manure.

Further investigations and experiments are therefore required to try and determine the principal factors influencing yields, both in ordinary climatic conditions and in years when the water-stress is high. A majority of farmers would like to see their yields stabilised from one year to the next, by overcoming the climatic variability and would welcome support for this. Are there ways of decreasing the frequent water stress that reduces yields? Those obtaining very low yields would greatly benefit from any exchanges of knowledge and know-how enabling them to achieve higher returns. How do they improve the quality of their soil and increase its organic matter content, if such is the principal problem?

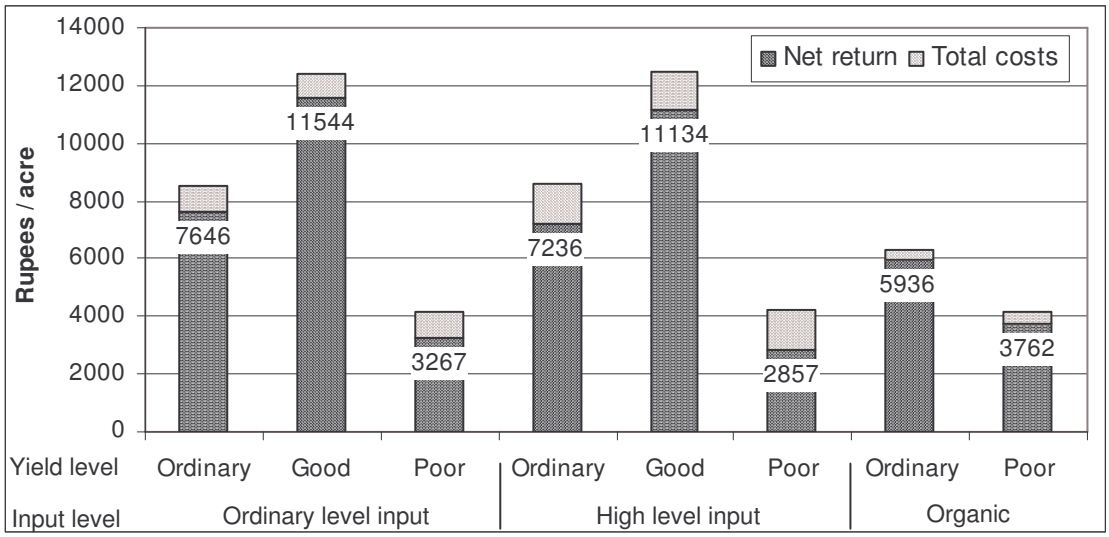
Confirmation that the level of soil organic matter and the soil quality are essential factors, as the interviews conducted here seem to indicate, is required. For this, the experimental protocol should be carefully thought through (§ 3.3.3.3). If confirmed, efforts to increase the organic restitutions to the soil can be redoubled. This is fairly tricky to achieve (§ 3.3.3.4), so that if it does not have that much effect, other measures can be given the priority.

Groundnut and intercrop yields

The results for groundnut are very similar to those for ragi. The main difference is that the overall per acre return is slightly higher with groundnut in all of the cases (Figure 66). Although the difference between the 2 choices of crops is only small, many farmers still prefer to sow up to half of their land with groundnut.

Two explanations of this fact appear plausible: either those farmers growing large areas of it are more interested in the fact that its work productivity is significantly higher (§ 2.4.5.3); or the land productivity is often higher because more farmers obtain the high-level yields of groundnut, whereas those obtaining high yields of ragi are rare. This second point appeared verified, but although over 10 interviews were conducted during which detailed information was obtained on the growing of groundnut and its results, this is insufficient for such conclusions to be drawn. It must also be remembered that up until recently, the average groundnut yields were much higher. Those still growing large areas of groundnut might simply be hoping that they will again obtain high returns.

Figure 66: Production costs and net return for 1 acre of groundnut and intercrops in different situations



The causes for the decrease in yields are difficult to establish. In areas where farmers are continuing to sow groundnut on important acreages, farmers claim that yields have only been low the last couple of years. It could therefore be the result of some difficult climatic conditions. Most have decreased their levels of chemicals, not wanting to waste "money" on an uncertain crop and hopeful that farmyard manure might prove just as effective. In other areas though, farmers report that yields have been low for at least 4 or 5 years. They got very good yields for several years, but since then, the numbers of nuts per plant have dropped, and the size of the grains has become very small. This could indicate a decrease in the quality of the soil, due to an excess of exported organic matter and too little returned to the soil. For some farmers, with land close to the forest, the problem is more one of a loss to wild animals, especially boar.

Verifying what factors are principally responsible for the decreases in groundnut yields could be of particular interest. Indeed, alternatives to be discussed with farmers are very different in the two cases: if yearly climatic variations are the problem, the varieties used, or even the pertinence of choosing groundnut as one of the main crops might require reflecting upon; if it is a question of soil quality, with too much organic matter having been removed from the fields and too little returned, Green Foundation's work around soil quality might be vital.

Irrigated crop yields

The yields of the irrigated crops are also very variable (annexe 8). Moreover, these crops also present much higher price fluctuations (§ 2.4.6.4) which impact on the returns generated. Of course, for these crops, climatic variability intervenes much less on yields. The wind can be a source of considerable damage for banana plants, but in theory, the plants' supply of water is controlled.

For mulberry, the variability of the silk yield is not so much due to the growth of the leaves, as to whether the silkworms develop well or not. The farmers have some control over the leaf growth, through the irrigation frequency and the amount of urea they apply. Of course, depending on the season, the light intensity and temperature vary and the growth rate is different. This conditions the number and frequency of the worms they can take on. The fact that a family usually takes on 6 batches a year seemed to give rise to an averaging of the yearly quantity of silk obtained. The difference in the average silk yield from one family to the next appears lower than for other crops, whereas it varies hugely from batch to batch (annexe 8). The frequency of water application and level of fertilisation can also be very different from one family to another. No doubt, optimisation of both of these could save water and money.

Farmers growing bananas obtain very different yields: 4-13 kg / plant were recorded (annexe 8). Detailed comparisons would require further investigations, but average yields appear to be at least as good as with high doses of chemical fertilisers. Lots of factors play a part, but the most important appear to be the quality and quantity of farmyard manure applied and the nature of the soil. Also, damage by elephants has been a cause of significant loss over the last 3 years, as with the dry-land crops.

The impact of organic cultivation on yields

The results currently observed under organic farming have been given here, but only to serve as a basis for looking into future research requirements: they are by no means representative of what might be possible under organic farming. Indeed, at present, the organic farmers of Veereianadoddi have been farming organically for a maximum of 3 years, and most only for 1 or 2 years; many have only been producing significant quantity of vermicompost for the last year, whereas this is one of the main strategies at the moment for increasing the organic matter content of the soils; most of this compost is being used on irrigated cropping systems; most organic farmers have access to irrigated land and therefore concentrate their efforts on this more productive land, as they consider their dry-land to be of lesser importance. Therefore the potential under organic practices is probably far from achieved yet.

As they stand at the moment, the dry-land yields under organic farming are very low. However, it must also be noted that the last 2 years have been poor years for most farmers, with a dry year followed by an exceptionally wet one. Also, in Veereianadoddi, none of the farmers were getting high yields any more: some did when the chemicals and high yielding varieties arrived; but for the point at which Green Foundation started work in the village, 3 years ago, the farmers report maximum ragi yields of 8 or 9 q / acre.

The farmers who were getting better yields before that were also the ones who had many more animals at that time. Among the lower caste community, of whom none were farming entirely organically up until this year, there are not the same reports of decreasing yields in the years prior to Green Foundation's arrival. Some of these farmers seem to get 8 or 9 q / acre, similar to previously. But then these farmers have never had large quantities of animals and probably have as many or more today than they have ever had. Amongst these

farmers, some are getting very low yields, either through damage from elephants, or because they have poor quality land on steep slopes.

Some aspects of the yields under organic cultivation are controversial: although locally all the organic farmers agree that ragi yields are very low (5 q/ acre was chosen here, but most farmers only got 3 q / acre last year), some claim that the straw yields are also much lower than previously, whereas others claim there has not been much decrease. The same is true with the intercrops: for some farmers the yields of the intercrops are similar to those obtained when they were farming with chemicals; for others these yields are lower as well. Both are very important aspects that need verifying: the quantity of straw that is produced will condition the number of cows that a farmer can keep; only approximately half of the net return generated per acre proceeds from ragi, most of the rest being the return generated from red-gram and cow-gram.

As the production costs are generally low, there is little chance that reducing these will prove to be a convincing argument in trying to persuade farmers to adopt organic practices. However, for those who always get low yields, there might be more interest in reducing the costs, as for such farmers, they represent a much larger percentage of the return generated. It would however require obtaining no further drop in yields under organic cultivation. If that is possible, there might be real potential for working with marginal farmers, struggling just to get decent yields.

For the other farmers, the current yields are not encouraging. Dry-land farming results must be examined and new strategies thought up, such as for increasing organic matter on these fields as well as on the irrigated crops. Otherwise, there is a high probability that all but the most convinced farmers will stop their organic practices on the dry-land crops. It might be best to proceed by encouraging farmers to test organic practices only on part of their dry-land fields, until effective practices can be identified and have proved their worth.

The opinions on the results of organic farming applied to bananas and mulberry all go in the same direction, despite the short test period, of between 2 and 3 years for the "oldest" organic farmers. Again, there is no information as to how the yields of these crops are to evolve in the future.

All the farmers questioned agree that without the urea, the mulberry leaves take an extra week to grow back sufficiently: this means one less batch per year; the economic consequence is loss of approximately 15 %, having taken into account the saved cost of not applying urea. The changes since conversion to organic seem to indicate that the growth rate of the leaves picks up gradually as the soil improves under continuous restitution of organic matter. The farmers believe that it could reach the rate they had when they were applying urea. Some also claim that they get a greater proportion of healthy batches of silkworms now that they are growing the mulberry bushes organically. There also seems to be a difference in the rate at which the bushes need to be cut back: differences in the frequency at which branches push out might mean that under organic practices, the bushes only need cutting back to the ground every other year, instead of the more usual once per year. This will require verifying in the coming years.

Farmers growing bananas organically were very pleased with the results so far: their yields appeared at least as good as those of other farmers. The lowest yields of organic farmers were an average of 5-6 kg of bananas per plant, whereas one conventional farmer had only recorded 4 kg per plant at the last harvest. Under both organic and conventional farming, the

average yields per plant could reach 12 or 13 kg per plant. The quantity of organic manure and the quality of the soil seem to be far more important factors.

Moreover, there were no recorded incidents of loss of banana plants due to diseases under organic farming, as opposed to the conventional farmers' plants (2.4.4.4). Organic plants were said to be much healthier and no plants have so far had to be ripped out. The plants are therefore considered to have a much longer lifespan without using urea or other chemicals.

2.4.6.4 The fluctuation of prices

Some crops are more subject to price variations than others. This has important repercussions on the net returns obtained by the farmers. Fruit and vegetables see huge differences in prices occur throughout the year, as does silk.

- At one point, in April 2006, farmers were feeding tomatoes to their cows: the price had dropped so low, down to Rs. 1 / kg, that it was not worth transporting them to the market. The price reached over Rs. 6 / kg at its maximum throughout the year. The variations are also very important from one year to the next, as 2003-2004 saw the price reach Rs. 18 / kg.
- The price that the farmers interviewed had received for bananas over the last couple of years varies between Rs. 6 and Rs. 18 / kg; there is no "ordinary" banana price.
- Silk fell victim to international trade regulations. In 2004-2005, the average sale price over the year dropped by 10 %, as silk from China flooded the market. In the end, the government reintroduced restrictions on the imports. In 2002-2003, a similar phenomenon had occurred, with a price drop of over 25 %. The day to day fluctuations are also very important, the price having varied between Rs. 80 / kg and Rs. 220 / kg throughout the year 2005-2006.

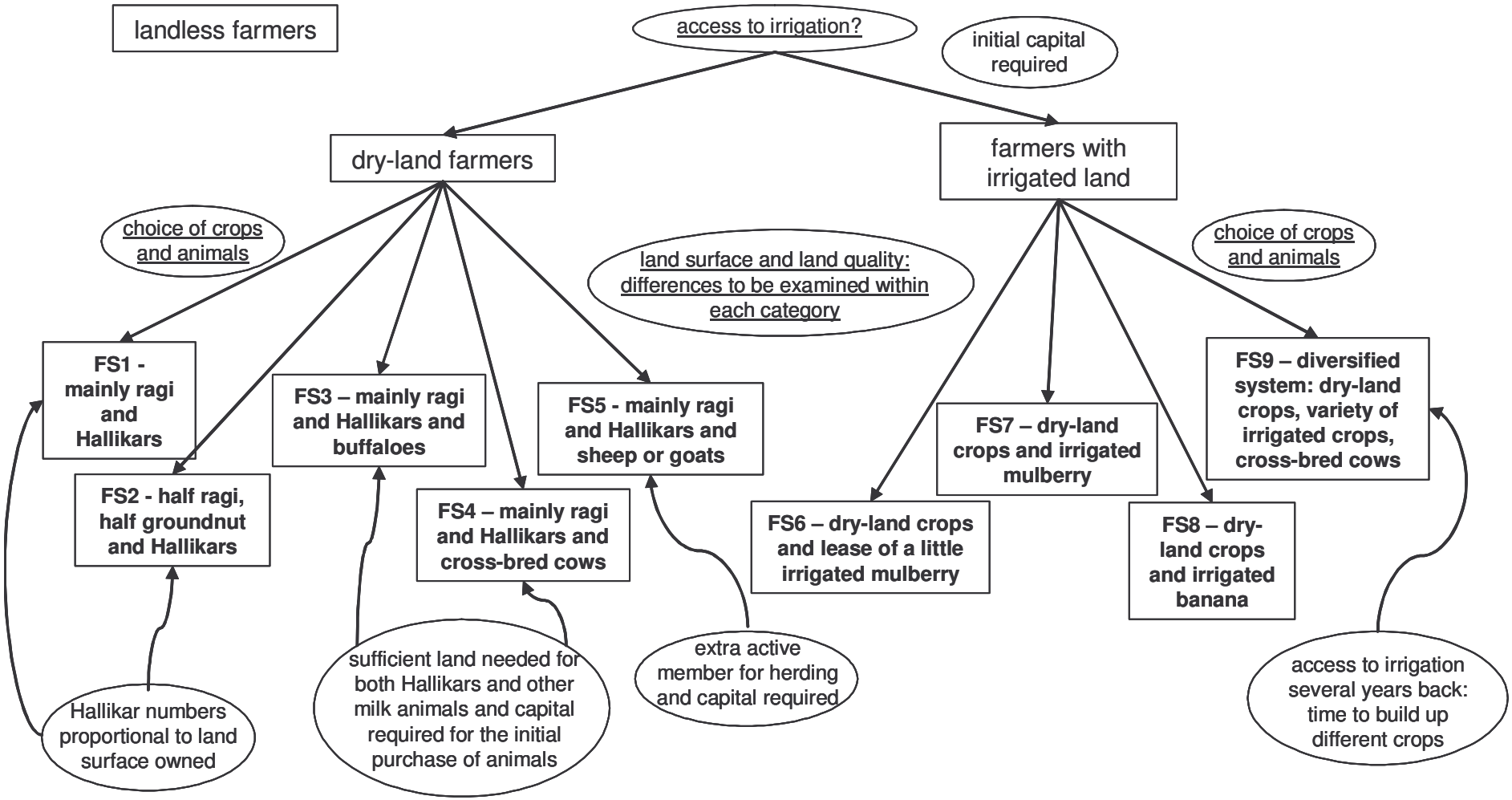
For the main staple crops, the government has a price regulation mechanism, buying up produce at a minimum support price (MSP, § 1.1.2). But in the area most farmers sell to intermediate traders and are far from benefiting from the MSP for many crops. For some crops, the price obtained from the traders is above the MSP, but for most it is lower. However, the government supported system means that the variations from one year to the next are much lower than they would otherwise be. For ragi for example, these variations can reach 20 %, but 10 % is a more common situation. Intra-annual variations remain, but they too are attenuated by the price regulation mechanism. For ragi, fluctuations of 5 % above or below the mean are common throughout the year.

This brief discussion highlights the importance of keeping price fluctuations in mind. They are particularly problematical for the irrigated crops, as 3-fold variations throughout the year are common, making the returns that farmers obtain extremely uncertain. Other marketing opportunities would be particularly welcome (§ 3.3.2, 3.4.2). For the dry-land crops, the variations tend to be smaller, of less than 25 % usually. However, this remains significant and other opportunities should not be neglected, as they could contribute precious increases in the net returns.

Currently, very little of the organic produce is commercialised as such. Most is sold through the conventional traders. Green Foundation is setting up new organic marketing opportunities for farmers who wish to join a local federation. They are also encouraging value-addition through the transformation of produce: dhal produced from whole gram for example. The

price of dhal is usually close to double the price of whole grams. Both ideas should have important repercussions for the local farmers. Other initiatives in this direction could be very useful. No doubt opportunities exist for both extra value-addition as well as new marketing possibilities, in the neighbouring cities, but also in the local villages themselves (§ 3.4).

Figure 67: Some representative farming systems of the area



2.5 SOME REPRESENTATIVE FARMING SYSTEMS OF THE AREA

To understand the situation that the farmers in the area are in, some characteristic farming systems of the area are presented. All of the cases cannot be examined; some representative ones have been selected (Figure 67). Possibilities and desire for change within different categories of families will be discussed, both as concerns organic farming and other issues.

2.5.1 The observed farming systems

Families will make all kinds of individual choices, based on their different priorities. However, the access to or ownership of land, water, labour, animals and other capital (§ 2.2.4), as well as any debts they owe, will partly restrict their freedom of choice (§ 2.4). Moreover, all families tend to choose the crop and livestock systems with the highest productivities (§ 2.4.5). In this, the economic analysis is useful: these factors push all of the families' choices in the same direction, so that general trends appear, whereas other factors, such as personal preferences are more complex. From there, a classification of farming systems can be established, with the particular combinations of crop and livestock systems that optimise the most critical resources within each category.

Family size and available labour

The size of families varies considerably. However, currently most couples have 2 children. This has been taken as a basis. A greater number of children has become rare since the government's family planning policy (§ 2.3.1). For such families, there are more mouths to feed, and possibly more daughters to marry… The situation is harder, at least up until the children are old enough to really take part in the work. If there are several couples with children within one household, they can be artificially split into 2 units.

The other difference is the number of active members. This commonly varies between 2 and 6, with the husband's parents, or a brother or two sometimes still living with the family. Above 5 active members, the situation often does not last long, as at some point in time, families divide the land between the sons. 2 and 4 active members represent 2 common situations, that can easily be extrapolated to families with say 3, or 5, active members.

Different numbers of active members increase the available work and required income. Most of the farming systems chosen have 2 active members and the income generated has been calculated in this case. With extra members, two different situations are possible.

- If the land surface available is sufficient for the extra members to contribute to generating a greater return or reducing the amount of paid labour required, the family tends to be slightly better off than otherwise. Most families with irrigated land are in this situation, and the larger dry-land farmers usually are too, as the more workers there are, the more can be grown. These cases are not detailed.
- If the land surface is too small, the workload will spread across all of the members, without the extra workforce being able to generate extra income, as the land surface restricts the return that can be obtained. These families, if they had access to the necessary capital, often have a herd of sheep of goats: keeping these animals, as in FS5, does not require any land (§ 2.4.3.4), but creates income with the extra workforce. Otherwise, the family's economic situation will be harder.

Other than the case of FS 5, the systems presented are based upon a family of 2 adults and 2 children to calculate the cost of extra labour, the income generated and that required for the

family. It must be kept in mind that extra active members in the family usually alleviate the difficulties faced, whereas extra non-active members make the economic situation harder.

To assess the income required for the family, 2 reference levels are used (annexe 4). The first is the income that just covers the family's basic food requirements and minimum upkeep: the survival level. This income is very low, due to the PDS (§ 1.1.2). The second is a low but reasonable income, covering a higher food ration and more diversified albeit simple diet, basic upkeep items and schooling costs: the basic upkeep level. Both of these incomes are insufficient to set money aside for future investments or for exceptional expenses.

Access or not to irrigation, an essential factor

The rest of the classification is based on the other factors that introduce differences between families. In the area, land is in short supply and land productivity is therefore critical for most farmers. Since the irrigated crop land productivity is much higher than the dry-land crop one (§ 2.4.5.2), access to water is essential in distinguishing between farmers. If it is chosen as the first factor of differentiation, as here, it allows 2 large categories to be established (Figure 67).

To own a pump, the only source of water studied here (§ 2.4.4), one must have the necessary capital. Other farmers with access to water have large debts covering the investment.

Taking into account land surface, land quality and the yields obtained

Within both of these categories, land surface is obviously an important parameter. The largest landowners, with over 10 acres are very rare and have not been specifically studied here. They have a very different reasoning and functioning, as land productivity is not an issue for them. They would find it impossible obtaining enough labourers to work all of their land, and therefore usually have plantation crops, or lease large parts of their land. At the opposite end, the situation of the families with no land of their own (Figure 67) is discussed, as these families remain numerous, especially in the larger villages of the zone.

For the other farmers, the land surface has been considered as a parameter within each different farming system. Indeed, farms with similar combinations of crop and livestock systems, but totally different land surfaces were observed. The area of irrigated land also varies, but within a smaller range, and many farmers had similar surfaces of irrigated crops, determined more by the amount that can be managed by one family.

Yields also being very variable from one farmer to the next, and from one year to the next, different scenarios have been examined within each farming system. 3 levels of yields are chosen: ordinary, good and poor (§ 2.4.6.3). The good yield is rare: only a few farmers obtain such yields for ragi on a normal year. The ordinary yield is what many farmers manage to grow when there are not too many climatic complications or too much damage from animals. This can be just once every other year or less for many farmers. The poor yield is what most farmers obtain on a year when the rain is a problem, or if there are losses due to animals. But it is also what certain farmers, with poor soil, little manure, etc., grow on ordinary years. For some farming systems, the yields currently obtained by the organic farmers are also presented.

Taking into account the crops grown and the animals owned

The choice of crops and animals is more complex. Hence specific farming systems have been defined, coherent with the interviews. The classification is also based on the analysis of the different crop and livestock systems, allowing farmers' choices to be understood.

Amongst the dry-land farmers, the first constraint faced is often a land shortage. Hence they select crops with a high land productivity: the main cropping systems are ragi and intercrops,

also needed to feed the cattle, and groundnut and intercrops (§ 2.4.5.2). A combination of half and half is preferred by farmers with enough land, unless their groundnut yields are low. Farmers with land far from the village, susceptible to damage from wild animals, often obtain low yields. But recently, low yields in many areas have meant the number of farmers growing mainly ragi has increased (§ 2.4.6.3). With the number of Hallikars fixed by the land surface owned, this gives 2 different farming systems: FS1 and FS2 (Figure 67).

In some villages, many farmers no longer keep Hallikars and have the ploughing work done by hiring a tractor and its driver. This has not been dealt with in this report. A few farmers do not own Hallikars, because of a lack of capital. Their situation is discussed below.

Owning milk-producing cows also depends on access to capital to purchase them initially. But land is also required, to provide the fodder. Such fodder can be bought, but few farmers do so in most of the study zone. Supposing the farmers have 2 Hallikars for ploughing, they need over 2 acres of ragi to feed any other cows. The number of animals has been determined by the area of land available for producing fodder in FS3 which includes buffaloes, and also by the land set aside for grazing in FS4 which includes cross-bred cows. Sheep or goats require initial capital and usually an extra member in the family for the herding, as in FS5.

The farmers with access to irrigated crops can be divided into 4 categories: those leasing land and growing the crop implanted there; those with access to dam water only; those with their own land and pump, either downstream of the dam and able to grow paddy, or upstream growing mainly perennial crops (§ 2.4.4.1). The irrigated land usually concerns mulberry, when leased, like in FS6. The case of the farmers downstream of the dam is not presented. The situation upstream of the dam is split into 3 farming systems, depending on the crops chosen: those who have only recently acquired access to irrigation, often have only one irrigated crop, most frequently mulberry, as in FS7, or bananas, as in FS8; farmers having had a pump for a long time often have a large irrigated area with a diversity of crops, such as FS9.

The money earnt and the money kept

For each farming system, the income generated is compared with the necessary income for keeping a family of that size. However the money generated by the farm is not always entirely kept for this purpose. Families do not necessarily own all of the land they farm, which means part of the income goes to the landlord. Some farmers do not have their own cows and extra wages have to be paid to have their land ploughed. For other farmers, the initial capital was a loan, for which there is interest to be paid. Some of the money made can also be spent on needs other than those of the family's upkeep. All of these issues create important differences between families with apparently similar farming systems. Examples will be given.

2.5.2 The landless labourers

Some 50 years ago, the year labouring wage was 6 bags of ragi, with usually a midday meal per day, and a set of clothes and pair of shoes per year. This would total approximately Rs. 4000 / year. The 6 bags of ragi covered the family's carbohydrate needs, but no more.

Now, the yearly wage is normally Rs. 10 000 / year, and sometimes up to Rs. 12 000 / year. Rs. 10 000 / year corresponds to less than Rs. 30 / day. When compared to the amount generated per day of work in a dry-land system, it represents somewhere between 1/3 and 1/2 of the added-value created. It remains insufficient to cover the basic needs of a family of four, meaning that if the husband is doing such labour, his wife must also go out to work as a day labourer. Generally though, very few people are prepared to work for so little.

Figure 68: Work calendar for FS 1 on 2 acres

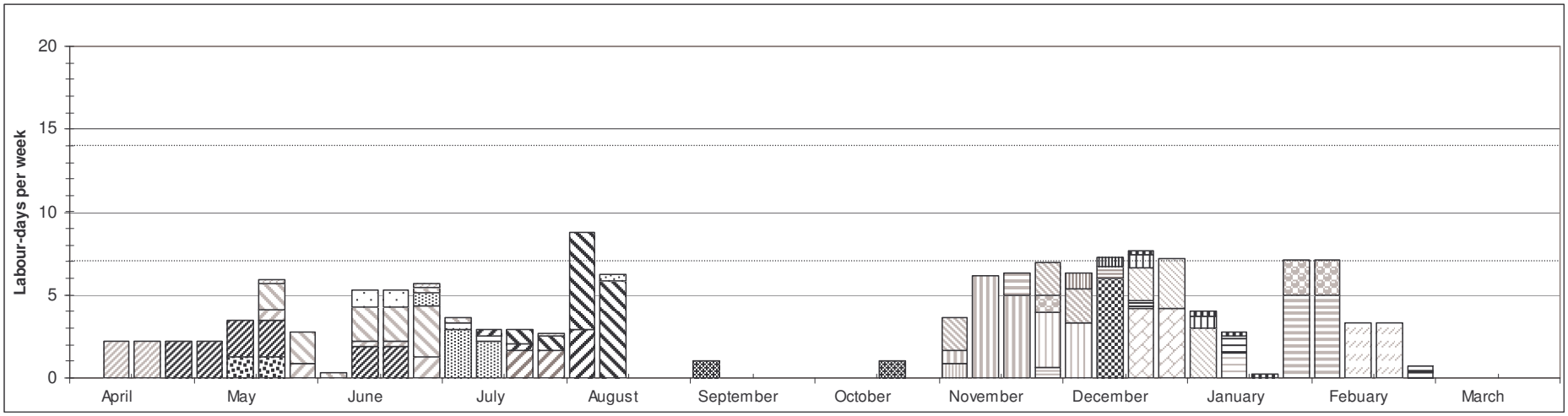
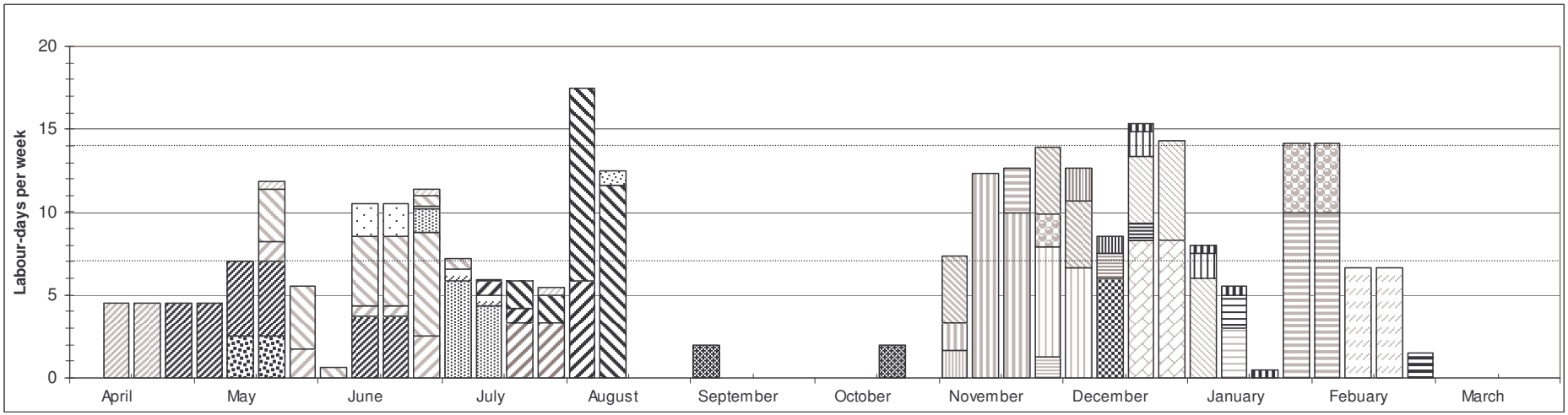


Figure 69: Work calendar for FS 1 on 4 acres



Most of the landless families in the area are of backward or low castes. They usually arrived less than 50 years ago. Many came from Tamil Nadu. Most prefer to work as day labourers, for which the men get at least Rs. 50 R / day and often Rs. 60 / day. They often travel to neighbouring cities to find work that is better paid than the work in the local fields, which has another disadvantage in that much of it is only available during the seasonal work peaks. If both parents find 260 days of work per year, at an average of Rs. 60 R / day for the men and Rs. 30 R / day for the women, the couple can earn enough to cover the ordinary upkeep of the family and schooling for their children. This means obtaining work on average 5 days a week, which is not guaranteed, and the temporary migrations are no doubt not the best for the family stability. They live precariously, with an income often below that needed.

2.5.3 The dry-land farmers

Five principal dry-land farming systems have been selected (Figure 67). They encompass the majority of farmers upstream of the dam. The smaller landowners are usually of lower castes; the larger landowners are nearly always of higher castes. Specific situations, such as farmers leasing land, or without any cows of their own, are also discussed.

2.5.3.1 FS 1 - Principally ragi and Hallikars

The families considered here have their own Hallikars, but only as many as their land will allow. They sow ragi on nearly all of the land, reserving just one field or two for groundnut, for their own consumption (CS1). This farming system concerns mainly very small farmers, as farmers with larger areas of land tend to have other cropping systems as well. It has however been represented for up to 10 acres, to compare it with other farming systems.

The number of cows that can be kept is one per acre: for 2 acres, the farming system will include 2 Hallikars; and for 4 acres, 4 of the animals, etc. Farmers with more land usually have enough capital to have purchased buffaloes or cross-bred cows. There is little point keeping more Hallikars, as they generate very little income. So the farmers in this category, with 6 or more acres are becoming rarer and represent families who have not yet had the opportunity of investing is milk-producing animals, the local dairies being very recent.

The work calendar for 2 acres of FS 1 shows that 2 active members can complete all of the work themselves (Figure 68). The work associated with the cows is not represented: the couple of hours for their daily maintenance will be done on top of the rest of the day's tasks; taking the animals to the forest will be organised so that it fits in with other work (§ 2.4.3.2).

Not only is the work calendar nearly empty during several months of the year, but even at busy times, with 2 acres of FS1, farmers are available for other work. With 4 acres, a small part of the work requires labourers (Figure 69): some of the weeding, and a few days to help out with the harvesting. After that, the amount of external labour increases fast, and with labourers often difficult to find, farmers have a tendency to sow a wider variety of crops: more groundnut, or horse-gram on some of the land, or sometimes red-gram grown separately, so as to reduce the workload and the amount of external labour that must be found.

The importance of the yields for the smaller landholders

A few farmers are obtaining high yields of ragi or groundnut. 2 acres can then just about cover the family's basic needs and 4 acres are sufficient to generate an income of twice that amount (Figure 70). These farmers are rare, but all seem to combine relatively high quantities of organic matter applied, land where the soil is probably fairly rich on the flatter upper parts

of the landscape, and the use of moderate quantities of fertilisers (2.4.6.3). Farmers in these conditions usually belong to upper-caste families.

With the more common "ordinary yields", 4 acres are required for the farm income to comfortably cover a family of four's basic upkeep (Figure 70). With 2 acres, the farm income is barely above that required for survival. Most of the very small landholders, of whom virtually none are getting high yields, must therefore work as labourers or find other sources of income to make a living.

With poor yields, the farm income generated from 2 acres does not reach the survival level (Figure 70). This is not uncommon, especially for low-caste families, who often have poor quality land (§ 2.3.2). These families are very vulnerable and must resort to labouring work just to cover their basic needs. They are often obliged to travel to find any work at times during the year and are uncertain of obtaining enough. If the yields are poor, 4 acres are required to earn enough for the family to survive; but even with more land, a farming system without animals other than Hallikars cannot maintain the family and cover the schooling costs of one of the children.

So the yields are an essential parameter to consider for the farmers, as it makes a large difference to the farm income generated. This is particularly true for the small landowners, as the farm income for many of them is below the amount required for the family's basic upkeep. It can even drop below the survival level if only poor yields are obtained.

With 4 or more acres, the time available for labouring work is much reduced. If the yields are low, it might be economically better finding paid work: the work productivity for the cropping system CS1, with low yields, is Rs 40 / day, less than a man's labouring wage.

If land must be leased

However, labouring work is seen as degrading. Families of higher castes, a few of whom are in the situation where they cannot make a living from their own land, would find it nearly impossible to accept to work as labourers, because of their status. The husband will plough for other farmers, when such opportunities arise. They can also take land on lease. Other very small land holders will also lease land on a share-cropping basis in certain cases. In this way, the family can push the surface farmed up to 4 acres, reaching an acreage that fills up their work calendar at the busiest time of the year.

On the share-cropped land, one third of the produce must be paid to the land-owner (§ 2.3.2) and the family’s resulting income is less than it would otherwise be (Figure 70). Two situations are presented, both assuming enough land is available and a family takes on as much as they can work themselves, which means farming about 4 acres: if all the land is farmed on a share-cropping basis, even with reasonable yields they cannot earn enough for the family's upkeep and children's schooling; if half of it is their own and the other half share-cropped, they can generate enough income with ordinary yields, but barely enough to survive with poor yields.

Without any cows of one's own

If the family does not own any cows, they must arrange to have the ploughing, but also the thinning and banking work done by neighbours or relatives, in exchange of some work or favour returned. If they must pay for the work, the cost is approximately Rs. 1200 / acre. Moreover, without their own cattle, they have no manure and so are often among those who repeatedly get very low yields. Either way, with 2 acres, their income is below or close to the survival level. They must depend on other work, just to cover their most basic needs.

No way in for the landless

It therefore does not seem surprising that the landless labourers, who have no animals of their own or equipment to start with, do not launch into share-cropping. Even though such land is available, if they had to invest to buy cows and equipment, or do without the manure and pay someone to do the ploughing, they would have to obtain good yields to be able to finance all of that as well as give the land owner a third of the produce! It seems less of a risk travelling off to places where work is available and paid at Rs. 50, 60 or sometimes 70 a day, even for women in certain places. It might not be ideal for the family stability, but they do not have much choice.

2.5.3.2 FS 2 - Half ragi, half groundnut and the Hallikars

FS2 is different to FS1 in that the farmers choose to sow half of their land with groundnut. This organisation will limit the number of cows that can be kept, as only half the quantity of straw is grown. Assuming the family has a minimum of 2 cows for ploughing, at least 4 acres are necessary for the farming system. With the same total acreage, the amount of external work required is less than for FS 1 (§ 2.4.2.2).

Groundnut or extra animals?

The income difference between farmers growing mainly ragi and those growing ragi and groundnut is small (Figure 70). This is linked to the fact that fewer animals can be maintained if less ragi is grown: the higher land productivity of the groundnut crop is partially counterbalanced by the lower number of animals. For families for whom more than 2 cows would require complicated arrangements, because of a lack of bunds on which to tie them for example, or for whom the number of cows is limited by another factor, growing groundnut can be interesting. With a fixed number of cattle, it is a way of generating a little extra income.

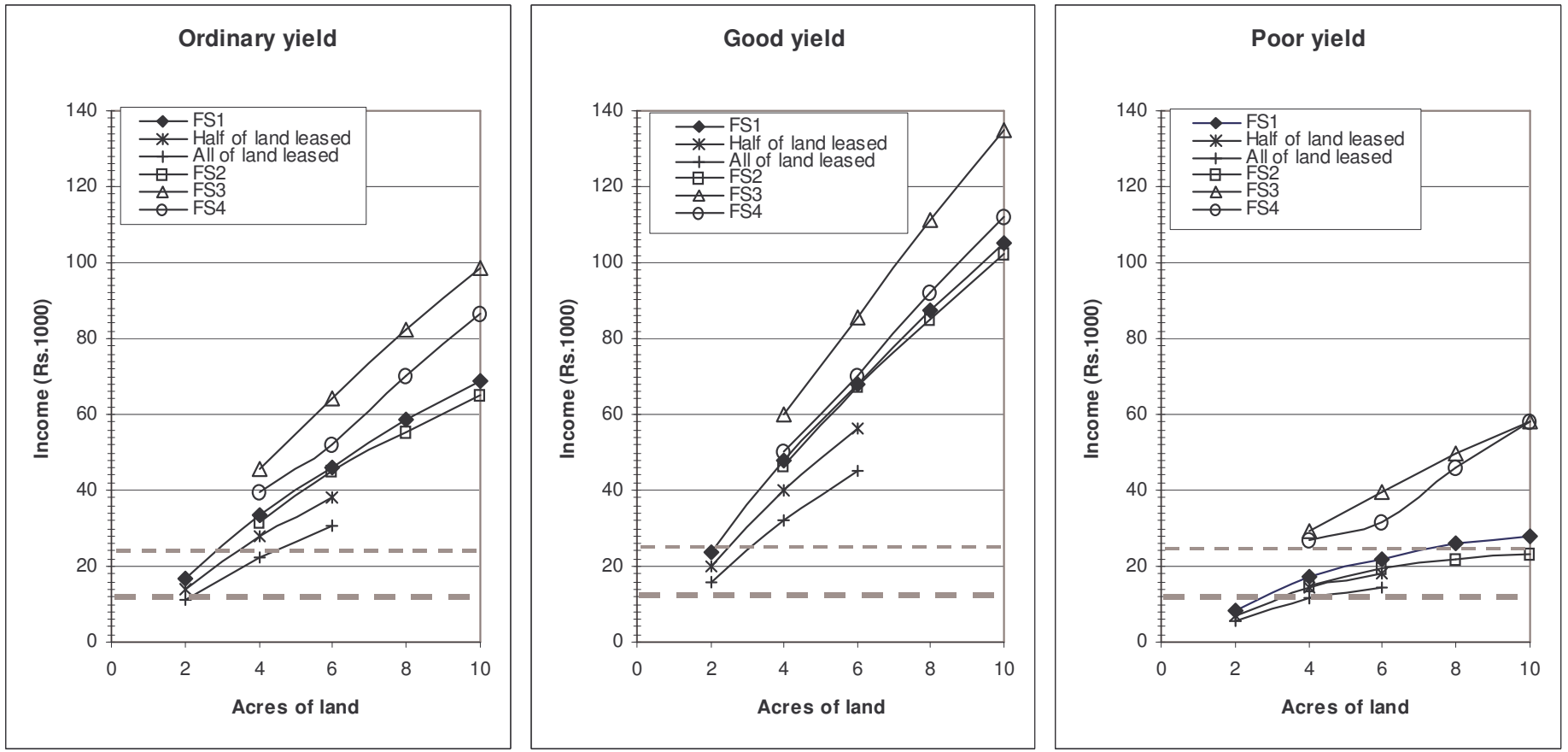
A few years ago, many farmers were getting high yields of groundnut, which would have made FS2 more productive than its counterpart FS1. However these last few years, most farmers agree that the groundnut has not been growing well and yields have been repeatedly low (§ 2.4.6.3). Moreover, today, extra animals tend to be buffaloes or cross-bred cows, which produce milk and generate a higher income, even when compared with CS2 with very good groundnut yields (Figure 70).

If growing groundnut means higher exports from the field, but fewer animals and less manure, and if the importance of manure is confirmed, this could also reduce the yields obtained in the long-run. Because of this, the change in groundnut yields is a subject that would require investigating.

The impact of growing other dry-land crops

As to other crops, for families whose problem is a lack of land to cover their needs, growing horse-gram or red-gram is of no help, as both have lower land productivities than ragi (§ 2.4.5.2). Horse-gram can be grown if the soil is so poor, or the wild animal attacks frequent enough to mean that the work investment for the ragi crop is not worthwhile. But the financial return generated is lower. These crops are grown mainly by farmers who have at least 4 acres of land and who reach their work saturation point at certain times of the year: their lower land productivity is compensated for by a higher work productivity (§ 2.4.5), important for farmers with enough land, but who have to pay labourers for a good part of their work.

Figure 70: Income for different dry-land farming systems with ordinary, good or poor yields



income needed for the reasonable upkeep of a family of 4 and the schooling of 2 children, one at primary level, one at secondary (annexe 4)

income needed for the survival of a family of 4 (annexe 4)

Sesame on the other hand is a supplementary crop, in that it can be grown as well as ragi, as it is sown earlier in the year. For a family with 2 active members, up to 2 acres can be sown, with just extra labour called upon for the harvesting of the sesame (10 labour-days are required for 2 acres, which means a cost of Rs. 500 or 600). The extra income that is generated if the yield is resonable, is over Rs 7000 on these 2 acres (annexe 6). This is far from negligible.

However, such a result is not guaranteed: the rain does not always come early enough in April or May to make it worthwhile and there can be dry spells that last too long during its growth and reduce the yield considerably; the income can drop to Rs. 2500 for 2 acres on a bad year. It can also have a negative impact on the ragi crop (§ 2.4.2.2).

2.5.3.3 FS 3 and 4 - Principally ragi, with buffaloes or cross-bred cows

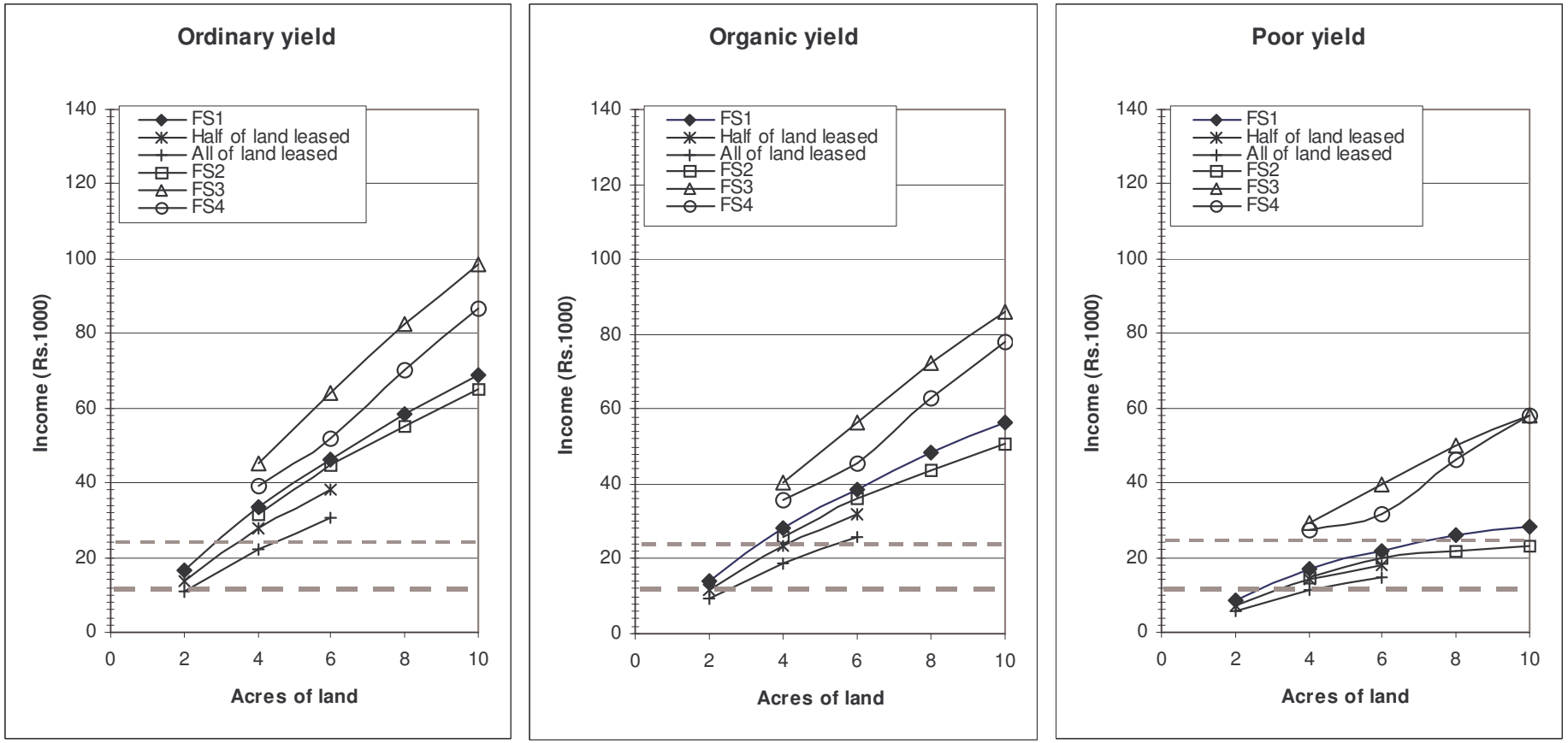
Once the land surface starts increasing, other animals can be kept. If the family has over 3 acres, and the necessary capital for the initial investment, they can keep buffaloes or cross-bred cows, alongside the Hallikars needed for ploughing. The work increases, but as an extra hour or so a day. This can be squeezed in, without resorting to systematic external labour, or without an extra member in the family. FS 3 considers buffaloes on top of the 2 to 4 Hallikars for ploughing. FS 4 includes cross-bred cows, along with the same Hallikars. In both cases, the number of extra animals is limited by the quantity of available straw and for the cross-bred cows, by the land available for grazing.

Keeping milk-producing animals can be a real asset (Figure 70). For larger farmers, getting ordinary yields, it can mean an income increase of up to 50 % compared with an equivalent farm of FS1 type. If there is a risk of poor yields, the milk-producing animals are particularly advantageous, as they guarantee the family a certain income security: even with 4 acres, the income generated remains above the basic upkeep level with low yields; it is in fact about double what it would be without these animals. With either buffaloes or cross-bred cows, the family can have an opportunity of saving a little money, as long as they do not have a loan to pay back, are careful and none of them have habits such as drinking (§ 2.5.5.1).

Comparing FS3 and FS4 shows that if the number of milk-producing cows is adjusted to the available land acreage, rearing buffaloes in fact appears to generate a higher income than rearing cross-bred cows (Figure 70). This is due to the fact that the cross-bred cows need grass-land set aside for them, that is then not itself productive, although the precise surface required needs verifying (§ 2.4.5.2). The buffaloes require only land for straw, and this straw is produces by growing ragi, which also provides grains and other inter-crop produce. In total, the productivity of the system with buffaloes seems higher, per acre of land, than that with the cross-bred cows. As to the initial investment, it is similar, for 1 cross-bred cow, or 2 buffaloes. But a family could start with just 1 buffalo, making the investment approximately half of that for acquiring a cross-bred cow.

In practise though, the number of cross-bred cows is increasing, whereas buffaloes have had a tendency to become rarer. This can be partly explained by the absence of most of the dairies up until a few years back: the buffaloes were kept for the family's own milk consumption by richer farmers. The difficulty of finding labour meant their numbers were on the decline. The creation of local dairies, and with them the opportunity of easily earning money from the milk, has increased the purchase of milk-producing animals. But farmers tend to choose cross-bred cows, which could be due to the perception that they generate a better return as each one produces a lot more milk; or it could be due to their higher work productivity (§ 2.4.5.3).

Figure 71: Comparison of the income potentially generated under organic farming for FS1 - FS4



income needed for the reasonable upkeep of a family of 4 and the schooling of 2 children, one at primary level, one at secondary (annexe 4)

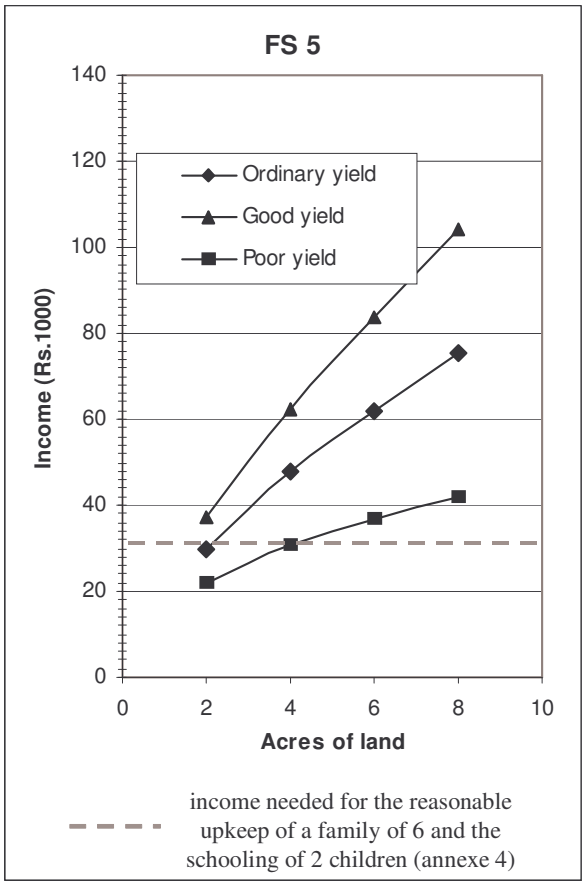
income needed for the survival of a family of 4 (annexe 4)

2.5.3.4 FS 5 - Sheep or goat keepers

Keeping goats or sheep requires someone to watch them full time. The families owning such animals nearly always have more than 2 active members. An example with 4 active members and a herd of sheep is considered here. The number kept is independent of the land surface owned, but depends on the dynamics of the herd (§ 2.4.3.4). A herd of around 10 adult females is common, and this for various land surfaces owned or farmed.

The comparison must this time be made with the income necessary to keep a family of 6. Only the "reasonable" income level, to provide for "upkeep" and "schooling" is used here.

Figure 72: Income generated by FS 5 for different yield levels and acreages



A family of 4 active members, with one member daily watching the sheep or goats, can work up to 6 acres without external labour. With 6 acres, outside of weeding and harvesting times, there are still many gaps in the work calendar.

With a flock or herd of 10 adult female sheep or goats, 2 acres of land is insufficient to keep a family of 6, unless the yields are good or the herd very big (Figure 72): extra labouring work is needed. Above 4 acres, the farming itself, with fair yields, can provide for the family. If the land is poor, external work will be needed to complement the income.

With a pair of buffaloes or a cross-bred cow instead of the goats or sheep, the income would be another Rs. 2000 or Rs. 3000 higher, and the situation a little better still. This does require enough straw and so counts out the smallest landholders. If the necessary capital is available, the workload for cross-bred cows and for buffaloes being low, one of these animals can be acquired alongside the sheep or goats. But many of the smaller farmers find it difficult to access credit. With a high interest loan, the situation is much harder (§ 2.5.5.2).

2.5.3.5 Overall situation for dry-land farmers and organic perspectives

Even with large land surfaces, on years when dry-land yields are low, the income generated by the dry-land farming systems can be very low. However, the larger landowners tend to own several milk-producing cows, which gives them a security margin, even on poor years. With ordinary yields, they obtain a high income. With a few more milk-producing animals, they can do so even with poor yields, putting these farmers in a very comfortable position, unless they have a high interest loan or have other large amounts of money to pay out (§ 2.5.5.1). This gives them possibilities of experimenting or growing other crops, such as red-gram. The larger farmers employing many labourers do struggle to find available workers.

For smaller farmers, the land surface determines whether they can grow enough food to feed their family, but more critically, enough straw for their cows. 4 acres is sufficient land to keep a cross-bred cow or a pair of buffaloes, giving such families a reasonable income and a security margin. The yields remain important factors (§ 2.4.6.3), making the farm income vary greatly, but for farmers with less land, or insufficient capital to buy any milk-producing animals, they are crucial: with 4 acres and poor yields, the farm income scarcely enables the family to survive; whereas with ordinary yields, these farmers earn above the basic upkeep level. Hence most farmers in the area, with only dry land and no cross-bred cows or buffaloes, are in a precarious situation. Many have to work as labourers, or find other sources of income, to maintain their families. Organic farming must take into account the yields obtained.

So far, no proper conclusions can be drawn about the organic yields (§ 2.4.6.3). In the long term, the yields of ragi and intercrops grown organically may prove to be close or even above the ordinary yields. To date no such evidence in the area exists. The opposite would be surprising, going on the short duration organic farming has been practised in the area; it will take time and there are many aspects of the cultivation in the area that need investigating and experimenting (§ 2.4.6.3). However, this does not change the reality for the farmers.

The pessimistic scenarios, which are the most realistic for the first few years after conversion, give 2 possible routes (§ 2.4.6.3). The first, with yields at or below the poor yield level indicated previously, makes it a non viable option for those farmers who have little land, but who so far often manage to obtain reasonable yields. The second is the one that has been represented in Figure 71, where the yields of ragi are at their "low" level, but where the yields of the other crops, notably the pulses remain "ordinary". In this case, the decrease in the cost of inputs helps reduce the impact of the decrease in ragi yields. The overall income generated is lower, but not dramatically so, and it could well be significantly better on a poor year, or for farmers who were already obtaining very low yields. This requires verifying in practise.

Until more is known about the probable outcome, it might be best to refrain from encouraging farmers with a low income level to experiment. Take for example farmers owning 2 acres of land of their own and farming an extra 2 acres through a share-cropping arrangement. With reasonable yields up until then, they would have managed to generate just enough to eat correctly, replace worn out clothes and equipment, and send their eldest child to the local secondary school. Should they try organic farming, and see their yields drop a little for a few years, their income would pass under the required amount for the family maintenance. They might take a loan, or go off to find work elsewhere, or end the schooling of their eldest, hoping things will be better when the second one reaches that age.

Farmers with buffaloes or cross-bred cows, or irrigated crops or other sources of income, can afford to lose a little return on their dry-land crops. However, the dry-land farmers do not have much to gain from the decrease of cost of inputs under organic practices: in the area studied, the levels of chemicals applied are low and the costs of inputs are small compared with returns, except in the case where the yields are very poor (§ 2.4.6.3). Other motivations are required, such as being convinced about the long-term benefits of organic practices on the soil quality or on human health, for these farmers to consider farming organically without other incentives. Knowledge about yields after a greater number of years would be useful.

Farmers with few animals and little land struggle more if they have more members. Without the necessary land, they cannot keep more cows. With the necessary capital, they can buy goats or sheep, which require an active member to watch over them. This increases their income, as well as the quantity of manure which they dispose of. It is favourable to the take-

up of organic practices, both due to the extra available organic matter, but also because the higher return gives the family more chance of some security if they try out new practices.

2.5.4 Farmers with access to irrigated crops

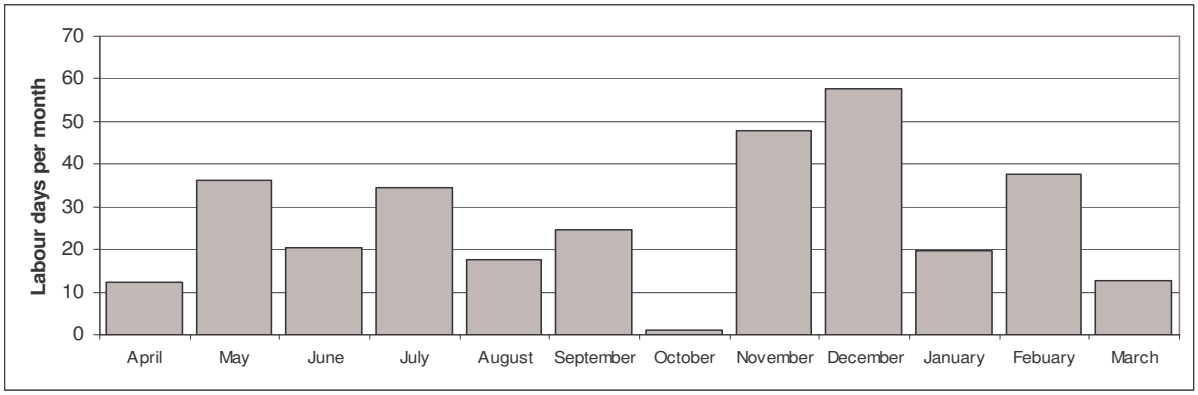
The farmers with access to irrigated crops can be divided into a further four categories: those leasing land and growing the crop that is implanted there; those with only access to water from the dam; those with their own land and pump, who had sufficient capital of their own to finance the irrigation investment or who have already paid off any loan; those who installed an irrigation system or purchased irrigated land by resorting to a loan (§ 2.5.5.2). The case of the farmers with access to dam water only is not presented here.

Three situations are illustrated on Figure 74, for each of these farming systems with irrigated crops. The ordinary returns are those commonly obtained; the organic ones are also the most frequent ones recorded amongst farmers farming organically; the poor return situation will be one where all of the cropping systems included in the farming system have lower than usual returns. Of course, this is rarely the case simultaneously, but it gives the extreme situation, above which families with this type of farm will almost always find themselves.

2.5.4.1 FS 6 - Farmers leasing a little irrigated mulberry

Mulberry is the crop with the highest land productivity. Those disposing of irrigated land frequently plant more mulberry than they can themselves farm: they lease small plots to other families. The usual method is to charge an annual fee for sufficient plants to rear a set number of worms. The plot is often enough to feed the worms from 50 mothers (50 worm units) with 1 crop every 2 months. The yearly rent for the bushes is very variable. The sum chosen here is an intermediate one, at Rs. 2500 / year for a plot of bushes able to feed 50 worm units.

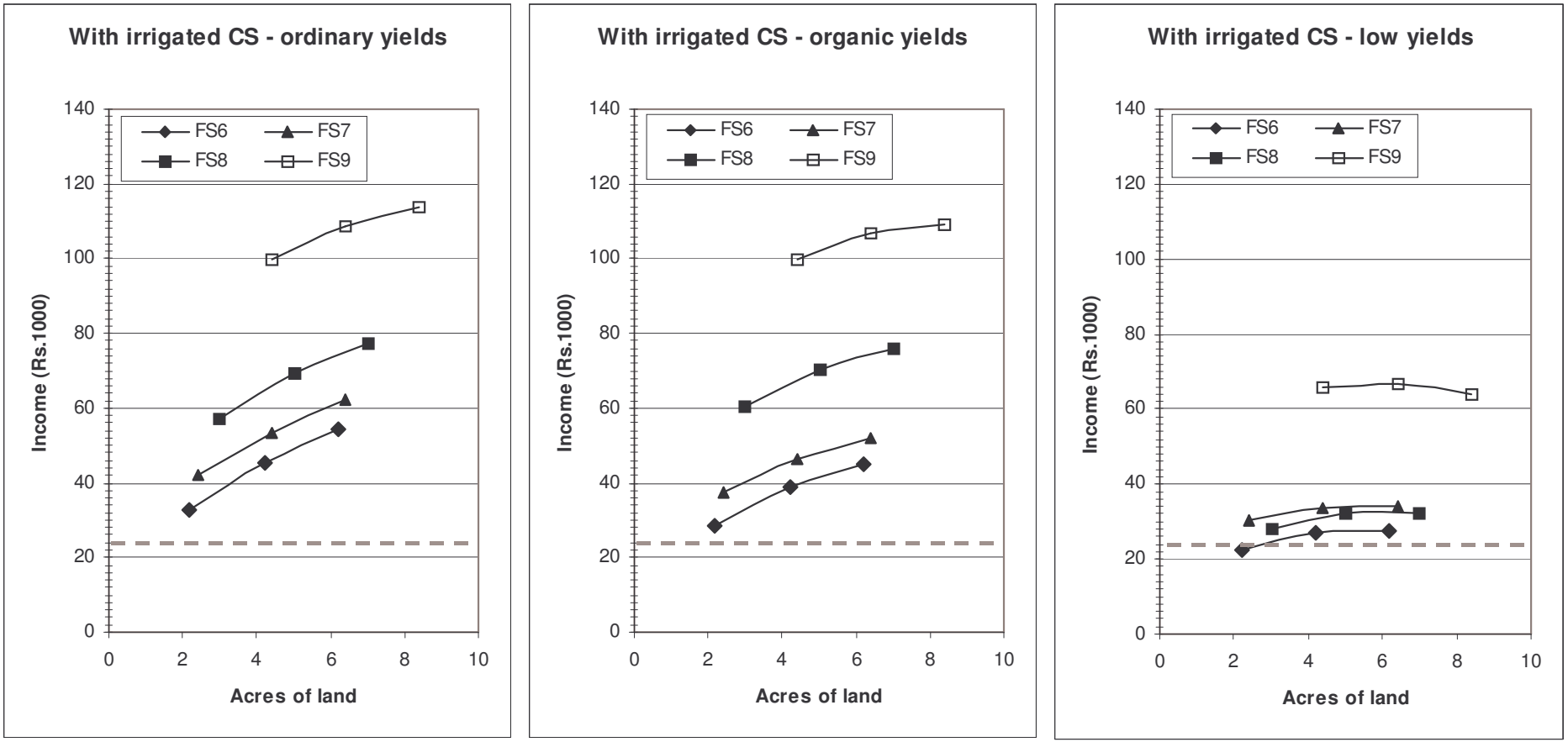
Figure 73: Monthly work calendar for 2 acres of CS1 and 0.2 acres of mulberry



For a family with 2 active members, renting such a plot of mulberry and owning just 2 acres of dry land on which they grow mainly ragi, the work calendar is not full, although there are a couple of months when it is nearly so (Figure 73). A monthly work calendar is not really precise enough, as both the work in the ragi fields and even more so that of caring for the worms, vary a lot from one week to the next (§ 2.4.2.1 and 2.4.4.3). It is possible that a little external labour will already have to be called upon in this case, but not much. From 4 acres upwards, there can be significant amounts of work that have to done by external labourers. This has been determined per month in the calculations of the remaining farm income.

The returns obtained are much higher than without the lease of the irrigated mulberry (Figure 74). With only 2 acres of their own land and poor yields, the family just manages to obtain the income needed for their upkeep. With ordinary yields, they are well above this level.

Figure 74: Income generated by the farming systems with irrigated crops



income needed for the reasonable upkeep of a family of 4 and the schooling of 2 children, one at primary level, one at secondary (annexe 4)

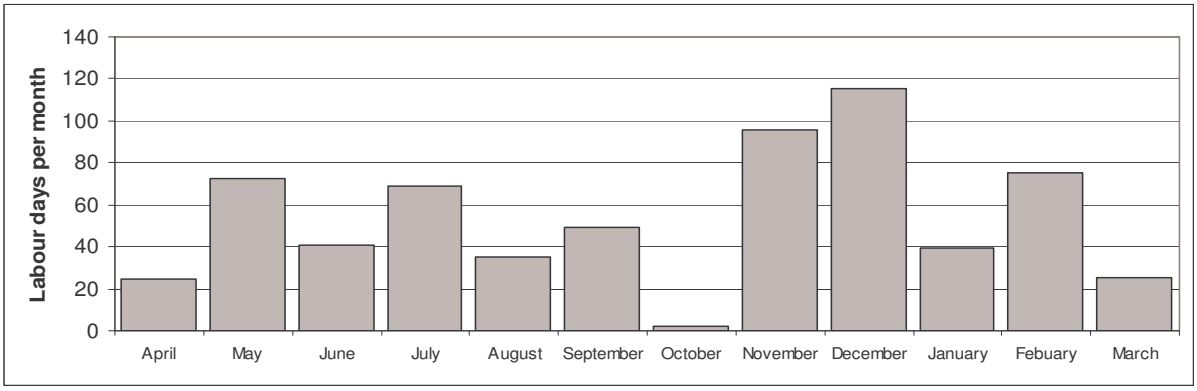
2.5.4.2 FS 7 - Farmers owning irrigated mulberry

The depreciation due to renewing or repairing part of the material needed for irrigated crops is of similar value to that required for leasing the same quantity of mulberry. Thus the results for a family leasing or owning their patch of mulberry are similar, unless the family who possesses their own has a loan to pay back in relation to this (§ 2.5.5.2). However, the families with their own irrigated land tend to cultivate a greater surface area of mulberry. A frequent case is having enough plants to rear 100 worm units (about 0.4 acres of plants).

In this case, for 2 active members, the all round work is double (Figure 75). External labour is systematically required at the end stage of the rearing of each batch of worms (§ 2.4.4.3); because the rearing takes place over one month only and is separated by a one month gap, there are months with little work. The necessary paid work was determined accordingly.

Above 4 acres of dry land, it is unlikely that the family will grow mainly ragi. They will probably sow some horse-gram, or more groundnut or red-gram, to decrease the work involved, and concentrate more on the irrigated crops.

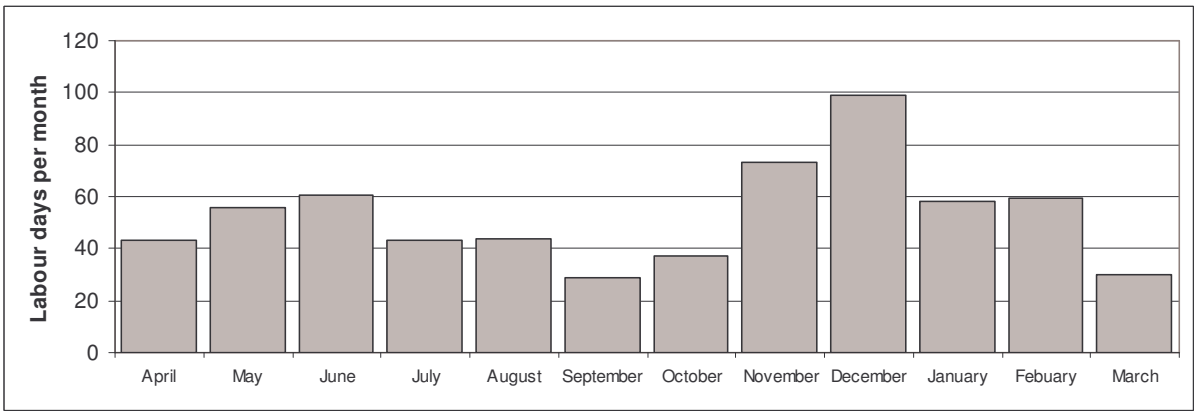
Figure 75: Work calendar for 4 acres of CS 1 and 0.4 acres of mulberry



Obviously, the return obtained is significantly higher than that of farmers with only half the quantity of mulberry, be it leased or their own irrigated land. With just 2 acres of dry-land, and the 0.4 acres of mulberry, and poor yields, the income generated is comfortably above the basic upkeep level (Figure 74). With more land, or better yields, the income is higher still.

2.5.4.3 FS 8 - When bananas are the main irrigated crop

Figure 76: Work calendar for 4 acres of CS1 and 1 acre of bananas



Some farmers choose to plant bananas as their first irrigated crop. The work for this crop is more evenly spread throughout the year (Figure 76). It creates fewer work peaks. Moreover,

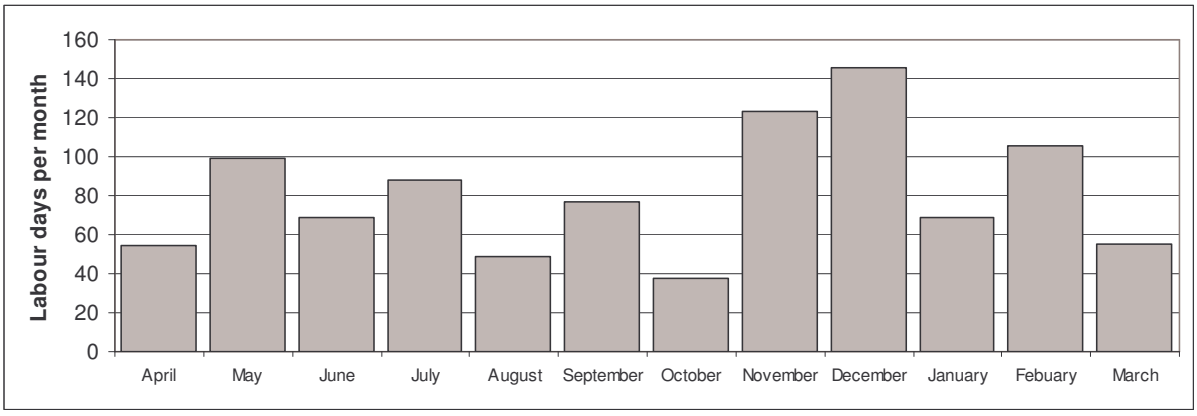
many of the tasks can wait an extra week if required, to fit into quieter periods. For 4 acres of CS1 with 1 acre of bananas, some 60 extra labour days are required, as opposed to 130 days for 0.4 acres of mulberry, with the same surface of CS1. Again for greater dry land surface areas, farmers usually diversify their crops.

The income generated is very similar to that of FS7 (Figure 74). With ordinary yields the bananas create a higher return. But the productivities vary more, due to the prices, which can change 3-fold, and the yields. Consequently, the income can be below that of FS7.

2.5.4.4 FS 9 - A variety of irrigated crops

There is usually only one irrigated crop grown for a few years after a family has installed their pump, while they organise their new work, and put aside money for any further investments that might be needed. After several years, most pump-owning families have a diversity of irrigated cropping systems, most of which are labour intensive: the family quickly find themselves employing many day-labourers; larger land-owners also take on year-labourers.

Figure 77: Monthly work calendar for 4 acres of CS1, 1 acre of bananas and 0.4 acres of mulberry



An example of one of the diversified farming systems combines a few acres of dry-land crops, 1 acre of banana plantation, 0.4 acres of mulberry, and some fodder grass such as elephant grass, to feed the cross-bred cow owned. A pair of Hallikars completes the system.

The amount of extra labour required is over 320 days for a family with 2 active members running a farm of the FS9 type with 4 acres of CS1 (Figure 77). The income of such a farming system is very high (Figure 74): even with poor yields, it remains nearly 3 times the basic upkeep level. The relative decrease with such low yields is similar to the other irrigated systems, but the much higher ordinary level gives this farming system a comfortable margin.

2.5.4.5 Irrigated crops and organic farming

As with the dry-land crops, the variations from one year to the next and from one farmer to the next are considerable. The reasons for the variations though are not just yields: the yields can vary considerably, but so can the prices. For example, price variations are 3-fold for bananas. This is the same with the vegetable cropping systems that have not been detailed here.

The irrigated crops represent a significant source of income. As such, farmers who have access to some irrigated cropping systems can usually increase their farm income very rapidly, and for the same total land surface are in a radically different situation to the dry-land farmers. Most of them generate returns well above the minimum required for the family upkeep and thus have opportunities for setting money aside for future investments or needs.

They have a certain room for manoeuvre and innovation. On the other hand, their work calendar is full most of the year and this can become a constraint in terms of availability for new ideas or new work.

An exception is the case where the family leases a small patch of mulberry. They obtain insufficient income if all the returns are low. However in this case, most of the farming systems, except for the one with more irrigated land, drop close to this required income, and this "low" scenario is an extreme case (§ 2.5.1). The main drawback in this latter case is that the family probably does not have access to as much irrigated land as they might be able to work or might hope for. Also, in certain cases, the amount demanded in rent can be very high. In some places, it can nearly wipe out the benefit of having access to an irrigated crop.

Farmers with irrigated crops rarely have sheep or goats, even in the case of larger families, as the extra available labour is usually invested in the irrigated cropping systems, which have higher work productivities. They often have cattle, especially cross-bred cows for which they can produce fodder on the irrigated land and which demand relatively little work.

Currently, without guessing at the longer-term outcome of organic practices, the organic farmers with irrigated land are getting similar incomes to other farmers with the same farming systems. If the only irrigated crop is banana, the income tends to be higher for the organic farmers; if it is mulberry it is a little lower. For irrigated crops, there is but a small difference in yields obtained between the organic and non organic practices (§ 2.4.4.5); and the relative chemical input levels, used by non organic farmers, are higher so that the saved expenditure under organic farming becomes significant.

Vegetables could be another crop for which organic practices bring a rapid benefit. Real marketing opportunities might exist for such produce (§ 3.3.2), to overcome the high price fluctuations that farmers currently face. Moreover, most farmers growing vegetables to sell, apply high levels of chemicals and could save important sums by reducing these inputs.

All in all, farmers with irrigated land are much more likely to be interested in organic farming: most have a more comfortable economic situation; they have higher chemical inputs initially and so have more scope for reducing their costs; they risk smaller relative drops in yields. The economic situation must be reviewed of an important proportion of the return generated is used for other purposes than the family maintenance.

2.5.5 Some extra risks for the farmers of the zone

From the farming systems described above, it is possible to see what situation many of the farmers in the zone are in, in an "ordinary" case. The net return generated can be very variable, due to animal mortality, or yield or price variations, that can all be considered as risks the farmers have to face (§ 2.4.6). But there are other factors that can influence the income available to the family and that represent extra hazards.

2.5.5.1 Differences between net return and the income kept for the family

All sorts or reasons account for the fact that the money available for the family can be much less than the net return generated. For example:

- some farmers are share-cropping and giving 33% of the produce to the landowner (§ 2.3.2 and § 2.5.3.1), or once costs are deduced nearer 40% of the net return;
- some husbands give Rs 3000 / year, or more, to the alcohol producers (§ 2.3.3);

- some farmers have to give Rs 1000 here, Rs. 2000 there, under the table to government officials, such as to have work done by the electricity board (§ 2.3.5);
- some are paying 50% yearly interest on a loan they took (§ 2.5.5.2) for a daughter's wedding or for a farm investment.

These situations must all be kept in mind when trying to understand the economic situation that a family is in. The case of farmers with a loan is examined in more detail.

2.5.5.2 Farmers with a loan

Loans are taken for various reasons: for a wedding or for a funeral; for buying seeds and fertilisers at the beginning of the season; for a long term investment, such as to start a herd of goats, to buy a cross-bred cow, to put in a pump or a bore-well. Many smaller farmers do struggle to gather together the necessary Rupees for buying seeds and fertilisers, despite the relatively low costs of production as compared to ordinary returns. Such situations were not directly encountered during the study and they are questions requiring further investigation.

The other two situations are examined here. Small farm investments can be covered by self-help group loans or cooperative banks. Larger loans, for a bore-well for example, cannot. The amount required for the dowry in many situations also exceeds the amount that can be obtained on a "low-interest" loan. In those cases, families often resort to "hand-loans" from other farmers nearby (§ 2.3.2). Having a loan to pay back, or being free from any debts completely changes the situation of many a family.

The burden of one's daughter

Consider a family of 6: the grand-parents, the parents and their 2 children. The eldest is a daughter. At 16, it is time for her to be married. The family, with only 2 acres of dry-land fields, farm an extra 2 on a share-cropping basis. By being very careful, over the years, they have built-up quite a little flock of sheep, in prevision for the wedding.

Figure 78: Loan and interest for marrying one's daughter

Sum required for dowry and wedding		**50000**
Initial capital (flock of sheep with 16 adult ewes)	Value:	73600
Sale of half the flock	Value:	36800
Sum obtained for a grouped sale		**24000**
Money left to borrow at 4% interest	**Loan:**	**26000**
	Monthly interest:	1040

Yearly income	**N. return**
Flock of 8 female sheep	10640
2 acres of CS1 (own land)	14280
2 acres of CS1 (share-cropped)	9520
Total net return	**34440**
Depreciation	770
Land tax	100
Farm income	**33570**

Yearly expenses	
Basic family needs (5 people, 1 child at high school)	28500
Interest	12480
Total	**40980**
Balance	**-7410**

They cannot pay all of the interest (Figure 78). They need over Rs. 7000.

They sell 2 adult ewes, to avoid the interest accumulating and cut their expenses by Rs. 500.

The next year, their sheep bring in: 10600 x 6 / 8 = Rs. 8000. At the end of the year, the balance is another Rs. 2600 down: -10 000. They need an extra Rs. 10 000 this year, just to cover the interest. They spend Rs. 2000 less. They think about removing their daughter from school, to save another Rs. 2000. The non-paid interest totals Rs. 8000 over the year. They owe Rs. 34 000. The sale of assets continues, under pressure from the creditors.

This is if the ragi yields are normal. It can get worse quicker if there is a bad year, if their soil is particularly poor, or if an illness strikes some of the remaining sheep. The borrowed amount was too much; and the interest rate too high.

Trying to start a herd

Having just a few acres of dry-land fields, a family decides to start a herd of goats. Their son, old enough to look after them now, can then contribute to the family income. They buy 5 adult females, with their new born young, one billy-goat and a couple of young females. They pay 15 000 for the whole lot, money which they borrow from a money lender in the village, at 4% interest.

Figure 79: Loan and interest for the purchase of a small herd of goats

Initial sum borrowed (Rs)		15000	Loan repayments					
Size of livestock system 4								
N° of adult female goats		5	Rate (%/month)	Loan amount	After 6 months	Monthly interest	Total across year	Loan repayments
Land/animal productivity	Rs/year	1378	1	15000	15923	159	1911	3 years
Size of	n° of animals	5	4	15000	18980	759	9110	impossible
Net return	Rs/year	6890						

With 4% interest on the local loans (Figure 79), with at least 6 months before they can sell any of the young, the yearly interest is higher than the net return. The investment cannot pay for itself. If the family had been generating more income than they needed, they probably would not have required a loan in the first place.

At 1% per month instead of 4%, the investment should be able to be returned. But it would still take 3 years to pay back the initial sum if all of the return generated was used to that effect.

Dreaming of water

For farmers with small areas of land, access to irrigation is tempting: the income that can be generated per acre is so much higher (§ 2.4.5.2). Previously there were those lucky enough to have access to a site where an open-well could be dug, next to one of the rivers for example, or who could install a pump directly in the river. Now, people take a gamble and try and find water by having a bore-well dug. The depth is often at least 100 m.

The minimum total investment to put in a bore-well, fence around approximately 1 acre and put in the necessary plants is Rs. 100 000. This is assuming the fencing is done one's self, that water is found first time, that it is not too deep, that the electricity officials do not add on an under-the-table charge for connecting up the pump to the mains, etc. It can be much more.

Some people have their own source of money. Others take a loan. A bank will not grant a loan for something as hazardous as digging a bore-well. People resort to local loans.

Farmers have different choices as to what to plant. One example is planting bananas. Along with a few acres of dry-land crops, 1 acre of bananas fills up a family's work calendar, and is about as much as one family can plant in the first year. The family must wait a whole year before the bananas provide any return. The money then generated from 1 acre of bananas is

sufficient to cover the interest of the loan, if the interest is only 1% per month, or if the loan is much less than Rs. 100 000 (Figure 80). For example, if the farmer has access to the river or an open-well and only needs to install a pump, it is possible to pay back a loan taken from another local farmer.

Figure 80: Loan and interest for a bore-well and banana plantation

Size of banana cropping system		**Net return**	**Rs/year**	**49120**	Labour costs	Rs/year	0
N° of plants	1000	Total depreciation	Rs/year	6000	Land tax	Rs/year	100
Land area required (acres)	1	Net value addition	Rs/year	43120	Water tax	Rs/year	2500
		Income generated	**Rs/year**	**43120**	(after 1 year)		

Sum borrowed:	
bore-well	100 000
open-well	64000

Loan repayments

Rate (%/month)	Loan amount	Amount owed after 1 year	1st year interest	Amount left after 1st-year harvest			
	Bore-well						
1	100000	112683	12683	69563	→	loan repayment	3 years
4	100000	160103	60103	116983	→	loan repayment	impossible
	Open-well						
1	64000	72117	8117	28997	→	loan repayment	2 years
4	64000	102466	38466	59346	→	loan repayment	5 years

If a bore-well is to be dug, and the money is taken on a 4% per month interest basis, 1 acre of bananas cannot generate enough income to cover the interest. It requires at least an extra 0.5 acres just to pay the interest; it is still impossible repaying the loan.

This scenario is supposing that all goes well, with the digging of the bore-well and other investments, but also with the first crop. If the first or second year crop happens to fail, because the plants get a disease, or are knocked over in violent winds, or many of them are munched away by the local cattle, there can be no hope of ever paying back the loan. The creditors make their visits more frequent, they become menacing, despair creeps in…

An example is given here with banana, but the situation is similar if mulberry is chosen. Money comes in more regularly and the frst lot after only 6 or 7 months, but the average yearly return generated is in fact lower. It is nearly impossible to pay back such high interest on the huge sums necessary for digging a bore-well, and this despite mulberry or banana being crops that can generate good returns.

The source of the debt can also be the purchase of irrigated land, for which the price per acre is approximately Rs. 100 000. As to the bore-wells, many of the attempts do not find water first time. What with extra complications such as longer distances for the electricity connection, or a pump that burns out, the investment can rapidly reach Rs. 150 000 or more.

2.5.5.3 Misleading appearances

One investment that is usually self-reimbursing, even with such high interest loans, are the cross-bred cows. The return on investment is very high. But this remains an exception. Mostly, the interest rates applied by farmers and the sums lent to one another are a source of great difficulty for the family borrowing; they too are remnants of the uneven distribution of assets that prevailed for so long in the area.

These hidden burdens, of interest repayments so high compared to incomes generated, can be a source of despair for those who have no hope of returning ever mounting sums. They create a strong divide in amongst those who appear to have some capital. For a proportion of these families, the interest will be swallowing everything they earn.

In the case of farmers with access to irrigation, not all are in the comfortable position described above (§ 2.5.4). Some will be fighting to survive, at the mercy of an unfortunate event that could upset a precarious balance. Others will be in a position where they can start putting money aside, for another investment, for a future wedding, or in case of an unforeseen problem.

This distinction must be made amongst those with access to water, but it must also be made amongst those with access to other forms of capital, such as land or animals. The same threat can hang over these families too, when the assets are only held alongside a large high-interest loan. The problem is not a local one, but affects many parts of the Karnataka state, as the following quotes from various articles show, and beyond, exists in other Indian states. Such debts can be totally crippling, or can amputate a family's income to different degrees. They cannot be ignored.

"From 2000-01 to 2005-06, around 8,600 farmers committed suicide in Karnataka, while the figures stood over 2,000 in Andhra Pradesh for the same period. "

Rediff news, 19th April 2006
More farmer suicides in Karnataka than Vidarbha

"While it is difficult to pin-point precise numbers, press reports indicate that at least 3000 farmers had taken their lives between the year 2000 and August, 2003. Through the year 2003, regional and local press reported an average of about four farmer suicides per week."

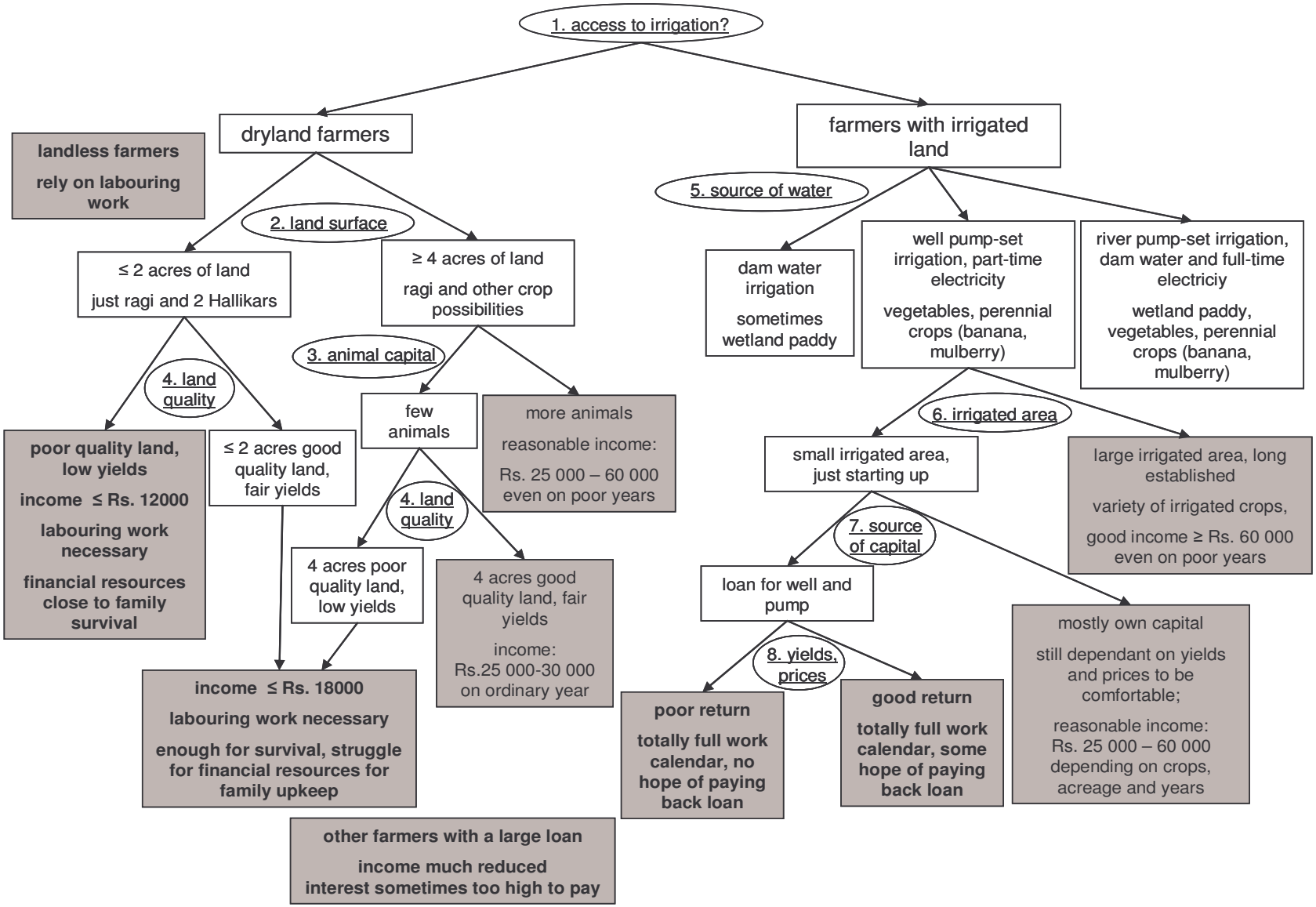
Shalmali Guttal, 14th September 2004
Farmers' suicides in Karnataka state

"On page 32 of the report it is stated that of the 105 cases studied among the 3544 suicides which had occurred in five districts during 2000 - 2001, 93 had debts, 54 percent had borrowed from private sources and money lenders."

Vandana Shiva, discussing the Government of Karnataka report on
"Farmers suicide in Karnataka - A scientific analysis", 5th April 2004

The other reasons for differences in the return generated and the money available for the family upkeep are as many reasons for concern. They rarely lead to such despairing situations, but deny a family the opportunity of making real choices for themselves.

Figure 81: An overview of some of the main types of farmers in the area



3 IN SEARCH OF EXTRA SECURITY IN AND AROUND VEEREIANADODDI

The situation of many farmers in the area is a very hazardous one. It need not be so. Families are capable of taking care of themselves, but the previous social organisation and the particularly difficult climatic conditions mean that they could use a little support in stabilising their livelihoods. Agricultural activities having such essential functions, these should be other incentives for taking an interest into these dry lands and the sustainability of the farming there.

3.1 CURRENT AND FUTURE HOPES AND DIFFICULTIES OF THE FARMERS

Families have access to different quantities of labour, land and capital, and some have access to irrigation. All of these factors play a large part in determining what type of crops and livestock a family can and will choose to grow. Without claiming that farmers have no personal freedom, understanding these constraints does give a global view of the situation of many families. Figure 81 gives a summary of the main categories of farmers, based upon their assets.

The incomes correspond to those of a family of 4, with 2 active members fixing the available labour. A family with an extra 1 or 2 active members has greater needs, but also has more available labour. In the case where the family has access to irrigated land, or has a large land surface, the extra labour is a benefit, as it can be productive on the farm and reduce the need for external labour. Otherwise, one of the members can be responsible for keeping a herd of sheep or goats, if the necessary capital is available for their initial purchase (§ 2.5.1). If not, the situation is more precarious and further labouring work must be done.

Families at risk

The families who have the least control over their own lives and who are the most at risk from climatic variations of unpredictable events are (Figure 81):

- the families who have no land, relying solely on outside labouring work, with little security as to its whereabouts and the working conditions, on low incomes;
- the families with only a very small area of dry land (up to 2 acres), or a slightly larger area but on poor soil (up to 4 acres), who both struggle to meet the family's needs and rely on labouring work when it is available; they may well have 1 member travelling to outside work; they have no money to invest in other animals;
- the families who have a loan with high interest compared to the income they can generate, some of whom are in an impossible situation and cannot even pay the mounting interest; these can be farmers who have taken a loan for a well and pump, but it also concerns families who have a loan for other reasons (§ 2.5.5); and families for whom a significant part of the net return is required for expenses other than the family's upkeep;

For the first two groups of farmers, the families are living in poverty. For those farming their own land, the land productivity is often very low, and therefore the relative cost of inputs will be high (§ 2.4.6.3). Some apply very few external inputs; some take high interest short term

loans to purchase them. They are interested in obtaining the highest land productivity possible. As such, their principal crops are ragi and intercrops, staple food products.

Their strategies can involve finding other work opportunities for one of the family members, often seasonal trading work, or moving away, to nearby urban centres. There, low paid labour is in abundance, but they only contribute to the growing numbers of poor with little chance of improving their economic situation.

The families with a high-interest loan often increase their workload more and more if they have irrigated land; or progressively sell their assets if not (§ 2.5.5.2). In many cases, there will be no way out. The sums being borrowed are too large; the interest is too high. They too are in a situation of poverty, if the term is used to mean having a lack of freedom to lead one's live as one would deem decent, as proposed by Sen (2003). They have lost much of the control over their lives.

For all of these farmers, a bad year, be it climatic, a price drop, or important losses to elephants or pests or diseases which can reach over 50% of the crop, can be dramatic (§ 2.5.3.5, 2.5.5.3). Most of them are hoping for a little security for the future.

Families who are safe

At the other extreme, are the families with plenty of land and animals, and those with access to a fair surface of irrigated land (§ 2.5.3.5, 2.5.4.5). They are generating a satisfactory income, and rarely subject to excessive concerns about the rain or the elephants.

They have to face losses and difficulties, but a primary difficulty for them is finding enough labourers to do the work they cannot carry out themselves. This has resulted in a decrease in the number of animals owned by farmers in this category, although that trend might be on the reverse now (§ 2.5.3.3). It also means these farmers leave parts of their land uncultivated; or plant mango or coconut trees, but often without much maintenance, or without using the full potential of the land. They have opportunities for investment and can usually improve their situation further still. Some of them also use this money to loan to other families.

And the others

In the middle, the majority of farmers suffer but cope with the bad years. A significant advantage is access to irrigated crops; or the possession of a greater number of animals, those producing milk being the most interesting financially, if there is enough land to sustain them (§ 2.4.3, 2.5.3).

The advantage of having access to irrigated crops means that many are dreaming of their own well and pump. Those with less ambition think of a cross-bred cow. They are not safe from the risks of a loan, nor from a run of bad events. The children of many of these families are turning to business to generate a higher income or moving to urban centres, in hope of something more secure.

Families' hopes

Attention must be paid to the nutritional intakes of families. The diet in the area seems well balanced while people have enough pulses, vegetables, oil along with a small quantity of animal products, mainly milk, eggs and a little meat. People close to the survival income level will be going short on much of the diversity and risking certain nutrient deficiencies. Children are tending to eat more rice and less ragi; this is problematical considering the families consuming virtually no milk will be provided with a large part of their calcium from the ragi, recognised for its high calcium content (Lupien, 1995).

The nutritional benefit, especially as concerns the protein content, of high fibre, traditional cereals such as ragi, are quite controversial: the quantity assimilated by the body is very difficult to determine and depends on many factors such as the cooking process, the other food consumed at the same time, etc. (Mariotti and Tomé, 1999). However, some sources state that they have higher contents of important micronutrients than fine grains such as rice and wheat (Planning Commission, Governement of India, 2002). The people in the area have been living well off of such produce for many generations, as long as they have sufficient of the staple cereal, and sufficient other food stuffs to complement them. For example, women's low status means they tend to eat less of the more nutritious food, as they serve their husbands, then their children before they get to eat.

A diversification of the PDS could be useful, to insure poor families can access pulses, or the local cereals as well, instead of mainly rice and wheat. Some fresh produce schemes might be necessary, so that these families can produce their own vegetables and possibly a few animal products. Indeed, this is one of the principal increases in spending that is observed when families start earning a little more.

Serious difficulties faced by some of the families include the increasing consumption of alcohol and the often associated violence on women (§ 2.3.3); the general status of women and the absurd dowry requirements are handicapping families' well-being (§ 2.3.1, 2.5.5.2). In the area, significant numbers of women in particular are suffering unnecessarily and unjustly. Most are silent, but many are hoping there will be some changes.

Moreover, access to health and education in the zone remain limited (§ 2.3.4, 2.3.5). Despite undeniable progress, improvements are still required. A solution for emergency treatment is needed. Real secondary and further education opportunities are also high on the priority list. Families who cannot wish they could send their children to school, up to at least 16 years old, or even 18; they would also like to be able to access medical care for their families.

3.2 LAND PRODUCTIVITY, FOOD PRODUCTION AND RURAL EMPLOYMENT

Beyond individual families' situations, lie some questions relating to India's future. With the total population still growing rapidly (Prime Minister's Council on Trade and Industry, Planning Commission, Governement of India, 2002), the level of food production in the country will continue to be crucial. As such, land productivity is a central issue. The problem of poor populations migrating to local urban centres, such as Bangalore, also needs addressing.

The importance of preserving soil and water resources

Soil erosion is an important phenomenon in the area and is causing the degradation of parts of the land. The soil in the study zone has good potential but is fragile (§ 2.1.3.5). Its organic matter content in particular is important for limiting soil loss, maintaining fertility and ensuring the possibility of cultivating the land and obtaining good yields in the long-term. Currently, very large differences in yields are observed between land of different quality.

The highest land productivity is obtained with irrigated crops, principally because crops can then be grown throughout all of the year. However, other than in the dam irrigated zone, groundwater is used for irrigation. There is no knowledge as to how much groundwater is present, how much can be safely pumped, and no regulations as to its use. This means that much of it is wasted, as run-off or evaporation, through excessive irrigation and inappropriate

practices. Already a number of open-wells have dried-up. There is a risk that the overuse of groundwater will cause this vital resource to become scarce.

The differences in yields observed on the staple food crops in the area suggest that there is potential for increasing the productivity of the dry-land in this area, without necessarily posing a threat to resources. Indeed, the ragi and intercropping system has a good land productivity, when the crops grow well. But currently, much of the land is under-productive.

Investigating the potential of such land and different means to enable more farmers to obtain reasonable yields is definitely required. This must avoid the drawbacks of the Green Revolution, whereby many farmers were left out or led into debt traps and natural resources were often degraded (§ 1.1). The use of non renewable groundwater for example is not a long term solution; nor is the use of chemical inputs that take no care of the soil health. Organic farming is certainly one hopeful possibility of sustaining increased land productivity.

Perspectives on migration and land ownership

Most farmers living in the area are producing food, both for their families and to sell. Those with larger surfaces, or access to irrigation, do not always produce as much food per acre: some will choose crops such as red-gram grown on its own, with a higher work productivity, despite the lower land productivity; some of those with irrigation will choose to grow crops such as mulberry, using precious groundwater to do so; some relying principally on paid labourers to do their work, can no longer find enough willing workers to farm all of their land and leave parts of it fallow and unproductive.

The steady stream of emigration from the zone over the past 10 years means that the production of staple food crops is decreasing. Indeed, if the land is very poor, no-one is interested in farming it and it is abandoned. If the land is of good quality, it is often bought up by investors from Bangalore or other towns, as ways of evading tax, or laundering money. They farm on an investor type of model, travelling weekly to the zone, but living in the city. They choose to grow the crops that bring in the most profit, which are usually those that use large quantities of water. They are not necessarily those with a high land productivity, nor those that supply staple food products. They push up the price of land, and with it any chance of its redistribution to families who could use a little more to achieve some security.

In this way more families are condemned to leave in the long run. They contribute to mounting problems in the nearby cities, where employment is insecure and low paid for the unqualified; whereas they could remain in the zone and help produce good quality food to feed the urban populations around. Allowing these families to achieve a sustainable livelihood through farming, will go in favour of maintaining or increasing the land productivity.

3.3 IDEAS FOR GREEN FOUNDATION TO CONSIDER

The following suggestions are some ideas for Green Foundation's future work.

3.3.1 Continue with soil and water conservation measures

The work concerned with soil and water conservation, carried out by Green Foundation, is comprehensive and essential. The high water run-off and soil erosion are being dealt with by: trench-cum bunding, boulder checks and check dams to slow run-off and recuperate soil; farm ponds to conserve humidity and allow ground-water recharge; soil cover, such as green-manure and mulching, and the increase of soil organic matter through compost addition, to decrease evaporation, increase infiltration, increase soil organic matter and stabilise the soil

structure (§ 1.1, 1.2). Given the soil and climate in the area (§ 2.1), these can be but recommended. A lot of effort is being put into convincing the farmers to adopt these practices, as well as pay particular attention to the quality of the organic matter and the nutrients returned to the soil.

3.3.2 Remember the marginal farmers have precarious livelihoods

The small landholders with just dry-land do not have many possibilities for experimenting. They are already in a precarious economic situation (2.5.3) and cannot afford a drop in yield. However, their frequently low yields mean they are to benefit more than most from decreases in costs of inputs, as long as yields can be maintained. These farmers definitely require support, as is part of Green Foundation's objectives (§ 1.2). Part of the support must permit the increase of the family's income. Another aspect is reducing social inequalities. Decreasing the use of chemical inputs is a possibility, as long as the yields obtained can be maintained, or even improved. The way of achieving this could be through an increased diversification of produce.

3.3.2.1 Income-generating activities

Several income-generating activities appear possible. The first is the transformation of agricultural produce, as Green Foundation has already been implementing in Veereianadoddi and other villages, with help setting up and selling red-gram dhal, a high value addition compared to whole red-gram. The packaging, and for those growing organically, the selling as organic produce is another way of obtaining a higher price for produce. A new federation is currently being created for the marketing of such produce. Once it is up and running, it should allow part of the products to be sold as organic produce and provide customers in local urban centres with much wanted quality food of known origin.

3.3.2.2 Diversifying production

Diversifying the produce includes several ideas.

Producing fresh vegetables

Another pertinent Green Foundation idea is the production and selling of vegetables. However, this requires water. The first possibility is growing vegetables in the wet season. Families already do this, when it is not too complicated. Green Foundation encourages a greater diversity of vegetables to be grown, through their seed scheme and by organising training days. Many farmers have been very impressed by some of the new vegetables or new varieties for which Green Foundation have provided seeds.

These farmers have used these vegetables for their family's own consumption. For the poorer families, it is an excellent means of increasing their diet's diversity and providing some of the important nutrients that they would otherwise be lacking.

And providing for the local market?

Excesses of some vegetables have, so far, not been able to provide a supplementary income. But there are times of the year when vegetables are not available in the smaller villages of the zone. Even when they are available, the range is often limited. Families who can afford to travel to the larger villages and purchase vegetables there, brought in from Kanakapura or further away. There are therefore local marketing opportunities for vegetables.

A more detailed investigation would be required to determine the extent of these opportunities: what quantities would be concerned and at what periods of the year? Indeed, in the rainy season, most people grow their own vegetables; there is no doubt much less demand. The rest of the year, water is needed to grow the vegetables.

Access to irrigation for out of season vegetable production

To grow vegetables outside of the rainy season, the farmers without their own pump and irrigation facilities, could group together and lease a small piece of land close to the village. A little live fencing and they could cheaply protect the field from domestic animals. Close to the village, water can be carried by hand to water the vegetables.

Another idea is the development of vegetable growing that requires very low inputs of water. These would need experimenting with first. Once such method is the BRF method ("Bois Raméaux Fragmentés"), developed in Canada, but also applied in Madagascar (Les jardins de BRF): the soil is covered in a layer of green wood that has been first shredded, the idea being to mimic processes that happen on a forst floor. Crop water requirements are reported to be extremely low. Other possibilities include agroforestry systems to conserve atmospheric humidity or using other water supplies to prolong the growing season, such as water stored in farm ponds or wet areas alongside watercourses.

Marketing ideas for vegetables

By cooperating, marketing schemes can be thought about: taking the produce to the vegetable stores in the local villages that so far usually get their produce from Kanakapura; selling them in the larger towns, by providing vegetables that are not usually found and by insuring a regular supply of the more common ones all year round. At the moment, the produce comes in very varying quantities, with important price fluctuations. A regular supply of a wide variety of vegetables, obtained by sequential planting, as opposed to the usual all at one go, could provide the stores with produce kept at a more constant price throughout the year: more constant price for the customers and for the producers.

An alternative is selling directly to the consumer and by-passing any intermediaries: some of the European countries have seen a rapidly developing vegetable scheme, the idea of which is not incompatible. Consumers agree to buy a basket of vegetables a week. A weekly collection point is decided upon, which saves on transport requirement for the farmers. Farmers and consumers decide on the quantity and diversity of vegetables for one basket. Farmers know how much they have to produce and deliver each week. Consumers know they will be getting the agreed quantity of fresh vegetable for a set price. Such potential consumers exist locally. The scheme could possibly be extended to larger towns if production was sufficient, but transport then becomes difficult.

Another possible outlet for such produce is the local schools. The schools have a small budget for fresh vegetables. This could be used to purchase vegetables directly from the farmers. The quality, quantity and type of vegetable could be discussed with the farmers and planned over the coming year, giving the schools guarantees as to the quality of the produce, and the farmers guarantees as to the quantity to be produced.

Supplying seedlings to other vegetable growers

The idea of creating a local nursery for the production of seedlings could also be thought through. Some of the farmers with irrigated land are producing vegetables using high chemical inputs and complaining about the cost. They often purchase hybrid seedlings from over the border in Tamil Nadu (where vegetable production is more common). They might

gladly switch to purchasing seedlings more locally, if they can be shown to provide good yields, with no chemical fertilisers and much fewer pests and diseases. Farmers growing old varieties organically indicate that they obtain such benefits.

The vegetable producers struggle to have the time and the right quality soil to produce their own seedlings. Organic farmers involved in the production of vermicompost and other high quality organic matter could use some of this, with careful planning, to produce the small plants for other farmers.

Other cropping possibilities

Sesame has been seen to provide an interesting supplementary income by using the end of the dry season. There might be other crops that could be grown at this time of year. They would have to be particularly drought resistant. Tree species could be an alternative; some could provide fodder resources for example, and might be a way of increasing the possible number of cattle.

Using alternative sources of water

The collection of water during the rainy season, from field run-off in farm ponds, or from roof run-off in other tanks, might be one way of having a small off season production. This would require careful examination, to determine estimates of the amount of water available and ways in which it could be used.

Alternatively, low-lying areas, along the watercourses for example, are zones that might provide opportunities for dry-season cropping. Their extent is fairly limited and the need for these areas as grazing land would have to be determined first. Trees' capacity to access deeper soil water and preserve higher atmospheric humidity levels could provide opportunities for high land-productivity systems set-up on small areas.

All of these ideas are simply suggestions at the moment, without any practical evidence as to their feasibility in this area. There are many unknown factors and difficulties. Some of the extra work would fall in a heavy harvesting and processing period. Problems such as the free-grazing of animals would also require investigating, etc.

3.3.2.3 Working on relations within the village

The relations within the village are crucial to the long-term outcome of Green Foundation's work. The functioning of the community can be improved through some collective actions and trough a reduction in the inequalities.

Strengthening the community

The measures evoked above, such as the collective leasing of land close to the village, or marketing strategies, require strengthening the community. Another idea based on this is the sharing of herding responsibilities, to make it easier for families to acquire extra animals. Looking after 1 or 2 buffaloes is a lot of work; looking after a whole herd, if it can be shared with neighbours becomes truly worthwhile. Work sharing exists for ragi crop work for which it is essential and sometimes for herding, but this could no doubt be extended.

The drawing together of the community is an aspect of Green Foundation's work. In Veereianadoddi it has been difficult, because of inevitable past divides and current tensions. It is no doubt something which requires extra attention, if the other work in the village is to fulfil its potential. An extra member of staff with specific experience in this domain was being considered and is needed.

Overcoming social inequalities

Extra work also needs to be done to overcome some of the social inequalities, both caste and gender based. This is high on Green Foundation's agenda, but has been proving difficult in Veereianadoddi. Again, an extra staff-member experienced in this domain would be very beneficial.

The set-up of a vegetable scheme for those without access to water would in effect be working to support the families struggling most. It will come up against the usual problems of internal conflicts within the village, hence the need to resolve these as mentioned above. At present, the lower-castes are less involved, because they face more day to day difficulties and do not necessarily see what benefits they can get from the project. Moreover, many of the men from this community are working part of the year on far-off tradesman activities. Their interest in farming is reduced. A number of the families are frequently subjected to very high losses from the elephants. That also discourages them from putting in extra work to their cropping systems. They can then have a tendency to rely more on labouring work than on what they can produce themselves.

Women are also put-aside from the work going on, because of men's attitudes and a feeling of inferiority. It is very important, in a context where many of the men drink, wasting money and turning violent, or simply absent for other work activities, that women should regain their share of the responsibilities, of the income management and of the respect. There is much interest from them on vegetable growing opportunities, producing seeds if a market can be found for them, or processing for value-addition. There would also be more general interest on the other agricultural work, were they given a chance. They need to be involved in the Green Foundation meetings and their comments heard and listened to. In the current climate of the village, this will not be easy and requires specific efforts to that effect.

The absence of many of the men, away for other trading activities for large parts of the year, might make it necessary for the women to be trained in ploughing and other cattle powered operations. As the use of the tractor is creeping in, pushing up costs, decreasing manure availability and worsening the need for weeding, this might be welcomed by the women. Certain of the male attitudes need to be carefully addressed for this. It might also give women an access to higher paid labouring work (§ 2.3.3)…

3.3.3 Re-center the work on dry-land crops

Helping the more marginal farmers means finding improvements for dry-land cropping. This can work in the same direction as a larger scale need to concentrate energies on the lesser productive land and to reduce the use and wastage of what might prove to be precious underground water resources. The introduction of a dry season production, be it vegetables, fodder, or a more conventional crop like sesame all need to be considered. But there is also the potential for increasing the productivity of the main crops.

Green Foundation is introducing measures in that direction, via the increase of organic matter in the soil and of nutrient restitution: compost addition, vermicompost production and application, green-manure sowing, etc. However, as yet, the results have been very poor. This is partly because the farmers with only dry land have only just started increasing their organic matter applications (1 or 2 years at the most) and have often encountered problems with their vermicompost production. As to the farmers more actively involved, they nearly all have irrigated land and as such concentrate their energies and organic matter on these crops.

3.3.3.1 Without neglecting the irrigated crops…

Efforts should be pursued, to show the positive aspects of organic banana cultivation, confirm that yields obtained can be just as high, look into the quantities of organic matter required, extend mulching, the use of special preparations such as *jeevamrutha*, etc. On mulberry the long-term effect under such organic practices are still to be determined and the work should be continued with all of the very keen farmers of the area. As explained above, vegetable production has potential for organic cultivation in the area. All of these farmers have the advantage of producing plenty of vegetable matter from their irrigated crops to use for their composting.

3.3.3.2 …experiment with dry-land productivity

The increased attention on the dry-land crops needs to look into the productivity potential of this land. For many farmers with small amounts of land and very low farm incomes, this is essential, if their livelihoods are to be sustainable. It could also go hand in hand with optimising the use of resources, both land, soil and water, and preventing their degradation. For that, the concepts of agro-ecology might need to be pushed further.

Firstly, there is the simple testing of the effect of the quantity of organic matter on the land productivity and the crop yields (§ 2.4.6.3). Is it really a determinant factor in the yields potentially obtainable? If so, is that in combination with a small amount of fertiliser, or replacement "cow urea" for example? Can this be obtained after a few years, even on initially poor land? Or can this poor land be significantly improved by the application of tank soil for a couple of years?

There are possibly already conclusive experiments in contexts sufficiently similar to this one. If so, then they just require confirming here. Otherwise, they need testing. In either case, it would seem wise to attempt these tests with farmers who are already convinced and who have a safe margin on their income generation to be able to support a few uncertain years. Another possibility, to make it more widespread is ensuring any losses in the first years are compensated for financially. This is however delicate and must be well-thought through.

3.3.3.3 Planning any experimentation

Any experimentation on the yields of different crops must take into account the different factors that can affect them (§ 2.4.6.3). Green Foundation is already conducting experimental and research activities, with a large focus on different varieties.

In the organic farming context of Veereianadoddi, and if the farmers' sayings are anything to go by, particular importance should also be given to soil quality and organic matter content. From the interviews conducted for this report, these appear to be two essential factors, along with climatic conditions, determinant for the yields obtained. Care needs to be given to the fields that are chosen for experimentation, and if possible, there should be some long term experiments. The chosen fields should have the same type of soil (2.1.3), if results are to be compared. This can be done in collaboration with farmers, who usually know their soil properties very well.

Ideally, separate experiments should be conducted both on the richer soil, usually situated on the flatter parts of the landscape and on the poorer soils, where the topsoil was thinner initially and has often been lost (§ 2.1.3). On the better soil, it can have become compacted, or it can still have a relatively good structure. These too should be differentiated. Yields, losses from elephants apart, could be charted against soil quality and type, as well as average level

of organic matter input, to try and confirm or infirm the importance of these factors. With time and the necessary resources, the other factors could be tested.

3.3.3.4 Increasing the organic matter of soils

If the importance of soil quality and organic matter content can be shown, ways need to be found to increase the organic matter of soils. For this, the organic matter must be obtained.

Difficulties for dry-land farmers

The dry-land farmers are in a very different situation to the farmers with irrigated crops: for these latter farmers, there are large quantities of waste vegetable matter from crops such as mulberry or bananas. For the other farmers, even for their vermicompost, they are often using waste such as weeds from the fields. Although this is probably a better way of dealing with the weeds than burning them, they are not available throughout the whole year and only in limited quantities. Farmers will need to be sure of the benefits obtained from such methods before they head off to the forest to collect up vegetable matter for composting. They can use leaves from trees in their fields, but these are often fed to the few goats they own.

Trees?

The production of organic matter for dry-land farmers is therefore an aspect that needs to be looked into. Trees can be planted. Again, this is likely to be taken up with more enthusiasm than currently, once farmers have shown the benefits of increasing organic matter levels. Green Foundation does indeed have an agro-forestry component to its current project, but many of the trees have not survived because of lack of attention from the farmers. Long-term schemes are difficult to implement.

And animals?

Increasing the number of animals is another possibility. This has the advantage, in the case of the milk-producing buffaloes or cross-bred cows, of generating significant income (§ 2.4.5, 2.5.3.3). However, they need a minimum amount of fodder (§ 2.4.3). A more precise determination of the quantity of land and the type of fodder is required, to confirm the estimations obtained here.

Although from the work productivity comparisons, the cross-bred cows might look more attractive, in the long run, it might prove more interesting to encourage buffaloes: these sturdy animals are probably less prone to health incidents; they use the local forest resources and so require a smaller area of own land for their upkeep (§ 2.4.5.2); if the herding, which can no doubt be reduced to escorting them to the forest, can be shared, it could represent but a small quantity of work. For the smallest landowners, alternative forage production might be required. Ideas include trees with fodder producing capacity, dry-season fodder crops, or extra intercrops.

Goats and sheep also have non-negligible income generation potential, along with their good manure producing capacity. The amount of work required is high for a small number of animals. Again, the sharing of herding responsibilities could have benefits.

3.3.4 Other dry-land strategies or innovations

Other ideas and research for the dry-land crops are required. Strategies for minimising the losses due to drought could include sowing more resistant millets on at least some of the land as was done before the high-yielding varieties of ragi arrived (§ 2.2.2.3), or the choice of

appropriate varieties for different years and different land. These are long-term possibilities, which require farmers increasing their knowledge about the different varieties, and will come from work such as Green Foundation is currently carrying out, encouraging their growing and experimentation.

Work intensive systems?

Lengthening the growing season is one way of increasing the land productivity. Optimising the use of water can include sowing an appropriate dry season crop, to use the precipitation that falls from March to June. There are also the farm ponds and other water sources or wet-ground areas close to streams, which could be used to extend the growing season. There might also be high biological life strategies. Ideas such as the BRF method, relying on the mimicking of a forest soil to overcome the need for exterior sources of water, is one possibility. Or it could just be extensive mulching, with consideration given to the source of organic matter for dry-land farmers. Also, some of the agro-forestry systems can provide a favourable environment for year-round crop growing, by maintaining atmospheric humidity. These remain ideas and would require further investigations (§ 3.3.2.2)

Reducing costs

Smaller farmers could benefit from a reduction of cultivation costs. Tests on alternative home-made plant-based pesticides, conducted by Green Foundation, need to be pursued. They would avoid the use of hazardous chemicals and unnecessary costs. As to the fertilisers, the yields given by farmers in this investigation indicate that quantities applied could be cut to their minimum level for the farmers applying higher quantities. This, along with more general results concerning yields, need to be tested, before too much is recommended to the smaller landholders.

3.3.5 Concentrate efforts more locally

Organic farming is difficult: it requires more knowledge, more energy and effort, and more time, to find ways of better using the biological potentialities in a particular context, than does conventional farming. Because of this, Green Foundation might find a benefit from concentrating its energies on a smaller geographical area.

Currently, there seem to be too few people working in and around Veereianandoddi for all that could be done and the number of complications there. It would be a shame to see farmers lose interest and become sceptical about organic farming, because some problems have not received enough attention or enough discussion. Many of the difficulties arising there are quite normal and would easily find solutions if a proper team supporting and encouraging each other were present on site. One full-time worker may not be enough.

3.4 IDEAS FOR OTHER ACTORS OF RURAL DEVELOPMENT IN SOUTHERN INDIA

In the light of what has been explained in this report, a certain number of social measures of the utmost importance are required. They will not be easy to implement, but they must be done. At the same time, measures more specifically in the direction of farming communities need to be brought in: to give more marginal farmers a chance of obtaining a decent income; to maintain families in rural areas and stop the migration to urban areas, as is one of the wishes of the government of Karnataka; to maintain satisfactory levels of food production.

3.4.1 Urgent measures to overcome social complications

The social organisation in the area leaves many people particularly vulnerable.

Stop the dowries

The unjust dowry system must be stopped. The situation is degenerating (§ 2.3.1, 2.5.5.2). It only needs outside regulation, in the form of firm and determined well-thought through political action, to put an end to what families know to be absurd, but see no way of avoiding. The simplest idea appears to be the banning of dowries, both in money and in kind. Any new legislation on the matter would have to backed-up by measures to make it effective. In this respect, families receiving the dowry are the ones that need to be at fault, not the ones feeling obliged to pay it: many of these do not wish to have to do so in the first place.

The efficiency with which certain measures have been implemented in the past, such as the family planning policy (§ 2.3.4), but also the end to a large part of the bonded labouring (§ 2.2.1.4), are reasons for optimism. It should not require more than a good public awareness campaign, along with a certain number of court cases, and judiciary follow-up to start putting things right. This does not mean any such policies do not require careful thought and planning: extensive social changes always do; but this situation can and must be ended.

End un-repayable loans

The existing loans at 3 % or more per month are also crippling. Very few investments in the area can generate such a return. Ending them requires a combination of measures. Firstly, the need for large loans must be removed. This means putting a stop to the dowry system, as discussed above. It also means concentrating efforts on dry-land farming, to stop the huge desire and need for access to irrigation, which is pushing people to desperate loans for putting in a bore-well or buying irrigated land.

The emphasis on micro-credit opportunities must be increased. There have been many effective schemes, giving significant numbers of families access to reasonable loans on lower interest repayments. Some have worked very well, others have encountered problems. For example, some families have not had access to such loans; other groups have not managed to pay back the money and have disintegrated. In the area, an assesment of these schemes is required.

Moreover, other possibilities exist, such as loans in kind and not in money. One example is Green Foundation's "loans" of seeds, whereby families are provided with seed free of cost, but must return double the quantity the following year. They have been very beneficial schemes. They can also be applied to animals. Families can be given a pair of animals and be expected to repay the loan in kind, with the young. On a small scale, this can again be very positive.

But in the meantime, judiciary measures must be taken to end the common practice of lending money at excessively high interest rates. This is something that must be thought through very carefully, but is essential unless farmer suicides throughout the state and the country are to be accepted (§ 2.5.5.3).

Combat alcohol consumption and women's inferior status

The alcohol consumption must be addressed. It is a source of wasted income that could be used for ensuring a greater diversity of food intake for many a poor family, possibilities of putting aside some savings or investing in the farm, or for the children's education. But it is also a cause of violence on women, leading to death in a number of cases. Educational

measures, awareness campaigns, and high-tax on the alcohol sold so as to fund these measures, as well as schemes designed to give women more power over the income generated, are all possibilities.

The current status of women must be changed. Social justice and families' well-being require that women and men be considered equally. There is a long-way to go in the rural society around Veeraianadoddi. The abolition of dowries, the fight against alcohol, measures to include women more actively in the financial management of households and to ensure them an education, can all contribute.

Other necessary changes include the revalorisation of women's wages, so that they are progressively brought up to the same level as men's. A minimum percentage difference could be installed, between the wage paid to men and the wage paid to women. This could over a few years be brought down to 0%.

Care must be taken, and thought be given to how farmers deal with this extra cost. But it is also a way of redistributing income between different farming families: those with plenty of land or significant quantities of irrigated land, who can afford to pay labourers; those with little land who have to rely on labouring work to bring in income. It can make more money available for families on very low income. It can reduce the extreme poverty of some families and help those with many women members. Moreover, it can make it more worthwhile working locally, rather than heading off to work in precarious situations elsewhere, or deserting the rural areas altogether.

Special care must be paid to the families in the middle, who employ labourers, but for whom that expense is an important one. Allowing them to increase their income, by accessing higher work productivity activities, or the owning of larger numbers of animals for example, must be thought through. It could simply be making their income generation less insecure, by finding ways of reducing yield and price fluctuations.

Education opportunities for all

Real education opportunities are required for all. At present, the cost of secondary and further education is too expensive for many families (§ 2.3.4).

Within primary schools, teachers are too few. Their numbers need increasing; and the use of the stick, which makes violence customary, must be ended.

Greater care should be paid to the nutritional content of the lunches. For some children, these will be their only chance of a more diversified meal. Reasonable most of the year, long periods when only part of the supplies arrive is hardly satisfactory.

3.4.2 Farming measures

The soil and water resources in the area are threatened, as are farmers' livelihoods. The local land productivity is not guaranteed in the long-run.

Support for dry-land farmers

Dry-land areas are often underproductive and have received little input from governments (§ 1.1.3). In the area, they have good potential, but currently it is very unevenly exploited. These areas need to be given their proper place if a long-term development perspective is to be adopted and if some stability between urban and rural populations is to be achieved. Indeed, dry-land farming concerns large surface areas and important numbers of farmers. In

the study zone, outside of the area downstream from the dam, most of the farmers will never have access to irrigation.

Moreover, the increasing use of groundwater for irrigation, could well turn into a disaster. If it is not necessary to use such sources of water for improving the situation of farmers, maybe it should be discouraged, and better regulated. To avoid it being necessary, dry-land farming requires attention. The current understanding of the large differences in the yields obtained from one farmer to the next, is insufficient and firstly, experimentation should be carried out (§ 3.2, 3.3.3). Support should continue to be given to organisations such as Green Foundation, working to find alternatives with and for farmers. Wider measures are undoubtedly also required.

Farmer experimenters

Past experiments, in the too well-controlled conditions of experimental centres, have shown their limits. One idea is farmer experimentation. This could take the form of farmers recording precisely their farming practices, inputs and outputs, quality of soil, crop rotations, etc., so that this material can then be analysed and hypotheses constructed as to: the principal factors affecting yields, judicious combinations of crops, density of seed to be sown, methods with particularly promising results…

Farmers could also be given the care of conducting a certain number of experiments, to test particular hypotheses. This work would have to take place in a fairly restricted number of zones, but no doubt certain researchers would be glad if they could obtain good quality data directly from field trials, on a topic as important as dry-land cropping possibilities.

The farmers would have to be paid for this, as it constitutes work and an extra risk in the case of experimentation. The pay should be coherent with the quantity of work and the level of risk incurred. The set-up would require careful planning, to decide how best to get the farmers truly involved and to avoid side-effects, such as the pay being the main or sole motivation. For example, it should be a sum per family and not per acre, if it is not to benefit principally the larger farmers, etc.

It would still require field workers, but could possibly be done in partnership with organisations already conducting field-work. The farmers would need to be actively involved, to see the reasoning behind the experimentation and so that they are the first to benefit from any results coming out of it. This would be one of the principal objectives.

It could also be a way of raising farmers' self-esteem, of re-directing income towards currently low-productive zones, while increasing the productivity potential of such areas. Moreover, it will give ideas as to the potential of such areas for the future, as food production issues become very delicate once again.

It is what is happening to some degree in the organic village: money is available for farmers via different components of the project, on an experimental basis. It highlights the need for care when giving support. For example, the farmers with more assets are the ones who have the most to gain from it at the moment. This is partly due to the fact that they have access to irrigated land; this makes it easier to produce important quantities of organic matter to increase restitutions to the soil; based on the current evidence, the economic results under organic farming are more encouraging for irrigated crops than for dry-land ones. Attention must be paid if the measures chosen are to be considered appropriate by more farmers.

Improvements to the minimum support price scheme

The idea of guaranteeing a MSP to farmers is a very good one. Currently, the farmers are not all benefiting from the MSP (§ 2.2.1.4, 2.4.6.4) and along with the 2.2.2.3, 2.2.4, 2.5.1, 3.1), they are very costly schemes (§ 1.1.2). It might be worth thinking of a more regional scheme, which would allow the local produce to be truly purchased from farmers at a set price and closer to the MSP for a number of crops.

For example, instead of supplying principally white rice, of which the quality has often been contested, and which can create nutritional complications, ragi could be purchased locally and distributed locally. It can indeed enable calcium deficiencies to be overcome and contains high levels of B vitamins (Lupien, 1995). The cost of ragi is indeed lower, such that this distribution could guarantee farmers a slightly higher and more constant price, while providing urban families benefiting from the PDS with more diversified and better quality food at a lower cost for the government. Some of the money spent on the PDS would in effect be redirected to the dry-land zones.

3.4.3 Support for the more marginal farmers

The smaller farmers will benefit from any improvements to the productivity of dry-land farming systems, especially for the currently lowly-productive ones. Such improvements could contribute significantly to their incomes and they will be among the first concerned by any necessary efforts to achieve them, if they have the resources to do so.

If these farmers leave, the low-productivity land that is often theirs will become totally unproductive. They themselves then contribute to the growing numbers of urban poor, when they could be part of a rural population maintaining or improving the productivity of the land.

The unending need for land reform

Unproductive land is present as land that larger farmers do not see any point in putting into cultivation, or for which they cannot find the necessary labourers. Families are also leaving the area in search of better work and their land is being left, or bought up by urban dwellers wishing to invest. Without looking into further radical land reforms, these are issues that need to be regulated. When many small farmers are suffering from lack of land, and could greatly increase the productivity of unused land, redistribution measures are required.

Serious damage by elephants

For this, problems such as the elephants that have been regularly destroying large parts of crops need to be addressed. They are making it nearly impossible for some families to survive in the area. They have only been a real nuisance over the last 3 years. The reasons behind their migration in much greater numbers require investigating. In parts of the zone, deep trenches have been dug, to keep them out. Extending these works to other parts of the area should be considered, along with other ideas that might come from a better understanding of the migratory routes of the animals.

Access to animal capital

Animals have been seen to constitute a precious source of income potential. Increasing their numbers, for income and for organic matter to preserve or improve the quality of soils, must be encouraged. This can take on the form of support to micro-credit schemes, as well as innovative measures of fodder production and social management (§ 3.3.3.4).

Local produce for local people

The farmers of the area receive some support via the PDS. This could be improved if other food grains, and notably pulses were made available, by local selling points for local produce. This need not represent much of an extra cost: the produce could be distributed at the cost of production.

Such schemes could be extended to local urban areas and could provide a means of both increasing the nutritional quality of the food available to poorer sections of the populations and guaranteeing a higher income for farmers. It is the essence of the MSP and PDS schemes. However, their efficiency could be improved by working with a more localised distribution of as much of the food stuffs as possible. Also, more of the necessary investment for their functioning could benefit farmers in dry-land areas such as this one, who have received little support and who face the most risks.

THE FUTURE OF DRY-LAND FARMERS

The farmers in this semi-arid zone of southern Karnataka have inherited a social organisation that leaves many divides. The access to land and the capital for purchasing any animals still depends principally on caste: accumulation of capital has only been possible over the last few decades for most lower-caste families. Land remains a very strong constraint for many farmers, producing principally food for their families. Progressively an extra distinction has been introduced: some farmers now have access to irrigation, from the dam, or from their own pump, whereas most have only dry-land.

The cropping opportunities and income generating possibilities are totally different. The much higher land productivity of the irrigated crops, in a zone where most farmers own just 2 to 4 acres, makes the thought of installing one's own bore-well a dream for many. Farmers with access to irrigation can indeed earn a decent living for their families, using higher levels of external inputs and commercialising a greater proportion of their produce. But this only remains true while water is available.

Those without rely mainly on ragi sown with intercrops, for which they still use low levels of external inputs and sell only the surplus. They can cope with the irregular rainfall in the area if they have a large land surface, or on more average-sized landholdings, if they have some extra animals. Goats and sheep are a possibility for families with spare labour, even if they have no land. Milk-producing buffaloes or cross-bred cows require a minimum acreage to produce the necessary fodder, but generate a good return.

Farmers who have not been able to acquire extra animals and have only a few acres of dry land suffer heavily from climatic variations, or other hazards, such as heavy losses to the elephants. Their income is close to, or below the level required to maintain their family. Like the landless labourers, they rely on selling their labour in the local fields, for larger farmers, or travel to towns where more work is available. They have little control over their lives and most days are a struggle. Few can afford to send their children to school past primary level.

Amongst the farmers owning good assets, some can only use part of the net return for the family's maintenance. Alcohol is becoming a serious expenditure in certain families, but debts are more commonly a cause of financial crippling. Families take loans to marry their daughters, or to invest in animals or irrigation, to try and improve their condition. The sums borrowed and the interest rates can be far too high, leaving families in a desperate situation.

Outside of the dam-irrigated area, groundwater is used for irrigation. Despite the economic difference that it can make, there is no information as to how much of the valuable resource is present. What with the extent of the dry-land zones and the number of farmers depending on rain for their water, it seems difficult to foresee irrigation as the future of the farming in the area. Rather, the fair productivity that can be achieved on such lands without irrigation, would favour efforts directed at making the livelihoods of more dry-land farmers economically and ecologically sustainable. This could improve the land productivity, supply good quality food to local urban centres and stabilise rural populations.

To achieve this, experimentation is required to determine the principal factors that affect the land productivity and ways of enabling more farmers to generate good returns. The task is a difficult one, but far from impossible. Traditional practices will probably have to be combined with more innovative ones. Cropping practices that improve the soil quality and decrease the problematical erosion must be found. For this organic farming is essential, to avoid errors

such as those of the Green Revolution and maintain the good potential of the soil and the other natural resources in the area.

Green Foundation is working to find such alternatives for farmers and they must continue. A greater understanding of the potential of organic farming, and the means of generating organic matter and best using available water, for dry-land farmers is required.

However, it should be remembered that some farmers are in a precarious situation. They might do well to adopt new practices once the outcome has been tested over longer periods, so that they do not have to bear the burden of extra uncertainties. In the meantime, if they are to remain in the area, they require support to improve their farm income. Measures include diversifying their produce, extending the cropping season and creating extra added-value.

Finding local outlets for produce is necessary. Collective initiatives, such as a vegetable scheme, or finding markets for organic produce, are a possibility. Better commercialisation could also be organised on a larger scale, so that local urban centres are supplied with quality produce and farmers obtain higher prices.

Increasing the animals owned is a promising means of enabling farmers to produce extra organic matter, whilst increasing their income. For this, collective organisation of herding could be proposed and access to low interest loans increased.

Lastly, the social organisation cannot be ignored. Certain aspects of it, such as the dowry system, the inequalities between men and women, or the interest charged on loans between farmers, are handicapping families. Along with insufficient access to health and education, they are causes of poverty for many families.

There have been important public policies that have made large differences in the area, but the situation today calls for new ones if the local farmers are to stay. These should aim both to overcome some of the difficulties caused by the social organisation and to support the farming activities in the area.

Organic farming could be part of the future for farmers in and around Veereianadoddi. It will be crucial to finding sustainable practices in the area. However, experimentation is still necessary. Alone it is currently insufficient to enable the more marginal farmers to generate a satisfactory farm income and overcome some of the social inequalities they face. It must be coupled with a wider approach, if farmers are to be able to ensure agriculture fulfils all of its functions.

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FIGURES

ANNEXES

Annexe 1: Units and conversions

The units chosen are the local units, so as to make the report easily usable by field workers. Their values in more standard units are the following:

- acre: 1 acre = 0.4 ha
- tractor load of manure: 1 tractor load ≈ 2 - 2.5 tons
- basket (*mankri*) of manure: 1 basket ≈ 10 - 15 kg
- bundle of straw: 1 bundle ≈ 10 kg; green grass or sorghum: 1 bundle ≈ 20 kg
- share (*seru*): volumetric measurement for grains and flour; 1 share ≈ 1,3 L
- Indian Rupees: Rs 1 ≈ 40 $

All land surface areas in the report are given acres; all monetary values are given in Indian Rupees.

Annexe 2: Local and latin names of plants and crops

Alternative English names are given for the main plants and crops in the area, followed by the local names and lastly the latin names in italics.

Dry-land crops

English names, *"Local name"*	*Latin name*
Castor, *"haralu"*	*Ricinus communis*
Cow-gram, field beans, hyacinth beans, *"avare"*	*Lablab purpureus*
Cowpea, *"alasande"," targuni"*	*Vigna unginenlatum*
Foxtail millet, italian millet, "*navane*"	*Setaria italica*
Groundnut, *"shenga"," kadle kaayi"*	*Arachis hypogaea*
Horse-gram, *"huruli"*	*Macrotyloma uniflorum*
Kodo millet, *"haraka"*	*Paspalum scroticulatum*
Little millet, *"saame*"	*Panicum miliare*
Mustard, *"sasuve"*	*Brassica juncea*
Niger, wild gingelli, *"huchellu"*	*Guizotia oleifera*
Ragi, finger millet, *"ragi"*	*Eleusine coracana*
Red-gram, pigeon pea, *"togari"*	*Cajanus cajan*
Sesame, gingelli, *"ellu"*	*Sesamum indicum*
Sorghum, great millet, *"jola"*	*Sorghum bicolor*
Sweetcorn, *"muskina jola"*	*Zea mays*

Vegetables

English names, *"Local name"*	*Latin name*
➢ Aubergine, *"badane kaayi*"	*Solanum melongena*
➢ Chilli, *"menasina kaayi"*	*Capsicum annum*
➢ Tomato, *"tomato"*	*Lycopersicon esculentum*

Irrigated crops

English names, *"Local name"*	*Latin name*
➢ Banana, *"baale"*	*Musa sapientum*
➢ Elephant grass, *(sime hullu)*	*Pennisetum purpureum*
➢ Mulberry, *"reesme"*	*Morus indica*
➢ Paddy, *"bhatta"*	*Oryza sativa*

Other trees and plants

English names, *"Local name"*	*Latin name*
➢ Coconut, *"tengina mara"*	*Cocos nucifera*
➢ Congress, *"congress*"	*Parthenium histerophorus*
➢ *"alada mara"*	*Ficus bengalensis*
➢ Glyricidia	*Glyricidia sepium*
➢ Jackfruit, *"alasina mara"*	*Artocarpus heterophyllus*
➢ Jatropa	*Euphorbia pulcherima*
➢ Lantana, *"gidi"*	*Lantana camara*
➢ Mango, *"mavina mara"*	*Mangifera indica*
➢ Neem, *"bevina mara"*	*Azadirachta indica*
➢ Papaya, "*parangi"*	*Carica papaya*
➢ Pongamia, *"honge"*	*Pongamia glabra*
➢ Tamarind, *"hunasina mara"*	*Tamarindus indica*
➢ Teak	*Tectona grandis*

Annexe 3: Local farm implements and their uses

The implements used for farming are numerous and have very specific uses.

The cattle-drawn implements:

- *alube*: a 1.5 m-wide harrow-type implement composed of 10 round-sectioned wooden teeth, which protrude approximately 15 cm below the horizontal piece of wood in which they are set and are spaced at nearly 20 cm intervals; the tool is used for gathering up weeds after ploughing, or for covering seeds such as sesame;

- *gundu*: threshing stone, cylindrical in shape, of 50-60 cm in diameter, of similar length, made from granite; it is pulled in circles by a pair of cows, over and over the stalks of the plant to be threshed, on a specially flattened and cleaned part of the field;
- *heggunte*: a 0.4 m-wide harrow-type implement composed of 4 flat-sectioned iron teeth, approximately 30 cm long, 5 cm wide and spaced at nearly 15 cm intervals; the implement is used for pulling up weeds that are buried deep, after a ploughing, and before the field is cleaned by hand; the collecting up of the waste organic matter is much quicker if it is done after a passage of the *heggunte*, rather than directly after a ploughing; if the sowing is delayed and the weeds have started to grow again, or the field is particularly full of weeds with deep roots, an extra passage of the *heggunte* can be made;
- *kunte*: a 0.4 m-wide harrow-type implement composed of 4 or 6 flat-sectioned iron teeth, which protrude approximately 10 cm below the wood in which they are set and are spaced at nearly 15 cm intervals; the teeth are 5 or 6 cm wide at their broadest point; the tool is used for pulling up weeds after the last ploughing and before sowing, if the sowing has been delayed and the weeds have started to grow again, or for thinning crops such as ragi; it is also used for banking, by fixing two teeth nearly touching in the centre of the instrument, instead of the usual 4-tooth configuration;
- *kuurge*: a seed-drill, just over 1 m wide, with 5 hollow teeth spaced at approximately 20 cm from one another; the hollow of each tooth is sufficiently wide to allow fertiliser pellets to be sown with the seed; the implement is mounted with a "bottle" at the top, permitting the distribution of grains and fertiliser to each tooth; previously an 8-toothed implement was used, with a smaller gap between each tooth, but dap fertiliser could not be sown with it, as the holes were too small - the new implement started being adopted at the same as chemical fertilisers were introduced;
- *neglu:* plough, of which 2 types are used in the area; a small wooden one, which is still used for sowing groundnut; a wider metal one, with a proper mould-board, used commonly by all farmers today, for nearly all of the ploughing tasks; some farmers only acquired a metal plough very recently (5-10 years ago in certain cases);
- *vuta*: a group of lantana bushes tied together; dragged across the land to lightly cover the ragi seeds, that are very small and want to be buried under a very thin covering of soil.

Hand-held implements:

- *kudlu*: sickle - 20 cm long, incurved blade, used for harvesting, but also for weeding;
- *guddli*: spade - handle at 90° from blade, used for digging, usually by scrapping;
- winnowing tray: 3-sided woven tray, used for winnowing and for cleaning grains

Annexe 4: Yearly needs of a family of 4 and a family of 6

Needs of a family of 4 (2 adults and 2 children) and of a family of 6 (4 adults and 2 children)

Montly needs	Family of 4	Family of 6			Family of 4	Family of 6	Family of 4	Family of 6	Very poor family of 4		Poor f. of 4
Product	Monthly qty consumed		Unit	Unit price *	Cost *		Totals by category *		Monthly qty	Cost *	Totals *
Rice	15	30	kg	3.25	48.75	97.5			15	48.75	
Rice (over limit)	10	10	kg	10	100	100				0	
Wheat	3	6	kg	4	12	24			3	12	
Wheat (over limit)	4	6	kg	6	24	36	Staples		4	24	
Ragi	40	60	kg	5	200	300	384.75	557.5	50	250	334.75
Redgram	3.5	5	kg	12	42	60			3	36	
Cowgram	3.5	5	kg	10	35	50			3	30	
Horsegram	2	3	kg	8	16	24			2	16	
Urad dhal	0.7	1	kg	40	28	40			0.2	8	
Kadle dhal	0.3	0.5	kg	30	9	15	Pulses		0.2	6	
Other beans	0.6	1	kg	15	9	15	139	204		0	96
Oil	3.5	5	L	50	175	250			1	50	
Sugar	0.5	1	kg	15	7.5	15			0.5	7.5	
Sugar (over limit)	3	4	kg	20	60	80			1	20	
Cane sugar	0.5	1	kg	20	10	20				0	
Tea	0.3	0.5	kg	50	15	25	Other basics		0.3	15	
Salt	3	5	kg	3	9	15	285.5	420	3	9	101.5
Meat 1	1.2	2	kg	120	144	240			0	0	
Meat 2	1.5	2.5	kg	40	60	100			1	40	
Eggs	16	24	piece	1	16	24	Animal products		16	16	
Milk	6	8	L	9.6	57.6	76.8	277.6	440.8	2	19.2	75.2
Leaves	4	6	kg	15	60	90			0	0	
Tomato	2	3	kg	8	16	24			2	16	
Aubergine	1	1.5	kg	6	6	9	Local vegetables		1	6	
Fresh chilli	0.7	1	kg	30	21	30	103	153	0.7	21	43
Onions	4	6	kg	8	32	48			2	16	
Garlic	0.7	1	kg	30	21	30			0.5	15	
Beans	1	1.5	kg	15	15	22.5				0	
Fruit	weight very variable				100	150	Other fruit and veg		20	0	
Coconut	10	15	piece	4	40	60	208	310.5	5	20	51
Pepper	0.15	0.2	kg	60	9	12			0.1	6	
Coriander	0.6	1	kg	30	18	30			0.2	6	
Cumin	0.2	0.3	kg	80	16	24			0.1	8	
Fenugreek	0.1	0.15	kg	60	6	9			0.06	3.6	
Turmeric	0.06	0.1	kg	80	4.8	8			0.06	4.8	
Chilli powder	0.6	1	kg	30	18	30			0.6	18	
Mustard	0.3	0.5	kg	15	4.5	7.5	Spices		0.3	4.5	
Tamarind	0.7	1	kg	30	21	30	97.3	150.5	0	0	50.9
Monthly food cost							**1486.2**	**2221.3**			**752.35**
Cloth soap	8	12	piece	5	40	60			8	40	
Washing powder	0.5	1	kg	50	25	50			0	0	
Body soap	2	3	piece	10	20	30			2	20	
Monthly washing cost							**85**	**140**			**60**
Kerosene	3	3	L	10.5	31.5	31.5					
Kerosene	0	0	L	20	0	0					
Wood					80	100				80	
Electricity					20	30				20	
Monthly energy cost							**131.5**	**161.5**			**100**

Needs of a family of 4 (2 adults and 2 children) and of a family of 6 (4 adults and 2 children)

Yearly needs	Family of 4	Family of 6			Family of 4	Family of 6	Family of 4	Family of 6	Very poor family of 4		Poor f. of 4
Product	Yearly qty consumed		Unit	Unit price *	Cost *		Totals by category *		Yearly qty	Cost *	Totals *
Clothes adult	1	2	1 new set per person every 2 years	250	250	500				0	
Clothes child	1	1		150	150	150			1	150	
Shoes adult	1	2		50	50	100				0	
Shoes child	1	1		30	30	30			1	30	
					0	0					
Pots	1	1	per year	50	50	50			1	50	
Water cans	1	1	per year	25	25	25			1	25	
Various	1	1		20	20	20			1	20	
Yearly clothes and equipment renewals							**575**	**875**			**275**
Yearly house tax							**100**	**100**			**100**

Yearly schooling

Primary school	**per year per child**				**1 child**			
Clothes	2	2	sets	100	200	200	primary	
Books	10	10	books	10	100	100	300	300
Secondary school	**per year per child**				**1 child**			
Clothes	2	2	sets	250	500	500		
Text books	15	15	books	20	300	300		
Note books	20	20	books	10	200	200		
Bus	1	1	pass	400	400	400	secondary	
Fees	1	1	student	1000	1000	1000	2400	2400
Yearly school costs (1 child at each level)							**2700**	**2700**

	Family of 4	Family of 6	Poor f. of 4
Total food expenses (1)	17834	26656	9028.2
Total upkeep expenses (2)	**21107**	**31249**	**11323**
Total upkeep and schooling expenses (3)	**23807**	**33949**	

(1) just the cost of food
(2) food, washing, energy, clothes and equipment renewal and tax
(3) all of (2) plus the cost of schooling for 1 child at primary and 1 child at secondary level

* all prices and costs in Indian Rupees

Annexe 5: General information on cropping systems

Units for measuring the work

The work measurement chosen here is one labour-day, involving 8 hours of work per day. Indeed, if labourers are employed, ploughing and other cow assisted operations usually takes place from 6 to 11 in the morning and then 3 to 6 in the after-noon, allowing the cows and ploughman a rest in the middle of the day. Some prefer a continuous day from 6 or 7 in the morning to 2 or 3 in the afternoon. For weeding, it is often one continuous period starting at 9 or 10 o'clock until 5 or 6, with just a few short breaks for tea and mid-day lunch supplied by the employer. Sometimes paid labour only involves 7 hours of work. For some jobs, the workers negotiate a rate for the whole job and then work as long as is needed for completion. In the case of people ploughing or working in their own fields, the working day can be shorter or longer.

Men and women days have been included, because of the observed attribution of tasks and because of the difference in wages. For example, only men plough and use the other cow drawn tools, they hardly ever weed and then only in their own fields, never as paid labourers. So weeding is a woman's job. Separating the grains and the straw involves both men and women, but the men will do all the stone rolling and later hay stacking, while the women will almost always be the ones separating the grain from the husks. Some jobs are done equally by men or women. The term "human day" (hd) or "labour day" (ld) has then been used.

The basic labouring wage is 25 R or 30 R for one "woman day" (wd) and 50 or 60 R per "man day" (md), even when the two are doing the same work. Some tasks are different, requiring special equipment. Hence ploughing, which is done with the ploughman's own cows and plough is around 120 R / day. Harvesting or transplanting tasks are also different, because of the need for large numbers of labourers. The labourers often join together as a team and then negotiate a price for the whole work.

When the tasks are short, the work required for various tasks has been measured in hours: labour hours (lh) or human hours (hh), if no gender distinction is made for that job, otherwise man hours (mh) or woman hours (wh). The work durations are then converted into equivalent days, to make comparisons between different crop and livestock systems.

Precision and variability of the estimations

The first difficulty in estimating, be it times for various tasks, or quantities of inputs and outputs, is the acreage people were talking about. Their own estimates for their whole land surface could be very approximate, let alone for the acreage of one particular crop. To compensate for this, the interviews were conducted as regularly as possible in the field, and the areas the farmer was talking about were identified. After the interview, the fields concerned were measured.

The most reliable measurement for the surface considered was found to be the time necessary for ploughing the field using two cows and a metal plough. Indeed, although there is a variation depending on whether cows or bullocks are used, depending on the health condition of the cows and depending on the type of soil and the slope of the field, the range was usually between 12 and 18 hours to plough one acre of land. As most people have cows rather than bullocks, the time retained is nearer the higher end of the range: 16 hours per acre. This is the value for dry-land and is the time for ploughing only. As it is spread over two days, it requires two trips to the field and back. Each trip is double, as the plough must be carried and the cows

must be led to the field. Hence an extra hour per day has been added, which represents four quarter of an hour trips, knowing that sometimes the fields can be further than this.

Added to the difficulty for farmers of estimating the time required for different jobs, is the variations from one farmer to another and from one year to the next. Factors that affect the duration of a particular operation include:

- the strength of the animals used for pulling the farm implements, which can range from underfed cows to well maintained bullocks
- the nature of the soil and the humidity level
- the quantities per animal or per acre (of manure to be picked up or spread, of weeds that have grown, of crops that need to be harvested, threshed and carried)
- the distances between the house and the fields, or the different fields and the area selected for the threshing plot; distances which often have to be travelled several times, to get to work, to carry the implements, to bring home the produce, to tie up the cows, to pour water on the threshing plot...
- the importance assigned to that particular job or that particular field

The times required for all of the jobs include an average-length trip to the fields and the carrying of the necessary equipment there.

Although the farmers can make rough estimates, splitting up the yields according to the different fields is not easy, as for the threshing the farmers group all the produce together and thus do not know how much comes from each field. Hence even distinguishing between the quantity of mixed crops from the ragi fields and those from the groundnut fields is difficult. Finer determination of yields would require being in the area at harvesting time, or at least selecting particular farmers to closely monitor the yields obtained.

The range, of work times and quantities applied and obtained, has been shown and the most commonly used values retained. Sometimes this is close to a median value, but not always. When the range is smaller, it has not always been given. The mixed-crop harvesting times are very approximate because of large differences in yields: the quantities can be very small, so that the threshing and winnowing time is not proportional to the quantity obtained. Also, the whole process takes less than a day for a few acres, introducing extra uncertainty: all are rounded up to 1 day. These estimations are less precise than most of the others.

Annexe 6 Dry-land cropping systems

1 INPUTS, OUTPUTS AND INVESTMENTS

The level and nature of the inputs used depend on the land, the climatic conditions, the family's economic situation, the quantity of inputs produced on the farm, and personal choices based on needs and past experiences. The main factors influencing the outputs are the climatic conditions, the land, the inputs, the extent of losses and the choice of the work to be done.

1.1 CS1 - RAGI AND INTERCROPS AND CS2 - GROUNDNUT AND INTERCROPS

The inputs for both of these cropping systems are similar and are discussed together.

1.1.1 Varieties

Ragi varieties grown are nearly all hybrid varieties. Indaf 5 and GPU 28 are two of the most common. Most farmers change their seeds every three years. A few renew them every two years. A few very rarely buy new seeds, some because of a shortage of money, some claiming that there is no reduction in yield. Green Foundation has reintroduced the use of traditional non-hybrid varieties in Veereianadoddi and in neighbouring villages. Varieties grown there over the last three years include Pitchkadi ragi, Bili Mundaga, Karikadi ragi...

As to the seeds grown as mixed crops, they are mostly local variety seeds. Farmers save their own seeds from one year to the next, picking grains from the best plants. If one of their crops fail, they will purchase seed from another local farmer for next year’s sowing. For red-gram, some farmers buy hybrid varieties. In that case they renew the seeds every three to five years.

Two main varieties of groundnut are currently grown: one red, which fetches a higher price because of its higher oil content; one white, preferred for the house consumption. Both are improved varieties. They have not been growing well for the last few years. Only few nuts are full, the others being small and shrivelled.

Most farmers keep their own groundnut seeds from one year to the next. Some exchange them with other farmers, or buy them from their neighbours. Occasionally, new seeds are purchased from suppliers in Kanakapura or in Tamil Nadu. The government are once again selling hybrid seeds of some of the main crops, at subsidised prices.

Traditionally, a creeping variety of groundnut used to be grown. This year, such a variety will be the object of an experiment initiated by Green Foundation. Several farmers want to sow it.

1.1.2 Quantities and prices of seed

The quantity of ragi seed applied is variable from one farmer to another (figure 1). The most common level is 10 to 15 kg / acre, but a few farmers use as little as 6 kg / acre. A couple of farmers estimated that they apply 25 kg / acre, which is a very high quantity. These particular farmers claimed to get high grain yields. This information could not be verified during the course of the study and might stem from a misevaluation of the land surface. However, in future experimentations and investigations on yields, the effect of the quantity of seed sown is a parameter that should be taken into account.

The mixed crop quantities are also very variable, because farmers space their mixed rows at different intervals and chose to prioritise different species. Some farmers argue that certain combinations are less productive. For example, certain farmers do not include red-gram with

ragi, because the red-gram shades the ragi say some, or because the ragi reduces the red-gram development say others. However, most farmers do include red-gram. Another combination that was considered negative by a couple of farmers is groundnut with cow-gram, because of its creeping nature that tends to invade the groundnut plants next to it, and castor, because of the shade the tall plant creates. Again though, farmers usually include both of these in the mixed rows, and sometimes with high levels of seeds.

Soil can be a factor that increases or decreases the quantities sown of various crops. For example, niger was said to produce better in poor, sandy or gravely soils, as it produces excessive vegetation in richer soils at the expense of seed. Red-gram was said to be better suited to the redder, more clayey soils of the area, and those who have sandy soils sometimes sow less red-gram and more cow-gram.

A major factor in determining the amount sown of the different crops is the amount needed. As most of these crops are firstly food for their families or for their cows, in as far as is possible the quantities sown should cover their own needs, and very often they do. Depending on the land available, they can then adjust the combinations according to what is best from experiences of different types of land and positive or negative effects of different crops on one another. There is no consensus as to the effect of these on the yield, possibly because there are too many other factors influencing the yield. They too require being taken into account in further experimentations and investigations.

The difference between the quantities of mixed crop seeds in the ragi fields and the groundnut fields have not been included. From the interviews conducted, it was not possible to identify particular differences on a regular basis, and certainly not to identify a link with the obtained yield. This would have required specific interviews and possibly in situ monitoring.

Most seeds are saved from one year to the next. If the previous year's grain yield of one of the crops is so low, the farmer might not have enough to cover his household needs and put the necessary seeds aside for sowing. Also, adverse climatic conditions or pest infestation before or after harvesting can mean that the seed is not up to quality for sowing. In these cases, the farmers buy seeds off of their neighbours. The rates are close to the rates after harvesting.

The seeds for three crops are sometimes purchased externally as new seed. These are ragi, groundnut and red-gram. The ragi and groundnut are nearly always hybrids, as explained above, and the red-gram can be either. Some farmers continue to purchase or exchange these seeds locally, when they judge that their own seed is not of sufficient quality, rather than purchasing them from suppliers in nearby towns. When they are purchased externally, the rate is much higher than the local rate. For groundnut, it is between 30 and 40 R / kg; for ragi, new seed can be purchased from private or government suppliers from 12 R / kg upwards; for red-gram, it is between 20 and 35 R / kg.

This year the government is subsidising the seed for certain crops including these three, so that ragi seed was available at less than the local 4 R / kg, red-gram seed at around 10 R / kg, and groundnut at close to 15 R / kg. This has not been taken into account in the economic calculations, as most of the farmers who had to buy new seed this year were not aware of this at the time of purchasing. They continued to buy seed from their previous supplier.

1.1.3 Organic manure - mainly cow manure

A few of the medium or larger farmers purchase cow manure from other farmers in their village or from neighbouring villages, although this usually concerns irrigated crops. Mostly, farmers distribute their own manure between their different crops. Based on this, fields which

are to be sown with ragi receive up to two tractor loads per acre (12 tons/ha). The most common rate of application is just one load per acre.

As to the groundnut fields, on average these receive less manure. If farmers do not have enough manure to cover all their fields, they tend to apply the manure on half of their land one year and on the other half the following year. If they are growing groundnut in any significant quantity, they usually sow the groundnut on the side that has not received manure that year.

The animal manure is nearly all prepared in the same way. Every day, the fresh manure is collected up from the animal pens or sheds, or from the street where the cows are tied, along with the refuse straw, and any household vegetable waste. It is carried to the manure pile in baskets, on top of the head by the household member responsible for that job. The pile is usually just outside the village, on the path to the main fields belonging to that household, or near the house for those living on the edge of the village. Sometimes it is situated in a depression, or in a previously dug hole. Now though, the matter is commonly just heaped on top of the ground and is left there to be broken down throughout the whole year. It will be applied to the fields all at once, before the second or the third ploughing of the land.

The farmers who apply the manure before the second ploughing think that the manure can then be well incorporated into the soil: it will be mixed by the two following ploughings and will have a long time to break down. Also, the weed seeds in it will be in favourable conditions to germinate after the second ploughing and thus be removed by the last ploughing, before the ragi seeds are sown. Those who apply it later, usually do so because they do not think it makes enough difference to set time aside for it earlier in the year.

Other practices thought to improve the crop growth include burning the crop residues and weeds collected on the field. Sometimes some of the weeds are fed to the animals, but they are never composted, and nearly always heaped in piles in the fields once they are dry and burnt. Presumably, this gives readily available minerals, but also avoids a nitrogen uptake by the soil micro-organisms when they break down the crop residues, and especially material like straw (§ 1.3.1).

Ash is also used by some farmers when they sow groundnut. It is applied like fertiliser, behind the plough, while the seeds are being dropped in the furrow, or sometimes mixed directly with the seeds.

In Veereianadoddi, the organic farmers, who are no longer applying dap or urea, have replaced them with organic fertilisers, the most common being vermicompost and a sand and cow urine preparation. Other additions include: other compost, neem cake, *jeevamrutha*, although these are used more frequently on the irrigated crops. These farmers also experimented with green manure crops during the summer season, turning them into the ground before getting the land ready for sowing the main rainy season crop.

1.1.4 Chemical fertilisers

For ragi, dap is applied at sowing and urea is applied just over one month later. Most farmers apply only dap to the groundnut crops (figure 3), and this at the time of sowing. This year in Guluvadi, significant numbers of farmers are not applying any chemical manures to the groundnut crops, as the previous years, the yields have been very low. They judged that it was not worthwhile. Some even thought the chemical fertilisers were part of the problem, causing excessive vegetative growth and possibly hindering good seed development. They had however previously applied them and obtained good yields.

The levels of fertiliser applied vary, but quite often within a range of 10-25 kg / acre of dap and the same of urea: a family buys one bag and applies it on their two, three or four acres (figure 1). It can however be up to 50 kg / acre. Sometimes, money availability determines how much fertiliser is applied. On the other hand, some larger farmers, applying just low levels, claim that this is sufficient for them to get very good yields.

1.1.5 Pesticides

To reduce the pest incidences on red-gram and cow-gram, various chemicals are used and in various combinations. Commonly, a tonic is used (composed of various micronutrients to reducing flower shedding and strengthen the plant), sometimes separately, sometimes mixed with an insecticide, such as Fenvalerate. This mixing appears a strange practice, but farmers claim the insecticide is ineffective without it. Certain farmers claim to use Metacid, although this is usually reserved for paddy. At the time of year when this study was carried out, none of the farmers had any of the bottles with them, so this information could not be verified. It may have become a common term designating various pesticides in the local language. Other pesticides used include Endosulphan and Monocrotophase.

Three different types of chemicals used (figure 5):

- the first combines tonic and Fenvalerate; if these are mixed and sprayed once, approximately 50 mL or 60 mL of each are applied per acre;

- the second variation consists of approximately 125 mL of Metacid ;

- another possibility is the use of Endosulphan, with about 100 mL applied per acre per spraying.

The number of sprayings depends on the farmer and on the year and the level of damage caused by the pests. Two sprayings was retained to evaluate the cost for farmers, as this is the most common number of applications, although some spray only once and a few not at all. Amongst those who spray twice, some use the same combination both times; others spray different chemicals for each intervention. The quantities applied often vary from simple to double. A few farmers apply even higher levels, some claiming that they apply as much as they can afford.

Whatever the chemical chosen, the cost of one spraying with the most frequently used quantity is similar (figure 5). Quite a few farmers apply double the amount. Hence the economic calculations (figure 1 and figure 3) consider two different levels of pesticides, the most common, and a higher one, applied twice.

The organic farmers do not apply the usual pesticides. Green Foundation has proposed a series of recipes based on plant extracts, such as mixtures of garlic, chilli, neem… During the 2005 kharif cropping season, the farmers already growing their crops organically had no need to apply pesticides of any kind. The plant based organic pesticides are said to be very effective, so it will be useful to have the opportunity to test them in Veereianadoddi.

Most farmers agreed that there were fewer pests this last year, because of the excessive rain, and some of those using chemicals did not need to resort to pesticides either. However, other farmers still sprayed their cow-gram and red-gram plants twice. Based on the different levels applied, it seems there is a lot of scope for reducing the quantities used. If local farmers can show that the plant based pesticides are effective, the chemical pesticides could potentially be dropped by most farmers. The cost of the garlic does however need to need considered, as this is not grown locally in any quantity and would have to be purchased.

1.1.6 Input scenarios

Based on this information, three different situations have been considered to establish the economic performance of these cropping systems (figure 1 and figure 3).

The first is the most commonly observed situation, with moderate levels of cow manure and chemical fertilisers. Seeds are only exceptionally purchased from private or government suppliers at higher rates; most are produced themselves, or exchanged between farmers.

The high external input scenario is one where new seeds are purchased from external suppliers every three years for ragi, groundnut and red-gram, as is frequent among larger landowning farmers, with higher levels of chemical fertilisers and pesticides (approximately twice the more common levels). It is not always the larger landowners who apply these higher levels, a certain number of the smaller farmers do too. This scenario gives an idea of the extra cost that chemicals and seeds can represent for farmers.

The last scenario is an organic scenario, with no external inputs. This is not the case for all organic farmers. Some purchase various organic inputs. Here however, all inputs will be considered o come from the farm, as it is the situation that would concern the greatest number of farmers at the moment, few being prepared to buy such external inputs.

1.1.7 Outputs

The outputs include the main grain, which will be consumed or sold, but also a certain number of products fed to the animals. The main one is the ragi straw. But the animals also get a lot of nourishment from the pods of cow-gram and red-gram. The sorghum is cut green for the cows, and some grain and straw will be obtained during the harvesting period. The cow-gram plants are also used to feed to the cows. These other products fed to the cows have been quantified, but not priced, as they are very rarely sold. If more is produced, more is fed to the cows, and the quantities sown will usually be adapted to the needs of the cows owned.

Variability

The yields obtained are extremely variable, from one farmer to another and from one year to the next (figure 2 and figure 4). The reasons for the variations are multiple, and the interviews conducted could not determine precise correlations. However, several strong hypotheses emerged, as to the main factors. These are discussed in the report (§ 2.4.6.3).

The yields

Four different yield levels represent what farmers commonly grow in the fields where they sow ragi. An ordinary yield was estimated at 8-9 q / acre. Indeed, this was the quantity most farmers reported on a year without any particular problems.

The highest level, of 10-15 q / acre, is only obtained by a few farmers, who apply common or high levels of chemical fertilisers, who have well situated land, near the village, less susceptible to wild animals, and with soil that is usually red and deep. Amongst the farmers in this category, such yields were reported by farmers who apply higher levels of manure (1.5-2 tractor loads / acre). But too few were in this category to be able to generalise.

Some farmers reported very low "ordinary" yields. These are farmers with poor soil, on the lower strata of the typical soil formation, half way down the hill. They might only get 5 q / acre normally. Other farmers get such a low yield when there are particular problems, such as unsteady rainfall, or losses to wild animals, especially elephants in the case of ragi. In

all these situations, the yields of the mixed crops are often very low too, although the level of damage varies from one crop to the next, and usually some crops do not suffer too much. So the poor scenario includes farmers with poor yielding land, or farmers with ordinary yielding land, but in a difficult year. It does not take into account the extremely low yield sometimes obtained, after an accumulation of problems or extensive damage by elephants.

An organic scenario has been included. The farmers farming organically in the area only started a few years ago. It is therefore not yet possible to know what yields can be expected once the levels of organic matter in the soil have increased. The ordinary organic scenario was based on what farmers can grow currently: a low amount of ragi, with only about 5 q / acre, but quantities of the mixed crops similar to other farmers, although these results are uncertain.

For example, the farmers did not agree on the straw yield. Some claimed there was not much change. Others had noticed an important decrease since taking up organic farming. Poor years are estimated as similar in yield to the poor yields for other farmers, as insufficient information is available to do otherwise. However, some farmers reported very low ragi yields, with only 3 q / acre this last year, a difficult year because of the high rainfall.

An optimistic scenario is the ordinary scenario, with around 9 q / acre of ragi. This is not unrealistic, in that some of the larger farmers reported obtaining such yields before the new varieties and chemical fertilisers were introduced. At that time, they had very large herds of cows or buffaloes and so were applying very high levels of organic manure to their fields.

Cow-gram has one peculiarity in that it can be picked as a green bean, somewhat like peas. Not all farmers choose to do this, as it requires extra days of labour during the busy harvesting time and also as they need the dry beans as food for the year. However, considering these beans have a much higher water percentage in them, the rate fetched is higher. Some farmers pick some as fresh beans, but keep enough to give them the necessary supply of dry beans for the year. Others pick them all as fresh beans, then buy their dry beans from local farmers.

The sorghum is fed to the cows as green fodder. As such, although some is left at harvesting time, the quantity is very variable depending on the number of cows, the amount of land, the quantity of seed sown, and sources of other green food for the cows.

1.1.8 Costs, returns and investments

The costs and returns were calculated for the different scenarios, for both ragi and intercrops and groundnut and intercrops (figure 6 and figure 7). The necessary investments were determined for the dry-land cropping systems (figure 8). Three different levels were distinguished, to take into account: farmers owning all the equipment required; farmers owning most of the implements, but sharing a few of them with their neighbours; farmers with only the implements that cannot be shared. However, the farmers in this last situation, with virtually none of their own implements, are dependant on their neighbours, and as such will usually have to go wait until last, after the other team members, for operations such as sowing, etc. The work on their crops is rarely done at the most effective time.

1.2 CS3, CS4 AND CS5 - OTHER DRY-LAND CROPPING SYSTEMS

Three other dry-land cropping systems have been detailed. The information relating to the quantities and costs of inputs, and the yields, prices and returns is presented (figures 9-13). The required investments are the same as those for ragi or other dry-land crops, considering the same implements are required.

Figure 1: Input data for 1 acre of ragi and intercrops

Ragi fields - per acre data											Extra outside input costs		
Inputs	All prices are given in Indian Rupees	Quantities used by different farmers	Most common quantity	Unit	Unit cost range	Selected unit cost	Renewal frequency range	Renewal frequency	Common acre cost	Cost of own farm inputs	Common input version	High input version*	Organic version*
Seeds	Ragi	10-15 (some only 6-7, some possibly 25)	12	share	4-12	12	2-6	5	29		28.8	48	12
	Redgram	1.5-5	3	share	15-35	20	3-5	5	12		12	20	12
	Cowgram	2.5-10	5	share	10-15	15	when their personal supply is insufficient in quantity or quality	5	15		15	15	15
	Sorghum	1-2	1.5	share	5-7	6		5	1.8		1.8	1.8	1.8
	Castor	1-5	2	share	10	10		5	4		4	4	4
	Niger	0.1-0.3	0.2	share	10	10		5	0.4		0.4	0.4	0.4
	Mustard	0.1-0.2	0.1	share	15-17	15		5	0.3		0.3	0.3	0.3
	Cowpea	0-2	NQ	share	NQ	NQ		5	NQ				
Fertilisers	Cow manure	0-2	1	tractor load	250-400	300			300	300	0	0	0
	Dap	0.25-0.5, some only 0.1	0.25	50 kg bag		510			127.5	0	127.5	255	0
	Urea	0.25-1, some 0	0.25	50 kg bag		280			70	0	70	140	0
Pesticides	Various products	0-2	2	sprayings	30-60	30			60	0	60	120	0
Total consumables									619.8	300	319.8	604.5	45.5
Services	Manure loading	0-2	1	tractor loads	75-100	80			80		80	80	80
	Manure tractor fee	0-2	1	tractor loads	150-200	200			200		200	200	200
	Sprayer rental	0-1	1	days	25-30	25			25		25	25	25
	Mending tools										5	5	5
	Plough parts	1 new end/ 3-4 days	1.5	pieces		10					15	15	15
Total services											325	325	325
Total extra external IC											**644.8**	**929.5**	**370.5**
Total IC											944.8	1229.5	670.5

All prices are in Indian Rupees
NQ: not quantified NA: not applicable

Figure 2: Output data for 1 acre of ragi and intercrops

Outputs	quantities	Quantity on a good year	Quantity last year	Ordinary yield scenario	Good yield scenario	Poor yield scenario	Organic yield scenario	Unit	Weight of 1 bag	Ordinary yield scenario	Good yield scenario	Poor yield scenario	Organic yield scenario	Unit
	Ragi	5-15	1-10	8	12	5	5	bags	1	8	12	5	5	qx
	Red gram	0.3-2	0.1-0.5	0.5	0.75	0.3	0.75	bags	1.05	0.525	0.7875	0.315	0.7875	qx
	Cowgram	1-3	0.2-1.5	0.75	1	0.5	0.75	bags	1.05	0.7875	1.05	0.525	0.7875	qx
	Sorghum	0.25-1	0-0.5	0.5	0.5	0.3	0.5	bags	0.95	0.475	0.475	0.285	0.475	qx
	Castor	0.3-1	0-0.2	0.5	0.5	0.1	0.5	bags	0.9	0.45	0.45	0.09	0.45	qx
	Niger	0.1-0.2	0.02-0.1	0.15	0.15	0.05	0.15	bags	0.9	0.135	0.135	0.045	0.135	qx
	Mustard	0.05-0.3	0.03-0.25	0.15	0.15	0.05	0.15	bags	0.95	0.1425	0.1425	0.0475	0.1425	qx
	Cowpea	0.1-0.3	0.1-0.2	0.2	0.2	0.1	0.2	bags	NQ	NQ	NQ	NQ	NQ	
	Green cowgram	0-2	0-2	1	2	0	1	qx		1	2	0	1	qx
Animal food	Straw	50-200	50-150	150	200	75	100	bundles	N.A.	N.A.	N.A.	N.A.	N.A.	
	Gram pods	0.5-1.5	0.5-1	1	1.5	0.5	1	bags		1	1.5	0.5	1	bags
	Sorghum	green for cows							N.A.	N.A.	N.A.	N.A.	N.A.	

Outputs	prices in Rupees	Unit selling price range	Unit selling price	Average seed qty required	Seed qty required high input scenario			Unit	Ordinary yield scenario	Good yield scenario	Poor yield scenario	Organic yield scenario	Extra high input sales
	Ragi	380-500	420	0.096	0.08			qx	3319.7	4999.7	2059.7	2059.7	6.72
	Red gram	1000-1500	1200	0.024	0.02			qx	601.2	916.2	349.2	916.2	4.8
	Cowgram	900-1500	1000	0.04	0.04			qx	747.5	1010	485	747.5	0
	Sorghum	400-600	500	0.012	0.012			qx	231.5	231.5	136.5	231.5	0
Human food	Castor	1000	1000	0.016	0.016			qx	434	434	74	434	0
	Niger	1000	1000	0.0016	0.0016			qx	133.4	133.4	43.4	133.4	0
	Mustard	1000-1600	1500	0.0008	0.0008			qx	212.55	212.55	70.05	212.55	0
	Cowpea			N.Q.	N.Q.				NQ	NQ	NQ	NQ	
	Green cowgram	700-900	800	N.A.	N.A.			qx	800	1600	0	800	
Animal food	Straw		10					bundles	1500	2000	750	1000	
	Pods		NQ						NQ	NQ	NQ	NQ	
	Sorghum		NQ						NQ	NQ	NQ	NQ	
							Gross return		7979.8	11537	3967.8	6534.8	11.52

All prices are in Indian Rupees
NQ: not quantified NA: not applicable

Figure 3: Input data for 1 acre of groundnut and intercrops

Groundnut fields - per acre											Extra outside input costs		
Inputs	All prices are given in Indian Rupees	Quantities used by different farmers	Most common quantity	Unit	Unit cost range	Selected unit cost	Renewal frequency range	Renewal frequency	Common acre cost	Cost of own farm inputs	Common input version	High input version*	Organic version*
Seeds	Groundnut	30-35	30	share	15-20 / 30-40	35	2-6	5	210		210	350	30
	Redgram	1.5-5	3	share	15-35	20	3-5	5	12		12	20	12
	Cowgram	2.5-10	5	share	10-15	15	when their personal supply is insufficient in quantity or quality	5	15		15	15	15
	Sorghum	1-2	1.5	share	5-7	6		5	1.8		1.8	1.8	1.8
	Castor	1-5	2	share	10	10		5	4		4	4	4
	Niger	0.1-0.3	0.2	share	10	10		5	0.4		0.4	0.4	0.4
	Cowpea	0-2	NQ	share	NQ	NQ		5	NQ				
Fertilisers	Cow manure	0-2	0.5	tractor load	250-400	300			150	150	0	0	0
	Dap	0-1	0.5	50 kg bag		510			255	0	255	510	0
Pesticides	Various products	0-2	2	sprayings	30-60	30			60	0	60	120	0
Total consumables									708.2	150	558.2	1021.2	63.2
Services	Manure loading	0-2	0.5	tractor loads	75-100	80			40		40	40	40
	Manure tractor fee	0-2	0.5	tractor loads	150-200	200			100		100	100	100
	Sprayer rental	0-1	1	days	25-30	25			25		25	25	25
	Mending tools										5	5	5
	Plough parts	1 new end/ 3-4 days	1.5	pieces		10					15	15	15
Total services											185	185	185
Total extra external IC											**743.2**	**1206.2**	**248.2**
Total IC											893.2	1356.2	398.2

All prices are in Indian Rupees
NQ: not quantified NA: not applicable

Figure 4: Output data for 1 acre of groundnut and intercrops

Outputs	quantities	Quantity on a good year	Quantity last year	Ordinary yield scenario	Good yield scenario	Poor yield scenario	Organic yield scenario	Unit	Weight of 1 bag	Ordinary yield scenario	Good yield scenario	Poor yield scenario	Organic yield scenario	Unit
	Groundnut	10-20	6-15	14	20	8	8	bags	0.35	4.9	7	2.8	2.8	qx
	Red gram	0.3-2	0.1-0.5	0.5	0.75	0.3	0.75	bags	1.05	0.525	0.7875	0.315	0.7875	qx
	Cowgram	1-3	0.2-1.5	0.75	1	0.5	0.75	bags	1.05	0.7875	1.05	0.525	0.7875	qx
	Sorghum	0.25-1	0-0.5	0.5	0.5	0.3	0.5	bags	0.95	0.475	0.475	0.285	0.475	qx
	Castor	0.3-1	0-0.2	0.5	0.5	0.1	0.5	bags	0.9	0.45	0.45	0.09	0.45	qx
	Niger	0.1-0.2	0.02-0.1	0.15	0.15	0.05	0.15	bags	0.9	0.135	0.135	0.045	0.135	qx
	Cowpea	0.1-0.3	0.1-0.2	0.2	0.2	0.1	0.2	bags	NQ	NQ	NQ	NQ	NQ	
	Green cowgram	0-2	0-2	1	2	0	1	qx		1	2	0	1	qx
Animal	Gram pods	0.5-1.5	0.5-1	1	1.5	0.5	1	bags		1	1.5	0.5	1	bags
food	Sorghum	green for cows							N.A.	N.A.	N.A.	N.A.	N.A.	

Outputs	prices in Rupees	Unit selling price range	Unit selling price	Average seed qty required	Seed qty required high input scenario			Unit	Ordinary yield scenario	Good yield scenario	Poor yield scenario	Organic yield scenario	Extra high input sales
	Groundnut	1100-1500	1200	0.24	0.2			qx	5592	8112	3072	3072	48
	Red gram	1000-1500	1200	0.02	0.02			qx	601.2	916.2	349.2	916.2	4.8
	Cowgram	900-1500	1000	0.04	0.04			qx	747.5	1010	485	747.5	0
Human	Sorghum	400-600	500	0.01	0.012			qx	231.5	231.5	136.5	231.5	0
food	Castor	1000	1000	0.02	0.016			qx	434	434	74	434	0
	Niger	1000	1000	0.00	0.0016			qx	133.4	133.4	43.4	133.4	0
	Cowpea			N.Q.	N.Q.				NQ	NQ	NQ	NQ	
	Green cowgram	700-900	800	N.A.	N.A.			qx	800	1600	0	800	
Animal	Pods		NQ						NQ	NQ	NQ	NQ	
food	Sorghum		NQ						NQ	NQ	NQ	NQ	
							Gross return		8539.6	12437	4160.1	6334.6	52.8

All prices are in Indian Rupees
NQ: not quantified NA: not applicable

Figure 5: Different types of pesticide used and their quantities and cost

Pesticides

For 1 spraying	Products applied	Quantities used by different farmers	Most common quantity	Common high input quantity	Unit	Unit cost in Rupees	Common input version	High input version	Organic input version
Scenario 1 - mixture of fen-valerate + tonic	Fenvalerate	0-2	0.5	1	125 mL pot	40	32.5	52.5	
	"Master veg" tonic	0-2	0.5	0.5	100 mL pot	25			
Scenario 2 - metacid	Metacid (Methyl parathion)	0-2	0.5	1	125 mL pot	60	30	60	
Scenario 3 - endosulphan	Endosulphan	0-2	1	2	125 mL pot	40	40	80	
Scenario 4 - plant based spray	Chilli	?			kg	?? *			?? *
	Neem	?			kg	?? *			?? *
	Garlic	?			kg	?			?

Figure 6: Costs and returns for 1 acre of ragi and mixed crops

Input level	Common			High			Organic	
Output level	Ordinary	Good	Poor	Ordinary	Good	Poor	Ordinary	Poor
Total costs	945	945	945	1230	1230	1230	671	671
G. return	7980	11537	3968	7991	11549	3979	6535	3968
Net return	7035	10593	3023	6762	10319	2750	5864	3297
Quantity of work	79	hours						
Net return / work day	89	133	38	85	130	35	74	42

Figure 7: Costs and returns for 1 acre of groundnut and mixed crops

Input level	Common			High			Organic	
Output level	Ordinary	Good	Poor	Ordinary	Good	Poor	Ordinary	Poor
Total costs	893	893	893	1356	1356	1356	398	398
G. return	8540	12437	4160	8592	12490	4213	6335	4160
Net return	7646	11544	3267	7236	11134	2857	5936	3762
Quantity of work	62	days						
Net return / work day	123	185	52	116	179	46	95	60

All prices are in Indian Rupees

Figure 8:Ragi and groundnut CS investments

Total cropping system investments and depreciation

	Nature	Number required			min price	max price	selected price	cost		lifespan	depreciation
np	cows	2			8000	12000				10	0
np	**metal plough**	**1**		**1**	**600**	**1000**	**600**	**600**		**10**	**60**
np	wooden plough	1		1	100	300	150	150	(1)	10	15
np	**wooden bar**	**1**		**1**		**30**	**30**	**30**	(1)	**20**	**1.5**
np	**alube**	**1**		**1**	**50**	**200**	**100**	**100**	(1)	**5**	**20**
np	kuurge	1		1	500	1500	1200	1200	(1)	10	120
np	**vuta**	**1**	3h work/y	**1**		**0**	**0**	**0**		**1**	**0**
np	**kunte**	**1**		**1**	**100**	**300**	**250**	**250**	(1)	**2**	**125**
np	**heggunte**	**1**		**1**	**100**	**500**	**350**	**350**	(1)	**5**	**70**
np	**mankri**	**2 or 3**		**2**	**25**	**30**	**25**	**50**		**2**	**25**
np	pulveriser and hand pump	1		1	??	500	500	500		10	50
np	**spade**	**2**		**2**	**50**	**60**	**60**	**120**		**5**	**24**
np	**crushing stone**	**1**		**1**		**1500**	**1500**	**1500**		**20**	**75**
np	**water pots**	**4**		**4**	**25**	**40**	**30**	**120**		**4**	**30**
sp	**wood for straw stacking**						**0**	**0**		**5**	**0**
sp	**fencing for straw**						**0**	**0**		**5**	**0**
np	**Mending plough, etc**	**20-40 ragi shares / year (2)**		**40**	3.8	4.5	**4.2**	**168**		**1**	**168**
p	**scythe**			**2**	**50**	**60**	**50**	**100**		**4**	**25**
p	**new parts for plough**	**1 piece / year**		**1**			**100**	**100**		**1**	**100**
p		**1 piece / 2 years**		**1**			**100**	**100**		**2**	**50**
p	new teeth for kunte 1x/2y		taken into account directly with new instrument				200			2	
p	new teeth for heggunte 1x/5y						300			5	
									Low(3)	Common(4)	Maximum
Total replacement sum									79	773.5	958.5
Total investment									290	3588	5438

(1) Considering the wood is fetched from the forest by the farmer himself
(2) The blacksmith is still payed a forfait quantity of ragi per year for the fixing of one set of all the cow drawn implements, as many times as required
(3) The minimum replacement sum supposes the farmer does not own all the necessary equipment, but borrows the ones he can: wooden plough, kuurge, heggunte if needed.
(4) The pulveriser is rented by all but the bigger farmers and so is considered as rental in the two lower investment situations. The kuurge is often shared between farmers and so is not included in te common situation either.

All prices are in Indian Rupees

Figure 9: Input data for 1 acre of horse-gram

Horsegram fields - per acre data

Inputs	All prices are given in Indian Rupees	Quantities used by different farmers	Most common quantity	Unit	Unit cost range	Selected unit cost	Renewal frequency range	Renewal frequency	Common acre cost	Cost of own farm inputs	Extra outside input costs
Seeds	Horsegram	5-15	10	share	8-10	10	5-10	5	20		20
Total consumables									20	0	20
Services	Mending tools										5
	Plough parts	1 new end/ 3-4 days	1.5	pieces		10					15
Total services											20
Total extra external IC											40
Total IC											40

Figure 10: Output data for 1 acre of horse-gram

Outputs	quantities	Quantity (good year) (in bags)	Quantity last year	Ordinary yield scenario	Good yield scenario	Poor yield scenario	Unit	Weight of 1 bag	Ordinary yield scenario	Good yield scenario	Poor yield scenario	Unit
	Horsegram	2-4	2-3	3	4	2	bags	1.15	3.45	4.6	2.3	qx
	Gram pods	0,5-1,5	0,5-1	1	1,5	0,5	bags		1	1,5	0,5	bags

Outputs	prices in Rupees	Unit selling price range	Unit selling price	Average seed qty required	Seed qty required high input scenario	Unit	Ordinary yield scenario	Good yield scenario	Poor yield scenario
	Horsegram	700-800	800	0.08	0.06667	qx	2696	3616	1776
	Gram pods		NQ				NQ	NQ	NQ
						Gross return	2696	3616	1776

All prices are in Indian Rupees
NQ: not quantified NA: not applicable

Figure 11: Input data for 1 acre of red-gram

Redgram fields - per acre data											Extra outside input costs		
Inputs	All prices are given in Indian Rupees	Quantities used by different farmers	Most common quantity	Unit	Unit cost range	Selected unit cost	Renewal frequency range	Renewal frequency	Common acre cost	Cost of own farm inputs	Common input version	High input version*	Organic version*
Seeds	Redgram	4-10	5	share	15-35	20	3-5	5	20		20	50	20
Fertilisers	Cow manure	0-2	1	tractor load	250-400	300			300	300	0	0	0
	Dap	0.25-0.5, some only 0.1	0.25	50 kg bag		510			127.5	0	127.5	255	0
	Urea	0.25-1, some 0	0.25	50 kg bag		280			70	0	70	140	0
Pesticides	Various products	0-2	2	sprayings	60-120	60			120	0	120	120	0
Total consumables									637.5	300	337.5	565	20
Services	Manure loading	0-2	1	tractor loads	75-100	80			80		80	80	80
	Manure tractor fee	0-2	1	tractor loads	150-200	200			200		200	200	200
	Sprayer rental	0-1	1	days	25-30	25			25		25	25	25
	Mending tools										5	5	5
	Plough parts	1 new end/ 3-4 days	1.5	pieces		10					15	15	15
Total services											325	325	325
Total extra external IC											**662.5**	**890**	**345**
Total IC											962.5	1190	645

Figure 12: Output data for 1 acre of red-gram

Outputs	**quantities**	Quantity (good year) (in bags)	Quantity last year	Ordinary yield scenario	Good yield scenario	Poor yield scenario	Unit	Weight of 1 bag	Ordinary yield scenario	Good yield scenario	Poor yield scenario	Unit
	Red gram	2-5	2	4	5	2	bags	1.05	4.2	5.25	2.1	qx
	Gram pods	0,5-1,5	0,5-1	1	1,5	0,5	bags		1	1,5	0,5	bags

Outputs	**prices in Rupees**	Unit selling price range	Unit selling price	Average seed qty required	Seed qty required high input scenario	Unit	Ordinary yield scenario	Good yield scenario	Poor yield scenario	Extra high input sales
	Red gram	1000-1500	1200	0.04	0.03333	qx	4992	6252	2472	8
	Pods		NQ				NQ	NQ	NQ	
						Gross return	4992	6252	2472	8

All prices are in Indian Rupees
NQ: not quantified NA: not applicable

Figure 13: Input data for 1 acre of sesame followed by ragi and intercrops

Sesame then ragi fields - per acre data											Extra outside input costs		
Inputs	All prices are given in Indian Rupees	Quantities used by different farmers	Most common quantity	Unit	Unit cost range	Selected unit cost	Renewal frequency range	Renewal frequency	Common acre cost	Cost of own farm inputs	Common input version	High input version*	Organic version*
Seeds	Ragi	10-15 (some only 6-7, some possibly 25)	12	share	4-12	12	2-6	5	29		28.8	48	12
	Redgram	1.5-5	3	share	15-35	20	3-5	5	12		12	20	12
	Cowgram	2.5-10	5	share	10-15	15	when their personal supply is insufficient in quantity or quality	5	15		15	15	15
	Sorghum	1-2	1.5	share	5-7	6		5	1.8		1.8	1.8	1.8
	Castor	1-5	2	share	10	10		5	4		4	4	4
	Niger	0.1-0.3	0.2	share	10	10		5	0.4		0.4	0.4	0.4
	Mustard	0.1-0.2	0.1	share	15-17	15		5	0.3		0.3	0.3	0.3
	Cowpea	0-2	NQ	share	NQ	NQ		5	NQ				
	Sesame	3-5	4	share	25-35	30		5	NQ		24	24	24
Fertilisers	Cow manure	0-2	1	tractor load	250-400	300			300	300	0	0	0
	Dap	0.25-0.5, some only 0.1	0.25	50 kg bag		510			127.5	0	127.5	255	0
	Urea	0.25-1, some 0	0.25	50 kg bag		280			70	0	70	140	0
Pesticides	Various products	0-2	2	sprayings	30-60	30			60	0	60	120	0
Total consumables									619.8	300	343.8	628.5	69.5
Services	Manure loading	0-2	1	tractor loads	75-100	80			80		80	80	80
	Manure tractor fee	0-2	1	tractor loads	150-200	200			200		200	200	200
	Sprayer rental	0-1	1	days	25-30	25			25		25	25	25
	Mending tools										5	5	5
	Plough parts	1 new end/ 3-4 days	1.5	pieces		10					15	15	15
Total services											325	325	325
Total extra external IC											**668.8**	**953.5**	**394.5**
Total IC											968.8	1253.5	694.5

All prices are in Indian Rupees
NQ: not quantified NA: not applicable

Figure 14: Output data for 1 acre of sesame followed by ragi and intercrops

Outputs	quantities	Quantity (good year) (in bags)	Quantity last year	Ordinary yield scenario	Good yield scenario	Poor yield scenario	Organic yield scenario	Unit	Weight of 1 bag	Ordinary yield scenario	Good yield scenario	Poor yield scenario	Organic yield scenario	Unit
	Ragi	5-15	1-10	8	12	5	5	bags	1	8	12	5	5	qx
	Red gram	0.3-2	0.1-0.5	0.5	0.75	0.3	0.75	bags	1.05	0.525	0.7875	0.315	0.7875	qx
	Cowgram	1-3	0.2-1.5	0.75	1	0.5	0.75	bags	1.05	0.7875	1.05	0.525	0.7875	qx
	Sorghum	0.25-1	0-0.5	0.5	0.5	0.3	0.5	bags	0.95	0.475	0.475	0.285	0.475	qx
use??	Castor	0.3-1	0-0.2	0.5	0.5	0.1	0.5	bags	0.9	0.45	0.45	0.09	0.45	qx
	Niger	0.1-0.2	0.02-0.1	0.15	0.15	0.05	0.15	bags	0.9	0.135	0.135	0.045	0.135	qx
	Mustard	0.05-0.3	0.03-0.25	0.15	0.15	0.05	0.15	bags	0.95	0.1425	0.1425	0.0475	0.1425	qx
	Cowpea	0.1-0.3	0.1-0.2	0.2	0.2	0.1	0.2	bags	NQ	NQ	NQ	NQ	NQ	
	Green cowgram	0-2	0-2	1	2	0	1	qx		1	2	0	1	qx
	Sesame	1-4	1-2.5	2.5	3	1	2.5	bags	0.8	2	2.4	0.8	2	qx
Animal food	Straw	50-200	50-150	150	200	75	100	bundles	N.A.	N.A.	N.A.	N.A.	N.A.	
	Gram pods	0.5-1.5	0.5-1	1	1.5	0.5	1	bags		1	1.5	0.5	1	bags
	Sorghum			green for cows					N.A.	N.A.	N.A.	N.A.	N.A.	

Outputs	prices in Rupees	Unit selling price range	Unit selling price	Average seed qty required	Seed qty required high input scenario		Unit	Ordinary yield scenario	Good yield scenario	Poor yield scenario	Organic yield scenario	Extra high input sales
	Ragi	380-500	420	0.096	0.08		qx	3319.7	4999.7	2059.7	2059.7	6.72
	Red gram	1000-1500	1200	0.024	0.02		qx	601.2	916.2	349.2	916.2	4.8
	Cowgram	900-1500	1000	0.04	0.04		qx	747.5	1010	485	747.5	0
	Sorghum	400-600	500	0.012	0.012		qx	231.5	231.5	136.5	231.5	0
Human food	Castor	1000	1000	0.016	0.016		qx	434	434	74	434	0
	Niger	1000	1000	0.0016	0.0016		qx	133.4	133.4	43.4	133.4	0
	Mustard	1000-1600	1500	0.0008	0.0008		qx	212.55	212.55	70.05	212.55	0
	Cowpea			N.Q.	N.Q.			NQ	NQ	NQ	NQ	
	Green cowgram	700-900	800	N.A.	N.A.		qx	800	1600	0	800	
	Sesame	1800-2200	2000	0.032	0.032			3936	4736	1536	3936	0
	Straw		10				bundles	1500	2000	750	1000	
Animal food	Pods		NQ					NQ	NQ	NQ	NQ	
	Sorghum		NQ					NQ	NQ	NQ	NQ	
						Gross return		11916	16273	5503.8	10471	11.52

All prices are in Indian Rupees
NQ: not quantified NA: not applicable

Figure 15: Costs and returns for 1 acre of horse-gram

Input level	Common		
Output level	Ordinary	Good	Poor
Total costs	40	40	40
G. return	2696	3616	1776
Net return	2656	3576	1736

Quantity of work	24	days	
Net return / work day	111	150	73

Figure 16: Costs and returns for 1 acre of red-gram

Input level	Common			High		
Output level	Ordinary	Good	Poor	Ordinary	Good	Poor
Total costs	962.5	962.5	962.5	1190	1190	1190
G. return	4992	6252	2472	5000	6260	2480
Net return	4029.5	5289.5	1509.5	3810	5070	1290

Quantity of work	32	days				
Net return / work day	124	163	47	118	157	40

Figure 17: Costs and returns for 1 acre of sesame followed by ragi and mixed crops

Input level	Common			High			Organic	
Output level	Ordinary	Good	Poor	Ordinary	Good	Poor	Ordinary	Poor
Total costs	968.8	968.8	968.8	1253.5	1253.5	1253.5	694.5	694.5
G. return	11915.8	16273.3	5503.83	11927.4	16285	5515.4	10471	5503.8
Net return	10947	15304.5	4535.03	10673.9	15031	4261.9	9776.3	4809.3

Quantity of work	79.375	hours						
Net return / work day	137.915	192.813	57.1342	134.474	189.37	53.693	123.17	60.59

All prices are in Indian Rupees

2 WORK FOR THE DRY-LAND-CROPS

The work for both ragi and groundnut is similar (figure 9). That for ragi and intercrops is presented first and differences for groundnut and intercrops are discussed afterwards. Other dryland crops

2.1 CS1 - RAGI AND INTERCROPS

The work for ragi is amongst one of the highest for dry-land crops. The crop needs good conditions if it is to develop well: it requires a fair quantity of water and does suffers rapidly from competition with weeds, so that it requires good land preparation and weeding. The dates for the different tasks can vary considerably, depending on the relative importance that the farmers give to their different crops, and depending on when the rains start and how much falls.

Teamwork

Farmers organise themselves into teams for some work. These teams usually involve two to three families, sometimes four, which means 6-12 members normally (2 or 3 from each family). The teams are essential for the sowing activities, where several operations need to be carried out on the same day. This organisation is also used for other tasks, such as weeding, which will only concern the women, or harvesting.

The advantage, as well as working with other people, which is nearly always better than on one's own, is to finish the task on one's own land much quicker: hence the harvesting activities can be done at the most suitable time, or the collecting up of weeds after ploughing can be done before the ground hardens again. The total time one person spends doing a job is meanwhile spread over a week or two, as when he is not working on his own land, he is returning the labour for the other team members. Children will also be asked to participate in the work at some of the peak labour times.

Clearing and ploughing the land

Most farmers collect up and burn the previous year crop residues in their fields before ploughing them a first time when the rain comes. These crop residues are mainly sorghum and castor stalks as well as a few of the other dried plants. They are troublesome when ploughing.

An alternative explanation is the fact that high lignin content residues, such as the stems of castor and sorghum plants, require an uptake of soil nitrogen to be decomposed in the soil. Burning them stops this consumption of nitrogen by soil organisms close to sowing time and might increase the quantity available to the young crops. This is not expressed as such, but this traditional practice might have developed because it allowed better initial growth of the crops. Tending to confirm this is the fact that when the previous crop is groundnut, these crop residues are left, as they are considered beneficial to the next crop. This could be due to their higher nitrogen content, which does not require such a high uptake from soil micro-organisms to break them down, and might allow some nitrogen to be restored rapidly to the soil.

At the same time, the banks between fields are cleared of excess vegetation, to prevent them becoming overgrown. This explains the large differences recorded in the time needed for the "cleaning" task, as some farmers have much larger bunds than others and they accord more or less importance to the job.

After the first rains, the fields are ploughed. This first ploughing can be as early as the beginning of April. Other farmers will not plough until the middle of May. The farmers who plough early argue that this enables the infiltration of a maximum quantity of water. Indeed, the run off is very high on the unploughed land, as the surface becomes very hard and impermeable, especially with the heavy showers that fall early in the year, from April to May. It also enables a longer gap between each of the ploughings. As many weed seeds as possible can then germinate and be turned into the soil on the next ploughing or collected up and burnt. The farmers who plough later do not consider this to be important enough to set time aside for it at the beginning of the season. This can create a rush for them if the rains come very early, which will be the main factor determining the sowing time.

After the second and third ploughings, the waste weeds are normally collected up, unless it has been so dry that there are very few. The time required depends on the amount of weeds, but also on whether the weeding is done directly after ploughing, in which case it is a very long job, or after the passage of a "toothed" tool, like a harrow or a cultivator. This can be the ten short-toothed *alube* for gathering together the weeds of the first 10-15 cm, or the four long-toothed *heggunte* that drags up the weeds and roots from deeper down. The four or six-toothed *kunte* is sometimes used when the weeds have grown back, after the third ploughing, but before it has been possible to sow. These short close teeth act like a hoe.

The time required for the use of the instruments is a bare 3 h / acre for the *aluve*, with its numerous wide teeth that do not offer much resistance to the forward motion of the instrument. With the much narrower *kunte* and *heggunte*, some 6-8 h / acre are needed. Whereas a direct collection of the waste weeds, with none of these instruments, can take up to 6 or 7 wd / acre, after the use of the *alube*, *kunte* or *heggunte*, the time is reduced to 2 to 3 wd / acre or less.

Manure

Cow manure is often applied before the second ploughing, sometimes before the third, as explained above (§ 1.1.3). The work required for spreading the manure depends on the quantity applied and the surface over which it is spread.

Sowing

On years when the rains come early, ragi can be sown by the end of June. This year the rain did not come. At mid-August most farmers where still waiting. Quite a lot of farmers had sown their groundnut seeds; some had sown ragi.

This shows what a gamble it can be. If the crops are sown very late, the farmers have the risk that the heads will be forming after the main rains of October are finished, at a time when it can be very dry. If this is the case, the yields can be very low. However, if they sow before the rains truly come, and there is no rain while the plants are in their seedling stage, again severe losses of yield might be caused. These differences in sowing dates are passed on to all the other tasks linked to the plant development stage. The ideal situation is when the rains start early, allowing a rapid implantation of the crop in correct moisture conditions, and with the hope that there will be a fair continuity in the early rain season.

The sowing requires a team of people: the land is levelled with two successive passages of *alube*, nearly always done by two different people, each with their pair of cows and *alube*; for collecting the weeds, two women are needed; the seeds are sown by three people with the *kuurge* and *sade* instruments, one mixing and supplying seeds and "dap" fertilizer, one driving the *kuurge* to sow five rows of ragi at nearly 15 cm intervals, one using the *sade* to sow the

mixed rows. A minimum of seven people are thus required, plus one woman to cook for the team.

But usually the teams are more numerous. For example, after the sowing, the seeds are covered with a *vuta* tool. This will be done on the same day if there are sufficient people, or else the following day. The *vuta* is made of a bunch of lanteena bushes tied together and dragged along behind a pair of cows if available, if not simply pulled by hand. One extra person can also mix seeds and fertilisers reducing the chance of any delays. A last person can break up the large clumps of soil. Any further people can act as relays, replacing anyone who is tired.

The larger teams work slightly faster than the smaller ones. Whether a team of the minimum 7 is considered, or the team has 9 members with one extra person mixing and preparing the seeds and one driving the *vuta*, the total work quantity is very similar. Indeed, in the first case the team can do about 3 acres in one long day, making it 3 h / acre, but then still has to cover the seeds the next day, an extra 3 mh. In the second case, the team can sow nearer 4 acres per day, so some 2.5 h / acre, or just over. In both cases, just under 25 hh / acre are required.

The team functions on a "I work for you, you work for me basis". This spreads one family's work over several days, one for their own land and another two on the other members' land for a frequent 2 or 3 acres of ragi grown. But some people do not organise themselves into a team with their neighbours and instead pay labourers for the work they cannot or choose not to do themselves. This can either be because they are too busy with work on other crops to be able to go and work for other people in return, or because they can afford to pay labourers.

Typically, people with irrigated land, growing crops like mulberry, fall into the first category; the main people doing very little work on their own land, other than supervising, belong to the upper castes, but the statement does not work the other way round, as many upper caste people do most of the work on their own fields themselves.

Thinning, banking and weeding

After sowing, three more cow drawn operations are needed. Firstly there are two successive thinnings carried out with a *kunte* with 4 or 6 teeth, which is drawn first perpendicular to the rows, about ten days after sowing, then again diagonally a week later. Because of the need to thin carefully, this takes longer than a simple *heggunte* or *kunte* passage used for weed removal before sowing.

Another week later, the same tool, but with only two teeth, fixed so that they are virtually touching each other, is drawn between the rows, weeding the inter-row, and banking the soil around the base of the plants. This reduces water evaporation from the soil, as it breaks the pore continuity and stops the upward capillary move of the soil water. Such an operation takes much longer than the first two thinnings, because a passage is required between each row.

The *kunte* inter-row weeding still needs to be backed up by a manual weeding, essentially to weed along the rows. This job is of course done by women, a few days later.

Fixing tools

All the tools required for ploughing, harrowing, thinning and banking need a certain amount of repairs. This can take variable amounts of time, some repairs occurring randomly, but some maintenance is very regular. For example, operations such as changing the tip of the plough need to be done every three to four days of ploughing. The teeth of the other implements also need to be reshaped regularly, to ensure they stay thin enough to be effective. Although the

hammering is done by the blacksmith, the owner must remove them, take them to the blacksmith, wait while he does the work... The blacksmith is still often paid in shares of ragi.

Other chemical inputs

Shortly after the weeding, chemical fertiliser, urea, is applied by hand. This takes just a few hours per acre. If it rains heavily soon after the application, another dose is usually applied to compensate for that washed away by the rain water. Red-gram, cow-gram and castor suffer from pest attacks, mainly boll worms or borers. Red-gram and cow-gram are treated with pesticides to prevent this. Most farmers claim to have to spray these plants twice, once at the flowering stage, and then again when the beans are forming.

The spraying requires two people, one for fetching the water, a woman usually, and one for spraying. It then takes around two hours to spray one field.

The castor is not treated, or the treatments are not effective. Some years there are no problems. Some years most of the crop is lost.

No treatment is used on ragi. It does not usually suffer from diseases or pests in this area.

The long harvesting

The harvesting starts usually start latein October. The mixed crops are ready at different times. For most of the crops, the plants are cut at the base. A week is then needed for them to dry if the weather is sunny. For some of these crops, the drying is delicate and the crops are put out while it is sunny, then carried in at night or if the sun disappears. Others will just be left out, but can take much longer to dry if the weather conditions are not good.

Once dry, the grains have to be separated from the rest of the plant. If there are only small quantities, this is done by beating the plants, often in front of the house if there is space available. In the case of big quantities, a large cylindrical stone is used for the threshing. It is pulled in circles with the help of two cows or bullocks.

This is done in part of the field, prepared into a level and "concreted" area of around 70-100 m^2. For this, the soil is dug and scrapped to remove all the weeds and level the area (2 md). Next, caskets of water are brought to soak the soil (9 mh) before compacting it down with the threshing-stone or by trampling (5 mh). It is left to dry overnight. Lastly, fresh cow manure is mixed with water and splashed all over (2 mh). Once dried this goes very hard. The area can then be brushed and kept very clean for threshing and winnowing the different crops.

The time required for the threshing and winnowing depends on the quantity harvested. However it is not proportional, as there tend to be work economies for larger quantities. For example, if there is a lot of produce the stone rolling will be used, which per kg of produce is much quicker than beating by hand or with the help of a stick.

Mustard is harvested first, followed soon by ragi. Ragi is left for a few days to dry in the fields, before being tied up in bundles. These are then stood vertically in the fields, to finish drying, and until other more pressing harvesting work is finished. Often a mix of ash and pesticide is spread on the ground were the bundles are stood, to protect the ragi from pest infestations. Only later (2-4 weeks) will the bundles be collected up and carried to the threshing field which will have been prepared in the meantime.

Close after ragi come sorghum and niger. During all this period, some farmers pick green cow-gram. The whole pods are picked, like with beans, and the customers will then pod the beans themselves. Towards the end of December, the beans are fully ripe and ready to pick

for year long storage, along with the red-gram ones. They are not all ready at the same time, so are often picked in two or three times, at one or two week intervals. Last of all is castor. This is harvested progressively, as the beans ripen, usually with one short trip per week.

Most of these crops are very quick to harvest, simply because there are not many plants of each type. Cow-gram requires much longer, both as fresh and dried cow-gram, because each pod has to be picked from the plant, as opposed to cutting the plants at the base for most of the others, or the heads for sorghum and castor.

When there is a break in the work, the bundles of ragi are carried and placed in a heap next to the threshing plot. The time required for this depends on the distances between the fields and the plot for threshing and so varies considerably from one farmer to the next. Once all the other crops have been harvested, the ragi threshing will start. The ragi is spread on the plot and left for a few hours in the sun. Next the large cylindrical stone will be drawn in a circle, over and over the stems. The stalks are then lifted with the help of a stick with a hook on the end. They are shaken, so that remaining grains are released, but also so that the grains fall to the ground and the straw lies above them and can be well separated.

The straw is carried and stacked, near the house in some cases, or in a fenced off part of the field for other people. In the first case it simplifies feeding the cows later in the year. In the second case, it reduces the distance that the straw has to be carried during the threshing. This will again be a big factor for determining the time required for stacking the straw.

The grains are swept into a pile for winnowing. For this a wicker tray with three shallow edges is used: the grains are piled in it; it is then held above one's head and the grains shaken out slowly. It must be windy, or the winnowing is delayed for a day. The grains fall in one pile and the lighter husks are carried further by the wind, allowing the separation of the two.

Work peaks, maximum acreage that one family can work, paid labourer requirements

To determine the work peaks, some of the tasks, such as sowing or harvesting, have been spread over a couple of weeks, whereas for one farmer they would really take place over very few days. There is indeed a common practice of forming teams to carry out work such as the sowing, where the preparation of the soil, sowing and covering of the seeds must be done on the same day. A farmer will work with his neighbours to sow his fields in one or two days, before returning the favour by working in theirs on the following days. From the quantity of work that he and his family must carry out, it is as if the task was spread over a longer period.

It must also be remembered that the tasks are gender divided. The comparison of the work peaks with the available work within the family is therefore slightly complicated. For a family with 2 active members, for some tasks there are 14 work days of available work per week; for tasks that are carried out by either men or women only, the number drops to 7 days per week. Due to the cows "rest-day" on Mondays, there are only 6 available days for using the cow-drawn implements. The peaks are discussed in the report (§ 2.4.2.1).

2.2 CS2 - GROUNDNUT AND INTERCROPS

Groundnut requires similar land preparation as ragi. The sowing will however be done on the third ploughing. After that, groundnut requires less work than does ragi.

Sowing

The sowing is done one or two weeks earlier than ragi. This has one obvious advantage of spreading out the harvesting of the two main crops.

The ploughing for sowing the groundnut is faster. Each passage of the plough is further apart, the groundnut being sown at a distance of about 20 cm. Often two ploughs are used, the first opening the furrow, the second covering the seeds deposited by the women in the meantime.

A typical team for groundnut sowing will consist of two men ploughing, one with a wooden plough, one with a metal one, another man for adding dap fertiliser in the furrow and four women sowing the seeds. Three of the women will usually sow just groundnut and one will have two pots of seeds: as well as sowing groundnut most of the time, she is in charge of depositing the seeds for the mixed rows.

The mixed rows are regularly spaced, but the chosen distance is very variable. In some cases, they are widely spread, with 3-4 m between them; other farmers sow the rows at 1-2 m intervals, similar to the inter-row distance used in the ragi fields.

Banking and weeding

After sowing, the plants are banked, using the *kunte*, the same as for ragi. However the rows being slightly wider spaced, the time required is shorter. The first banking is done around two weeks after sowing, the second after an extra week. The reasons behind the banking are the same as for ragi: weeding the inter-row; loosening the top soil to prevent water evaporation.

Weeding is still required along the rows. Again the wider spacing between groundnut rows means this takes less time per acre than in ragi fields.

Other chemical inputs

Urea is not applied to groundnut. Pesticides are not used on groundnut either, but they are applied to the same mixed crops as with ragi: cow-gram and red-gram.

Harvesting

The harvesting of the mixed crops is the same as that for the mixed crops in the ragi fields, despite slightly different sowing dates. With the crops that are harvested progressively, such as cow-gram and red-gram, this means that most of the part in the groundnut fields will be collected during the earlier trips, while most of that present in the ragi fields will be harvested on the later ones. As to crops harvested all at once, they will be done when a majority of the grains are ripe, so after the ripening of most of the heads in the groundnut fields.

Both the groundnut and the common varieties of ragi grown in the area need just over 4 months to reach maturity. Because of the earlier sowing of groundnut, its harvesting is slightly earlier. The plants are pulled up, then left to dry in the field. Approximately one week later, the seeds will be separated from the plants and bagged up and carried back to the house.

No difference has been included for the harvesting times for the mixed crops, as compared to that required for the ragi fields. The quantities of seeds sown vary too much from one farmer to the next to be able to make a distinction between the quantities grown in the ragi fields and the groundnut ones, and hence any differences between harvesting and threshing times.

Watching

It is necessary to watch both ragi and groundnut during the night at critical stages. After sowing the groundnut seeds, they can be dug up by wild boar before germination and must be watched for about a week. Once the grains form, they will again be vulnerable and as with ragi, the last month before harvesting, the crops need regular surveillance at night. This does not decrease the available day time work, but does increase the tiredness caused.

Figure 18: Work times for 1 acre of ragi and intercrops and 1 acre of groundnut and intercrops

Work for 1 acre of ragi and mixed crops				Work for 1 acre of groundnut and mixed crops			
Gap before	Nature of the work	Quantity of work in h or d	Chosen value	Gap before	Nature of the work	Quantity of work in h or d	Chosen value
	waste cleaning (WC)	10-20 mh	18 mh		waste cleaning (WC)	10-20 mh	18 mh
	spreading manure (M)	10-16 mh	10 mh		spreading manure (M)	8-16 mh	10 mh
correct soil moisture	ploughing (P)	16-20 mh	18 mh	correct soil moisture	ploughing (P)	16-20 mh	18 mh
next day	harrow (heggunte - or alube)	6 mh or 3 mh	6 mh / 3 mh	next day	harrow (heggunte - or alube)	6 mh or 3 mh	6 mh / 3 mh
same or next day	collecting weeds (CW)	12-20 wh	15 wh	same or next day	collecting weeds (CW)	12-20 wh	15 wh
or..	direct weed collection	20-50 wh		or..	direct weed collection	20-50 wh	
when soil moisture is right	sowing, wastage collection (S)	21 hh			preparing seeds	6 wd	
same or next day	covering seeds - vuta	3 mh		when soil moisture is right	ploughing for sowing, sowing (S)	35 hh	
a few days after, **if no rain**	(alube for breaking hard top layer)	3 mh		same or next day	levelling (alube)	3 mh	
10-15 d after S, then after 5-8 d	thinning (T)	8 mh		same or next day	collecting weeds (CW)	12-20 wh	15 wh
1week	banking (B)	14-16 mh	14 mh	10-15 d after S, then after 5-8 d	banking (B)	10-14 mh	10 mh
next few days	weeding (W)	7 wd		next few days	weeding (W)	5 wd	
	fixing tools				fixing tools		
just after W	applying urea (AU)	2 mh					
	applying pesticides (AP)	4 mh			applying pesticides (AP)	4 mh	
	harvesting mustard (Hm)	4 hh			harvesting groundnut (Hgn)	6 hd	
7-15 d drying	seperating mustard (Sm)	3 hh		1 week drying	seperating groundnut (Sgn)	4 hd	
	harvesting ragi (Hr)	6 hd			carrying groundnut (Cgn)	3 hd	
1 week lying	bundling ragi (Br)	4 hd					
	preparing plot (P)	6 hd					
bundles 15d standing	stacking ragi (STr)	5 hd					
weekly once	harvesting fresh cowgram	3 x 1 hd		weekly once	harvesting fresh cowgram	3 x 1 hd	
	harvesting sorghum (Hs)	4 hh			harvesting sorghum (Hs)	4 hh	
	seperating sorghum (Ss)	3 hh			seperating sorghum (Ss)	3 hh	
	harvesting niger (Hn)	2 hh			harvesting niger (Hn)	2 hh	
	seperating niger (Sn)	2 hh			seperating niger (Sn)	2 hh	
sometimes all at once	harvesting cowgram (Hc)	4 wd		sometimes all at once	harvesting cowgram (Hc)	4 wd	
	seperating cowgram (Sc)	6 hh			seperating cowgram (Sc)	6 hh	
sometimes all at once	harvesting redgram (Hrg)	6 hh		sometimes all at once	harvesting redgram (Hrg)	6 hh	
	seperating redgram (Srg)	4 hh			seperating redgram (Srg)	4 hh	
	harvesting castor (Hc)	4 hh			harvesting castor (Hc)	4 hh	
	seperating castor (Sc)	3 hh			seperating castor (Sc)	3 hh	
	seperating ragi (Sr)	6 hd					
	bagging, carrying (BCr)	2.5 hd					
	stacking straw (SSr)	4 md					

2.3 CS3, CS4 AND CS5 - OTHER DRY-LAND CROPPING SYSTEMS

The work for the other dry-land crops consists of similar tasks. All are not required for each crop. Horse-gram for example is a very undemanding crop, both in terms of inputs and in terms of work. The corresponding tasks and the work times, for horse-gram, red-gram and sesame followed by ragi and intercrops, are given here (figure 19 and figure 20).

Figure 19: Work necessary for1 acre of horse-gram and 1 acre of red-gram

Work for horsegram			Work for redgram		
Gap before	Nature of the work	Quantity of work in h or d	Gap before	Nature of the work	Quantity of work in h or d
	waste cleaning (WC)	10-20 mh		waste cleaning (WC)	10-20 mh
	spreading manure (M)	10-16 mh		spreading manure (M)	10-16 mh
correct soil moisture	ploughing (P)	16-20 mh	correct soil moisture	ploughing (P)	16-20 mh
next day	harrow (heggunte - or alube)	6 mh or 3 mh	next day	harrow (heggunte - or alube)	6 mh or 3 mh
same or next day	collecting weeds (CW)	12-20 wh	same or next day	collecting weeds (CW)	12-20 wh
or..	direct weed collection	20-50 wh	or..	direct weed collection	20-50 wh
when soil moisture is right	sowing, ploughing to cover (S)	22 hh	when soil moisture is right	ploughing for sowing, sowing (S)	28 hh
same or next day	levelling (alube)	3 mh	same or next day	levelling (alube)	3 mh
1week	banking (B)	6-8 mh	1week	banking (B)	6-8 mh
	fixing tools			fixing tools	
just after W	applying urea (AU)	2 mh	just after W	applying urea (AU)	2 mh
	applying pesticides (AP)	4 mh		applying pesticides (AP)	4 mh
	harvesting horsegram (Hhg)	12 hd	sometimes all at once	harvesting redgram (Hrg)	2 hd
	seperating horsegram (Shg)	4 hd		seperating redgram (Srg)	4 hd

Figure 20: Work necessary for1 acre of sesame followed by ragi and intercrops

Work for 1 acre of sesame folowed by ragi and mixed crops

Gap before	Nature of the work	Quantity of work in h or d
	waste cleaning (WC)	10-20 mh
	spreading manure (M)	10-16 mh
correct soil moisture	ploughing (P)	16-20 mh
next day	harrow (heggunte - or alube)	6 mh or 3 mh
same or next day	collecting weeds (CW)	12-20 wh
or..	direct weed collection	20-50 wh
	preparing seeds	
when soil moisture is right	sowing, wastage collection (S)	21 hh
same or next day	covering seeds - vuta - or levelling-alube	3 mh
same or next day	collecting weeds (CW) (gn)	12-20 wh
10-15 d after S, again after 5-8 d	thinning (T)	8 mh
1week	banking (B)	14-16 mh
next few days	weeding (W)	7 wd
	harvesting sesame (Hs)	8 hd
	seperating sesame (Ss)	3 hd
	fixing tools	
just after W	applying urea (AU)	2 mh
	applying pesticides (AP)	4 mh
	harvesting mustard (Hm)	4 hh
7-15 d drying	seperating mustard (Sm)	3 hh
	harvesting main crop (H)	6 hd
1 week lying	bundling ragi (Br)	4 hd
	preparing plot (P)	6 hd
1 week drying	seperating groundnut (Sgn)	4 hd
	carrying groundnut (Cgn)	3 hd
bundles 15d standing	stacking ragi (STr)	5 hd
weekly once	harvesting fresh cowgram	3 x 1 hd
	harvesting sorghum (Hs)	4 hh
	seperating sorghum (Ss)	3 hh
	harvesting niger (Hn)	2 hh
	seperating niger (Sn)	2 hh
sometimes all at once	harvesting cowgram (Hc)	4 wd
	seperating cowgram (Sc)	6 hh
sometimes all at once	harvesting redgram (Hrg)	6 hh
	seperating redgram (Srg)	4 hh
	harvesting castor (Hc)	4 hh
	seperating castor (Sc)	3 hh
	seperating ragi (Sr)	6 hd
	bagging, carrying (BCr)	2.5 hd
	stacking straw (SSr)	4 md

Annexe 7 - Livestock systems

The different livestock systems are presented successively.

1 LS 1 - LOCAL HALLIKAR COWS

The size of a typical herd is 2 adult females and their young (main report § 2.4.3.2).

1.1 WORK LOOKING AFTER THE HALLIKARS

The work is a daily routine. The cow dung and refuse straw must be picked up from the street where the cows are tied, or from the cow shelter, and carried to the manure heap in a wicker basket balanced on the head of the person responsible for that task. Depending on the distance to the manure heap, and the number of cows, this takes different amount of times. For 2 adult cows, one wicker basket of manure is produced. In most cases, at least half an hour is required to clean up and carry the manure. To bring straw or cut and carry grass to feed to the animals another half an hour or more is needed, depending on the distance to the straw stack, or to the fields to cut the grass. When straw is brought, enough is usually brought in the evening for that evening and the following morning. With green grass, because of the extra weight several trips would be necessary anyway, so the time also depends on the period of the year.

The cows must also be milked during the period when they are still producing milk and the milk taken to the dairy. This means a quarter of an hour in the morning and the same again in the evening, but it can be much more if the family lives a long way from the dairy. Again straw or grass must be brought in the evening. If the cows were not near a source of water in the day, extra must be brought for them at the time when the women fetch the water for the household needs. The total work for all of these every day tasks is at least 2 hours, for 2 cows. It increases slightly with the number of cows.

In the periods when the cows roam free, they are just untied and left to go. They come home by themselves. During the growing season, either someone must go to the forest with them, which means a whole day's work, or they must be taken and tied on a piece of scrap land or on a bund between fields.

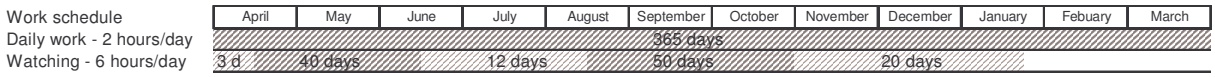
The former solution is usually chosen when there is not too much work on (figure 21). For example, during the cropping season, the limited grass available on the bunds can be used at the beginning while people are busy sowing, banking and weeding, and at the end, when the harvesting begins. During these periods, there is little spare time for watching the animals. In between, people who have no access to irrigation usually take the animals off to the forest. So this whole day's work is carried out when there are not too many other pressing tasks. Sometimes the cows are taken to the forest and left all day, then collected in the evening, like the buffaloes. Sometimes several neighbours organise themselves, so that one of them watches the others' cows as well. Some of the cows stay in the forest by themselves, although this is rare.

At other times in the growing season, they will be taken to the forest less frequently. Instead, the animals are tied on the bunds or uncultivated land. They are taken there as people are off to work, and brought home when their owners return, so this represents little extra work.

A distinction must be made between the farmers who have irrigated land and those who do not. Those who do not, and who grow mainly ragi and groundnut, sometimes also some red-

gram, horse-gram and sesame, have a work gap towards the end of August and into September. They can therefore function as explained above. Those who have irrigated crops often have continual work. But they also have activities with high productivity of the land, and therefore are usually able to set aside a little more land on which to tie the animals for grazing. They can reduce the number of days where the cows need to find food elsewhere.

Figure 21: LS1 - Hallikar cows - Necessary work throughout the year



Total work time	185	days/year	including herding
	91	days/year	if there is no herding (more land set aside, or hybrid grass, or organistion with neighbours)

The quantity of work does not increase proportionally to the number of cows. All of the watching barely increases at all, up to 15 or 20 cows, which can be dealt with by 1 person. The sweeping of the cow shed and the milking will increase to some degree. The carrying of the straw, back to the cow-shed, and the removal of the manure are nearly proportional to the number of cows, unless both the straw-stack and manure heap are close by. For a couple more cows, the extra work can be estimated as 1 hour / day. Larger herds will function differently, the owner then usually having a cart to transport manure for example and placing his haystack next to the house (which is not possible for many of the smaller farmers who do not own land near their house).

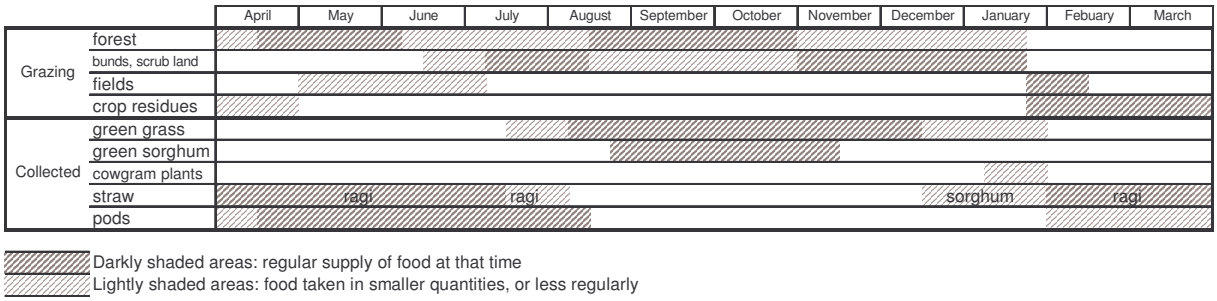
1.2 FOOD FOR THE HALLIKARS

The cows graze in the day and are given extra food in the morning and again in the evening. When they are herded or roam free, they find water some when during the day. At other times, the woman may have to fetch water for them, when she brings the household water.

Grazing

Figure 22 shows the places where the cows find food at different times of the year. While the crops are growing, they are not free to roam, and must be tied on pieces of land that have been set aside. At periods where there is not enough food available in the fields, the cows can also be taken to the forest.

Figure 22: LS1 - Hallikar zebus - sources of food throughout the year



The periods when food is scarce elsewhere include the time when the crops are growing. This is the wet season and the grass also grows readily. However many farmers do not have enough land to set any aside for grazing, and so have only bunds between fields and very small areas that might be too stony to properly cultivate. There are also common areas, besides the rivers and streams for example, where the grass can be quite lush. Again, these represent limited surfaces. For many farmers, the cows must be taken off to the forest during this period. By using the grass on the bunds, they do not have to go off to the forest everyday during the kharif season. As explained above, the farmers can use the bunds when they have a

lot of work in the fields and take them off to the forest when the work quietens down, in August and September for example. On such days, either the animals pass a water point on their way there or their way home, or else extra water will have to be fetched for them along with that for the household needs.

Figure 23: Nutritional requirements of the Hallikars and values supplied by their rations

Nutritional needs of the Hallikars

Approximate weight of the cows (kg): 250

	UFL (2)	PDI (3) (g/day)	Max IDM (4) (kg)
Upkeep	2.3	150	6.25
1 L milk / day	0.38	60	0.28
2 L milk / day	0.76	120	0.56
Total (2 L milk / day)	3.06	270	6.81

Nutritional values of food stuffs

Nature	DM (1)	UFL / kg DM	PDIN / kg DM	PDIE / kg DM
Ragi straw	0.85	0.4	20	40
Sorghum straw	0.8	0.3	20	40
Elephant grass	0.19	0.6	49	70
Regrowth grass	0.2	0.8	50	70
Flowering grass	0.6	0.6	40	60
Straw type grass	0.9	0.5	30	50
Sorghum	0.2	0.6	50	60

Example of daily intake dry season

Nature	Quantity (kg)	DM (1)	UFL (2)	PDI (3)
Ragi straw	4	3.4	1.36	68
Sorghum straw	0	0	0	0
Elephant grass	0	0	0	0
Regrowth grass	0	0	0	0
Flowering grass	5.2	3.12	1.872	124.8
Straw type grass	0	0	0	0
Sorghum	0	0	0	0
TOTAL		6.52	3.232	192.8

Example of daily intake wet season

Nature	Quantity (kg)	DM (1)	UFL (2)	PDI (3)
Ragi straw	0	0	0	0
Sorghum straw	0	0	0	0
Elephant grass	0	0	0	0
Regrowth grass	24	4.8	3.84	240
Flowering grass	0	0	0	0
Straw type grass	0	0	0	0
Sorghum	10	2	1.2	100
TOTAL		6.8	5.04	340

(1) Dry matter
(2) Energy unit for cows
(3) Digestible protein
(4) Maximum ingestible dry matter

After harvesting, the cows roam freely. At first the crop residues are plentiful. By the time the first ploughing starts, these are completely gone and the ground is very dry and hard. The surface becomes nearly impermeable and water from any rare downpours just runs off. Around this time, the cows are often taken off to the forest. The herder will make sure they pass a water point in the morning or the evening.

After the first rains, many farmers try to plough their land as soon as possible. This breaking of the surface, as well as the arrival of water, allow the weeds to grow and constitute some kind of nourishment for the cows. After the next ploughing, the weeds are turned in and the cows again have to look elsewhere for food, so are once more frequently taken to the forest.

Other food

In the morning and at night the cows are fed. The types of food used at different times of year are also illustrated in figure 22. While there is lush green food available to graze, they do not eat straw. They will therefore be given fresh grass cut from the bunds. When the sorghum is starting to develop well, that will be used as green material. As well as being very nutritious, it allows the grass on the bunds to grow again. People with very few bunds or pieces of land left for the grass to grow could face a problem of having to share these areas between cutting the grass for evening food, and allowing the cows to graze it directly. Then, they either collect green grass from near the streams or the forest, on common land, or take the animals more frequently to the forest.

Once the summer season arrives, and grass becomes rare, other food sources are required. At first, in December, the ragi threshing has not been done, so no new straw is available. There can be some left from the previous year's harvest. There is also some straw from the sorghum, which is separated much earlier. Another important source of food available in the spell where green grass has become scarce, but before the ragi threshing starts, is the waste plant material from the cow-gram, once the beans have been separated from the rest. If groundnut has been grown, these plants are also used as fodder. Lastly there are the pods of the cow-gram, red-gram and horse-gram. These are used as complementary food when other items are scarce, throughout the summer season, then are regularly fed to the cows during the period where they are used for ploughing and harrowing and are expending a lot of energy.

Nutritional requirements

Most of the types of food are given in very different quantities depending on the amount available. The growth of the grass at a particular period of the year can be very slow if there is little rain that year. The pods might need to be eaten at times when there is a need to compensate for a lack of other food.

The quantities given by farmers (figure 23) take into account the needs of the mothers and the needs of the young calves, as the farmers do not measure how much they distribute to each animal. However, the calf helping is only very small. Indeed, for their first ten months, the calves are drinking milk, along with progressive grazing. So the young animals will be fed a little straw or green material, but not much more.

The females that are kept for an extra 2 years will need more. But as can be seen from the zootechnic unit (figure 24), the rate of replacement of the older animals is slow and so the number of these young females is low. Therefore on average they do not account for much extra nutritional requirement.

Figure 24: Reproductive and numerical data for the Hallikars

Average local data for the halikars

Reproduction

Age of first pregnancy	3	years
Average calving interval	15	months
Number of young per delivery	1	calf
Losses through interrupted pregnancies and calf mortality	15	%
Age at weaning	9-10	months

Adults

Age of the end of career	13	years
Mortality of animals over 1 year old	5	%

Career of one cow

Age at first calving	4	years
Number of pregnancies over next 9 years	7	pregnancies
Interrupted pregnancies and calves that die	1	loss
Total number of calves reaching weaning	7	calves

Milk

Daily quantity produced by various cows	0.5-1.5	L	for	8-10 months
Average daily quantity consumed by calf	most		for	1 month
	0.25	L	for	8 months
Average daily quantity obtained	low		for	1 month
	0.5	L	for	8 months
Average yearly quantity (milk for 8 of a 15 month cycle)	96	L		

Livestock system based on two adult female halikars

Number of adult females: 2

Average yearly data

Numerical productivity at weaning

Number of calves per year reaching weaning	1.36

Sales and losses

Number of adult females sold	0.2
Number of adult females dying	0.1
Number of young females kept (accounting for their mortality)	0.33
Number of young calves (1 year old) sold	1.03

Total animals in herd

Adult females	2
Young females kept for renewal (1-3 years old) (1 kept every 3 years, for an extra 2 years before reaching sexual maturity)	0.67
Young calves (0-1 year old) (4 every 3 years)	1.36

Zootechnic unit	Equivalent nutritional requirements (ENR)	N°	ENR
Adult cow	1	1	1
Young females (1-3 years old)	0.7	0.33	0.23
Young calves (0-1 year old)	0.25	0.68	0.17

Based on the fact that one cow eats nearly half a bundle of ragi straw per day (about 4 kg) in the dry season, the quantity of grass that the cow must ingest can be calculated so as to respect the maximum quantity of dry matter ingestible. The fresh quantity and the nutritional content of the daily ration ingested depend a lot on the quality of the grass. When it is not young and lush, as is often the case during the dry season, the cows struggle to obtain enough protein to cover their nutritional requirements. Increasing the straw ration is of no use, as it does not significantly increase the amount of protein available and only so much can be ingested.

In these conditions, the food available to the cows is often the limiting factor to their milk production. With poor quality grass, they struggle to produce 1 L of milk per day (figure 23). In the wet season, the grass has a much higher nutrient content, and other green food replaces the straw, so that the cows that have the genetic potential to do so, can easily produce 2 L of milk per day (figure 23): the food no longer limits the quantity of milk produced.

To produce enough straw to cover the dry summer season, 2 acres of ragi are sufficient to feed 3 cows and their calves on a good year (annexe 6, figure 25). But for a farmer whose maximum yields are at the ordinary level, and to ensure there are some reserves in case of a poor year, a maximum of 2 cows can be kept on 2 acres of ragi.

Very little was left of farmers' haystacks late in July 2006, after the poor 2005-2006 harvest. The rains did not come at the end of June or in July as they were expected. Usually by August, everything has gone green. This year, the grass had not yet grown and the farmers were still relying on hay to feed their cows. Their hay resources were running out. This farmer, like many of his neighbours had to purchase hay to cover his cows' needs. The prices had increased by at least 20 %.

1.3 REPRODUCTIVE PARAMETERS

The reproductive parameters are given in figure 24 The first pregnancies of young females are observed when the cow is over 2.5 years of age, giving a first delivery at 3.5 or 4 years old.

The insemination of the Hallikar cows is done naturally. In a few of the villages in the area, a bull is kept. The farmers take their cows there when they are on heat. Only very rarely is the insemination ineffective. The percentage of cows that are pregnant first time is close to 95 %. In the case of an ineffectual insemination, a delay of one or two months is incurred. Hence this parameter is taken into account by the interval between two deliveries. This birth to birth interval has been determined by counting only pregnancies that lead to a live calf. Miscarriages and stillbirths are more frequent, but also depend on the cow’s condition. They have been considered along with the deaths during the first few months of the calf’s life, and can be estimated as a 15 % loss of the number of calves that should be born and survive.

After the delivery of a new calf, it usually takes between 3 to 9 months for the cow to be on heat for the first time again. It can sometimes as low as 2 months. The quantity of milk produced decreases when the cow is approximately 4 months pregnant. To increase the duration over which milk is obtained, if the cow comes on heat very early, the farmers do not proceed with the insemination until around 4 months after the delivery. In this way, they get a minimum of 8 months of milk. An average of 15 months is observed between 2 births.

Figure 24 details the number of animals present in a typical herd, with 2 adult cows. Fractions are used to account for the variability from one year to the next because of the low number of animals and the length of the cycle.

Figure 25: Costs of inputs for the Hallikars

LS1 Halikar cows - costs and returns for 1 adult animal and its offspring

Inputs

Food		Daily quantities used by different farmers	Common daily quantity	Period	Number of days	Yearly quantity	Unit	Unit cost range*	Selected unit cost*	Common cost per animal*	Cost of own farm inputs*	Cost of outside inputs*
	Grazing	6-7 h minimum		all year	365	NQ				work		
extra food necessary for 1 cow,1 calf (0-1 y-old) every other year, 1 calf (0-3 y-old) 3 y out of 6 y	Green grass		0.63	mid-July to January (1)	112	71	bundles		NQ	work		
	Sorghum		0.63	end August to mid-November (1)	180	113	bundles		NQ	work		
	Cowgram plants	NQ	NQ	some days in January	15	NQ			NQ	NQ		
	Ragi straw		0.63	Febuary-July and a little at other times (2)	210	132	bundles		10	1323	1323	
	Sorghum straw		0.63	some days end of December and January	21	13	share		NQ	NQ		
	Pods	2 shares per week	0.40	mid-April to mid-August and a little at oher times	150	60	share		NQ	NQ		
	Water		NQ				share	Not Applicable	Not Applicable	Not Applicable	Not Applicable	
Total consumables										1323	1323	0

Services	Bull fee	1 time every 15 months				0.8	visits / year		50	40		40
	Veterinary fees and medication	when there are problems - rarely				1	visits / year	10-50	20	20		20
Total services										60	0	60
Total extra external IC												60
Total IC										1383		

* All prices are given in Indian Rupees

(1) Green grass is the main food source for one period of approximately 6 weeks (0.5 bundles/day/adult cow), before and after sorghum is available; while sorghum is available, about 11 weeks, both sorghum and green grass will be used, depending on the quantities available (estimate of half and half); at the start and end of the green grass season, some green grass is available for close to 9 weeks (estimate of half of the cow's food over that period)

(2) 6 months and a few extra days

(3) 4 months and a few extra weeks. Approximately 2 shares per week for an adult cow, but depending on quantity available.

1.4 END OF CAREER

The causes of mortality include different illnesses, and an occasional death occurs during delivery. The mortality rate is at least 5%. A fair number of cows die before they need to be sold, unless the farmer wants to reduce the number he owns, or needs the money. Because the causes of their death are linked to health problems, their age at the time of dying is very variable. So is the age at which they are sold, if so is the case. 13 years old is a rough estimate.

To renew the cows in the herd, young females are often kept periodically. On average, if the owner has 2 cows, one is needed every 3 years. Because of the unpredictability and randomness of some of the deaths, a young female who is old enough to take over the work in the fields is not always available. A new cow is then sometimes purchased. Depending on the need for money, one of the female calves can be kept for a couple of years and sold at a higher price than most of the calves, compensating for the expenditure. Otherwise, the extra cost incurred is given in the lower part of figure 26. As the renewals are rare, the average net return is only slightly lower. However, if a loan must be taken to buy the cow, the situation is quite different (main report, § 2.5.5.2).

The whole career of a cow is summarised in figure 24.

1.5 HEALTH DIFFICULTIES

A vet is present in the area and is called upon when the animals are unwell. There is therefore no set veterinary and medicine charge. Some years the vet's services are not needed at all. Some year the costs incurred can reach 50 R or more per cow (figure 25).

1.6 PRODUCE

The products that can be used or sold are milk, manure and the calves (figure 26). Sometimes, the old cows are also sold, as explained previously.

Milk

For the first 15 days after the delivery, the quantity of milk produced increases. It then stabilises around an average value until about 4 months into the next pregnancy. It does in fact decrease, 3 or 4 months after the delivery, but slowly and an average value can be considered for a period of 8 months in the case of an early pregnancy, but on average for about 10 months. The quantity produced depends a lot on the animal. The calf drinks most of this for the first two months. The cow will be milked more heavily for the next 8 months on average, while the calf’s consumption averages 0.25 L. The total production is given in figure 26. This milk is sometimes consumed directly by the family. However, the poorer farmers will sell at least part of it as a source of income.

Manure

A cow produces just under half a basket a day of dung and straw that will be used for producing manure. Once broken down, during the composting process, this works out about 1 tractor load of manure per year. The calves also produce a little, so that the total amount of manure obtained per year, from 2 adults and their offspring, averages 2.5 tractor loads. The manure is used directly on the farmer's fields. Exceptions include some farmers with large quantities of animals, who can sell some. But even that is rare.

Figure 26: Outputs and returns for the Hallikars

LS1 Halikar cows - costs and returns for 1 adult animal and its offspring

Outputs		Daily quantity produced by different animals	Common daily quantity	Period	Number of days	Yearly quantity	Unit	Unit price range*	Selected unit price*	Return*	Return on products sold*
1 cow,1 calf (0-1 y-old) every other year, 1 calf (0-3 y-old) 3 y out of 6 y	Milk	0.5-1.5 L (calf drinking 0.25 L)	0.5	8 of 15 months between 2 births	192	96	L	9-10	9.6	922	922
	Calves					0.5	1 year-old calf	2000-4000	2600	1300	1300
	Manure		0.62 baskets	daily		1.25	tractor load	250-350	300	375	0
Sales	Old cows			1 every 10 years		0.1	cow	3000-5000	3500	350	350
Deaths	Adult cows			1 every 20 years		0.05	cow		0	0	0

* All prices are given in Indian Rupees

Situation where one of the young females is kept for replacing the older ones

(1 renewal every 6 years)

		Total cost and return of LS*	External costs and return*
For 2 adult cows and calves	**Gross return**	5 893	5 143
	Production costs	2 766	120
	Net return	3 127	5 023
Work productivity (Rs/day)		16.9	27.2
Extra land productivity (Rs/acre)		1 564	
Without watching time included	Work productivity	34	55

Situation where a new cow is purchased instead of keeping one of the young females

Every 6 years: renewal of the cow; sale of an extra 1 year-old calf				Unit price range*	Selected unit price*	Yearly total*
Cost	1 female bought every 6 years or	0.15	5 year-old females purchased every year	8000-12000	8000	1200
Return	1 female sold every 6 years or	0.15	1-year-old females sold every year	3000-4000	3500	525
Reduced straw cost						-250
Reduced manure return						-75

		Total cost and return of LS*	External costs and return*
For 2 adult cows and calves	**Gross return**	6 793	6 193
	Production costs	4 666	2 520
	Net return	2 127	3 673

** All prices are given in Indian Rupees*

1.7 ECONOMIC RETURN

The net return has been calculated considering the livestock system as independent from the rest of the farm ("total cost and return") and by taking into account the inputs and outputs from the ragi and groundnut cropping system as not being paid for ("external costs and return") (figure 26).

It has also been evaluated if the farmer replaces his older cows by purchasing younger ones. In that case, the return generated is smaller. But if the farmer has to take a loan, then it becomes very difficult. Assuming he can sell an extra one year old calf at that time, to cover half the loan, that leaves him with at least a 4000 R loan. The interest is 480 R/year if a loan can be obtained from the bank at 1% monthly interest, or up to 1920 R/year if it is a hand loan. In the latter case, at 4900 R/year net return, the farmer will not even be able to pay off the loan over one year. Small landowners with 2 acres count on the animals to bring their income over the survival level and up to an acceptable upkeep level. So with high interest loans, such a functioning is not viable for the small farmers. They must try to manage with their cows' own offspring.

If the young females are kept for replacing the older ones, the net return is approximately 6200 R/year with 2 cows, if all the fodder is the farmer's own. The work productivity is very low, at 17 R/day for the system itself if there is no cow watching to do, or around 15 R/day if there is that supplementary work.

As the number of cows increase, the work productivity increases fast. However this requires a greater quantity of fodder. Most farmers therefore maintain just 2 cows: the income generated is low and it is beter usig this straw for animals that produce ore milk.

2 LS 2 - INDIGENOUS BUFFALOES

The buffaloes found in the area are a local breed. Hardy animals, they get much of their food from the forest. They produce far more milk than the Hallikars and it is very appreciated for its high fat content. In the area, the milk production has always been their main function.

2.1 LOW NUMBERS

Like the Hallikars, the buffaloes are fewer today than 20 years ago. Richer farmers sometimes have 1 or 2, more rarely 5 or more. These farmers have trouble finding labourers to look after them, as for the Hallikars, and many sold all of their buffaloes along with most of their cows a good few years ago. Smaller landowners seldom own any. They have to maintain their cows first, to have the necessary traction power for ploughing and other operations. Sometimes they still have unreturned loans on these animals; then they cannot afford to purchase a buffalo for example. Others have insufficient fodder to maintain other large animals.

The buffaloes are quite similar to the Hallikars as concerns the work involved, the reproductive parameters, the mortality rates, the products obtained. The basic "herd" can be considered as identical to that for the Hallikars, as the calving interval and age at first calving are the same, at least within the precision allowed by the interviews. Specific questioning and possibly in-situ monitoring would have been required to obtain finer estimations.

In this section, only the principal differences with the Hallikars will be detailed. A herd of 2 buffaloes has been chosen, a common number among the farmers owning them, to enable a comparison with the cows and to discuss the future of these animals in the area.

2.2 WORK

The work required for maintaining buffaloes is similar to that for the cows, in that the dung and refuse straw must be collected up, and straw or grass must be fetched for the animals. As the owners usually have cows as well, the extra work incurred can be estimated at 1 hour per day. Indeed, the cleaning task is not proportional to the number of animals. If there are no cows, the workload is similar to that of the cows.

Like the cows, when there is food in the fields after harvesting, the buffaloes are just untied and left to roam. During the cropping season, but also when the food has become insufficient in the empty fields, one of the farmer's family or paid workers must take them to the forest. Often, they will be left there. In the evening, they will be fetched and escorted home during the growing season, or otherwise left to return by themselves. They can also graze a piece of land set aside for that purpose. This remains rare though, as it is usually reserved for the cows.

The fact that most buffaloes do not need to be watched while they are in the forest greatly reduces the workload during the periods when food is short elsewhere. It can be estimated as 1 to 2 hours of work on those days, depending on the location of the farm with respect to the forest, as well as the need to make the evening trip or not. An average of 1.5 hours will be considered here. However, for farmers with a very busy time table, even this can be too much.

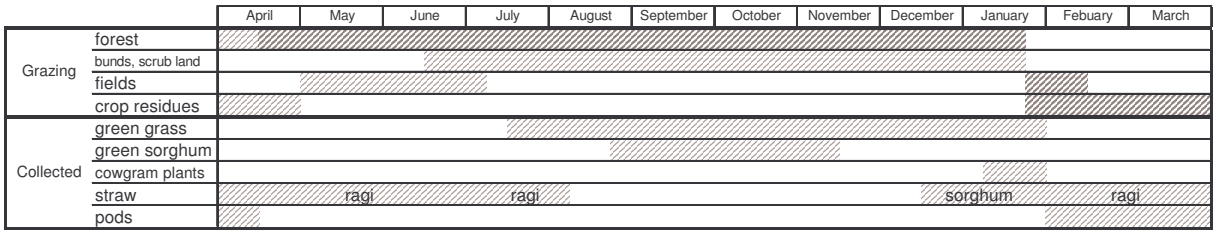
2.3 FOOD

Like the Hallikars, the buffaloes get most of their food from grazing. They are given a little extra food in the morning and evening.

Grazing

Figure 27 illustrates the main sources of food for the buffalo. These are similar to those for the Hallikars. The principal difference is that the buffaloes will be taken more regularly to the forest. Because of this, they are less often set aside scrap land or grass land. Unlike the cows, they are not used for the agricultural work, and so do not have days when they are not free to go to the forest. They will rely on food from the forest during the whole of the growing season, but also once the crop residues have disappeared from the fields. The growth of weeds in the fields can provide a few days of food up until the start of the sowing, but this is usually a minor supply.

Figure 27: LS2 - Indigenous buffaloes - sources of food throughout the year



Other food

The buffaloes are fed little else. They will be given some ragi straw across the whole of the dry season. Once the green grass is growing, they will be given some of that, or some of the green sorghum. Quantification would have required more specific interviews: the information was not sufficient to differentiate between the quantities fed to the Halikars and those fed to the buffaloes.

Cow-gram plants and husks from the legume grains are also fed to the buffaloes, to cover difficult periods, as with the Hallikars. However, unlike the Hallikars, they will not be fed the husks on a regular basis during the late summer season and early kharif season: they are not involved in the agricultural work, and do not have the extra energy expenditure and reduced feeding time during that period. If there are enough, the husks can be used to stimulate milk production at the beginning of the lactation.

Figure 28: Reproductive and numerical data for the buffaloes

Average local data for the buffaloes

Reproduction

Age of first pregnancy	3	years
Average calving interval	15	months
Number of young per delivery	1	calf
Losses through interrupted pregnancies and calf mortality	15	%
Age at weaning	9-10	months

Adults

Age of the end of career	13	years
Mortality of animals over 1 year old	5	%

Career of one cow

Age at first calving	4	years
Number of pregnancies over next 9 years	7	pregnancies
Interrupted pregnancies and calves that die	1	loss
Total number of calves reaching weaning	7	calves

Milk

Daily quantity produced by various cows	3-5 L	for	8-10 months
Average daily quantity consumed by calf	1 L	for	1 months
	0.5 L	for	9 months
Average daily quantity obtained	2.5	for	1 months
	3 L	for	9 months
Average yearly quantity (milk for 10 of a 15 month cycle)	708 L		

Livestock system based on two adult female buffaloes

Number of adult females: 2

Average yearly data

Numerical productivity at weaning

Number of calves per year reaching weaning: 1.36

Sales and losses

Number of adult females sold	0.2
Number of adult females dying	0.1
Number of young females kept (accounting for their mortality)	0.33
Number of young calves (1 year old) sold	1.03

Total animals in herd

Adult females	2
Young females kept for renewal (1-3 years old) (1 kept every 3 years, for an extra 2 years before reaching sexual maturity)	0.67
Young calves (0-1 year old) (4 every 3 years)	1.36

Zootechnic unit	Equivalent nutritional requirements (ENR)	N°	ENR
Adult cow	1	1	1
Young females (1-3 years old)	0.7	0.33	0.23
Young calves (0-1 year old)	0.25	0.68	0.17

2.4 REPRODUCTION

The reproductive parameters are similar to those of the Hallikars, both as concerns the age at first calving, the calving interval and the young calf mortality. Any differences appeared to be no more than the 10% error margin on the various estimations for the Hallikars, so the same values will be considered here (figure 28).

2.5 END OF CAREER

Adult mortality information was not available due to the low number of animals of many owners and the recent acquisitions for some of them. Further interviews would have been required, but the data for the Hallikars gives a rough estimate. The same is true for veterinary services.

2.6 PRODUCE

The products that can be used or sold are again milk, manure and the calves. Sometimes, the older animals are also sold. The quantities involved and returns on these products are all very similar to those for the Hallikars, except for the milk (figure 30).

This is the main difference with the Hallikars. The return on the milk can reach 9000 R / buffalo if the buffaloes are well fed and the quantity of milk drawn averages 4 L / day. With a low average daily quantity of around 3 L of milk over 10 months, the return generated is 6900 R / buffalo as opposed to 900 R / cow for the cows.

2.7 ECONOMIC RETURN

The costs are the similar to those for the Hallikars (figure 29). The net return is much higher though, because of the extra return obtained from the milk. This extra of at least 6000 R / buffalo, brings the net return to 7500 R / animal, incomparable to that of the Hallikars. It is a significant amount, as it is probably over three quarters of the price of the animal.

Figure 29: Costs of inputs for the buffaloes

LS2 Buffaloes - costs and returns for 1 adult animal and its offspring

Inputs

Food		Daily quantities used by different farmers	Common daily quantity	Period	Number of days	Yearly quantity	Unit	Unit cost range*	Selected unit cost*	Common cost per animal*	Cost of own farm inputs*	Cost of outside inputs*
	Grazing	6-7 h minimum		all year	365	NQ				work		
extra food necessary for 1 cow,1 calf (0-1 y-old) every other year, 1 calf (0-3 y-old) 3 y out of 6 y	Green grass		0.63	mid-July to January (1)	112	71	bundles		NQ	work		
	Sorghum		0.63	end August to mid-November (1)	180	113	bundles		NQ	work		
	Cowgram plants	NQ	NQ	some days in January	15	NQ			NQ	NQ		
	Ragi straw		0.63	Febuary-July and a little at other times (2)	210	132	bundles		10	1323	1323	
	Sorghum straw		0.63	some days end of December and January	21	13	share		NQ	NQ		
	Pods	1 share per week	0.63	a little Febuary to mid-April and some at the start of the lactation	90	57	share		NQ	NQ		
	Water		NQ				share	Not Applicable	Not Applicable	Not Applicable	Not Applicable	
Total consumables										1323	1323	0
Services	Bull fee	1 time every 15 months				0.8	visits / year		50	40		40
	Veterinary fees and medication	when there are problems - rarely				1	visits / year	10-50	20	20		20
Total services										60	0	60
Total extra external IC												60
Total IC										1383		

** All prices are given in Indian Rupees*

(1) Green grass is the main food source for one period of approximately 6 weeks (0.5 bundles/day/adult cow), before and after sorghum is available; while sorghum is available, about 11 weeks, both sorghum and green grass will be used, depending on the quantities available (estimate of half and half); at the start and end of the green grass season, some green grass is available for close to 9 weeks (estimate of half of the cow's food over that period)

(2) 6 months and a few extra days

(3) 4 months and a few extra weeks. Approximately 2 shares per week for an adult cow, but depending on quantity available.

Figure 30: Outputs and returns for the buffaloes

LS2 Buffaloes - costs and returns for 1 adult animal and its offspring

Outputs		Daily quantity produced by different animals	Common daily quantity	Period	Number of days	Yearly quantity	Unit	Unit price range*	Selected unit price*	Return*	Return on products sold*
1 cow,1 calf (0-1 y-old) every other year, 1 calf (0-3 y-old) 3 y out of 6 y	Milk	3-5 L (calf drinking 0-1 L)	3	10 of the 15-month calving interval	240	720	L	9-10	9.6	6912	6912
	Calves					0.5	1 year-old calf	2000-4000	2600	1300	1300
	Manure		0.62 baskets	daily		1.25	tractor load	300	300	375	0
Sales	Old cows			1 every 10 years		0.1	cow	3000-5000	3500	350	350
Deaths	Adult cows			1 every 20 years		0.05	cow		0	0	0

Situation where one of the young females is kept for replacing the older ones

(1 renewal every 6 years)

		Total cost and return of LS*	External costs and return*
For 2 adult cows and calves	**Gross return**	17 874	17 124
	Production costs	2 766	120
	Net return	15 108	17 004
Work productivity (Rs/day)		113.2	1 019.4
Extra land productivity (Rs/acre)		7 554	

Situation where a new cow is purchased instead of keeping one of the young females

Every 6 years: renewal of the cow; sale of an extra 1 year-old calf

				Unit price range*	Selected unit price*	Yearly total*
Cost	1 female bought every 6 years or	0.15	5 year-old females purchased every year	8000-12000	8000	1200
Return	1 female sold every 6 years or	0.15	1-year-old females sold every year	3000-4000	3500	525
Reduced straw cost						-250
Reduced manure return						-75

		Total cost and return of LS*	External costs and return*
For 2 adult cows and calves	**Gross return**	18 774	18 174
	Production costs	4 666	2 520
	Net return	14 108	15 654

** All prices are given in Indian Rupees*

3 LS 3 - SHEEP AND LS 4 - GOATS

These animals are also land races. Two different breeds of goats are present in the area, although by far the most common is a breed of usually entirely jet black animals, with a thin build. The sheep have dominantly white fleece, some with light brown around the neck area. The animals are not milked but are kept mainly to sell the young for meat.

3.1 REGULAR INCOME OR SOURCE OF CREDIT

The income generated by these livestock systems has been evaluated by considering a herd with stable numbers. However, this is rarely the case: significant numbers of farmers have acquired their animals recently and still have herds on the increase; for others, there have been drastic decreases in numbers, due to a disease present in the area since about 3 years ago, or because the family required money and sold an important part of the flock. The income generated by the sale of half of the herd has also been determined. This is often how the herd functions: people build up their capital, selling just the young males and keeping the young females. When they need a large sum, they sell a big part of the herd. Sales also occur if the owners no longer have the necessary available labour to look after them.

3.2 WORK

The main part of the work is herding these animals. Even during the summer season, when they can roam around the fields, they must be watched over, to ensure they all return home. This requires a minimum of 6 h / day, but often 7 h / day. The hours when the animals are grazed vary throughout the year and from one family to another. During the summer season, after harvesting and before the ploughing starts, when crop residues are plentiful in the fields, the shepherd does not need to go very far. He then takes the animals out from 9 to 1 o'clock and again from 3 to 5 o'clock for example. The times are organised around other jobs that need doing, and if he herder is a woman who must first cook for the family, she will usually leave later. When the animals must be taken to the forest, the herder will leave for the whole day.

The goat or sheep shed must also be cleared out, which takes an hour at least, more if the manure heap is a long way away. A little extra work arises when one of the animals falls ill, but also when new kids or lambs are born or for controlling the state of the pregnant mothers or the lactating ones and their young. As such, the daily work averages 8 h or more. It therefore corresponds to a full time job.

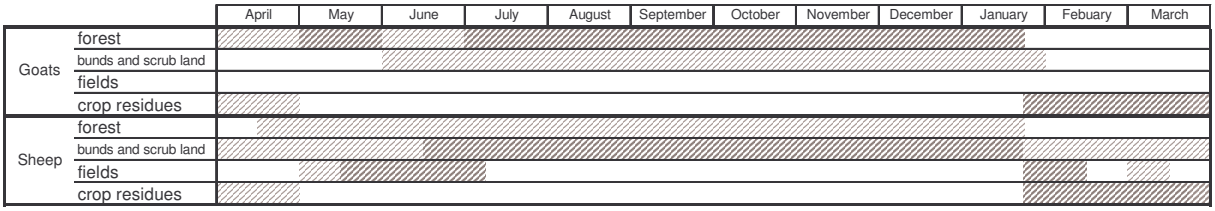
3.3 FOOD

The goats or sheep are given virtually no extra food on top of what they find for themselves during the day. Some farmers feed their billy goats or rams a little supplementary food: this is usually something like horse-gram grains and "*mudde*" (the ragi flour ball that people eat themselves). The females can also be given a little bit of this concentrated food for a few days if they have trouble producing milk in the first weeks. A few farmers fatten up the young animals quicker by using the horse-gram. Mostly though, the small animals are not fed any such food. They are kept at home during the first month or two when they are heavily dependant on milk. During this time, the herder will bring home some fresh green material, such as young leaves from various trees. Then they set off with the older animals and must find their food for themselves, along with a little milk still from their mothers. Therefore, just

a little extra food has been taken into account (figure 33): a small quantity of ragi flour and horse-gram grains, to feed the ram or male goat, as well as the lactating mothers if needed.

Figure 31 details the places where the sheep and goats are grazed throughout the year. This is one of the main differences between the 2 animals: the sheep are contented with the grass growing on the bunds throughout the year, whereas the goats need more leafy material.

Figure 31: LS3 - Sheep and LS4 - Goats - sources of food throughout the year



Other than the period where the crop residues are numerous, the goats are taken to the forest. There are some periods when they can rely on fresh growth on some of the low growing trees and bushes in the edges of the fields, to cover their needs for a week or so: in the later part of the summer season for example, if some rain has come to stimulate green shoots and leaves.

On the other hand, the sheep can rely on the food growing in and around the fields for most of the year. They will be taken to the forest, but only close to the edge, where grass grows along with the bushy vegetation. After harvesting, they too will feed off of the crop residues, but will also continue to graze the bunds and any weeds in the fields. Once the weeds push up again in the fields, with showers in May and June, this will constitute an important source of food for them, along with the grass growing back on the bunds. After sowing, they can find food on the scrubland and on the edge of the forest.

When families decide which animals to invest in, this is often a determinant criterion. Women do not often go alone to the forest. If the main herder is a woman, or an elderly man who will have difficulty walking long distances and fending off any predators, sheep are chosen. If at least one of the herders is a young man, goats are preferred and are taken deep into the forest.

3.4 REPRODUCTION

Many of the reproductive parameters are similar for both the goats and the sheep (figure 32). Separate values have been indicated for prolificacy levels, as the goats give birth to significantly higher number of young than do the sheep.

For both the sheep and goats, one male animal is kept. No flocks or herds of over 30 adult females were come across, and up until at least this number, one male is sufficient. Except for the very young animals, the animals are taken out all together throughout the whole year. When they are penned up, the male will be separated from the others, but will be in amongst the herd when they are out grazing. In this way, the deliveries will be spread across the year.

No definite seasonality is observed for the periods where the females come on heat or for the deliveries. There did appear to be fewer births between March and July than at other times in the year. However the nutritional condition of the females is important for the start up of the sexual cycles after a delivery and an extra delay before the next pregnancy can be incurred when food is scarce. The parturition interval is very variable for different she-goats or ewes and different years and times of the year. The age of the first delivery is just as variable. Usual ranges are given in figure 32. 10 months might be a slightly optimistic average value for the parturition interval. On the other hand, 2.5 years for the age of fist delivery is slightly over-estimated. Too many factors intervene for more precise values to be given here.

Figure 32: Reproductive and numerical data for the sheep and goats

Average local data for the goats and sheep

	Sheep		Goats	
Reproduction				
Age of first pregnancy (1.5-2 years)	2	years	2	years
Interval between two births (8-12 months)	10	months	10	months
Number of young per delivery	1.1	lambs	1.3	kids
Losses through interrupted pregnancies and pre-weaning mortality	15	%	15	%
Age at weaning	3-4	months	3-4	months
Adults				
Age at selling (6-7 years)	7	years	7	years
Mortality of animals over weaning age	10	%	15	%
Career of one animal				
Age at first delivery (2-2.5 years)	2.5	years	2.5	years
Number of pregnancies over next 5 years	6	pregnancies	6	pregnancies
Interrupted pregnancies and young that die	1	loss	1	loss
Total number of young reaching weaning	7	lambs	8	kids

Livestock system based on 10 adult females

	Sheep	Goats
Number of adult females	10	10
Average yearly data		
Numerical productivity at weaning		
Number of young per year reaching weaning	11.2	13
Number of young males	5.6	6.6
Number of young females	5.6	6.6
Number of young reaching 1 year old	10.7	12.3
Sales and losses		
Number of adult females sold	2	2
Number of adult females dying	1	1.5
Number of young females kept (accounting for their mortality)	3.33	4.12
Number of adult males sold (1 every 5 years)	0.2	0.2
Number of young males kept (1 every 5 years)	0.2	0.2
Number of young (1 year old) sold	7.13	7.95
Total animals in herd		
Adult females	10	10
Young females kept for renewal (1-2 years old)	3.33	4.12
Adult males	1	1
Young males kept for renewal (1-2 years old) (1 every 5 years)	0.2	0.2
Young (0-1 year old)	11	13

Zootechnic unit	Equivalent nutritional requirements (ENR)	Sheep N°	Sheep ENR	Goats N°	Goats ENR
Adult females	1	1	1	1	1
Young females (1-2 years old)	0.75	0.33	0.25	0.41	0.31
Young (0-1 year old)	0.25	1.12	0.28	1.33	0.33
Adult males	1	0.1	0.1	0.1	0.1

	Sheep		Goats	
Increasing herd scenario				
Number of young females kept (mortality deduced)	4.8		5.1	
Increase in numbers of females	1.8		1.6	
Percentage increase in number of females per year	18	%	16	%
Number of young (1 year old) sold	5.4		6.4	

3.5 HEALTH AND END OF CAREER

The goats and sheep are sold between 6 and 7 years old, usually after approximately 6 pregnancies. The adult mortality rates are however fairly high. The causes of mortality include problems during pregnancy and different illnesses, but for the last three years, one particular disease has been causing severe problems to herders.

This disease tends to affect both goats and sheep and at all ages. It causes fever and other flu like symptoms, along with skin eruptions. It weakens the animal drastically and without a veterinary intervention, the mortality of affected animals is very high. Some farmers choose to have all their animals regularly treated, in a preventive fashion. Others call upon the vet as soon as the animals fall ill. In both cases, high veterinary fees are incurred, as indicated in figure 33. The values here correspond to regular preventative injections.

It is also the approximate cost per year if most of the herd are affected. However, if that is the case, there is the risk that the animals first affected will succumb to the disease before the herder realises it is not just an ordinary flu and calls out the vet. Quite a few farmers only call the vet as a last resort. Several herders in the area have lost 50 % or more of their animals. Some use the services of an ayurvedic vet, the efficiency of which was not investigated here.

Dramatic mortality rates have not been included here, as they are recent, and difficult to predict or include as average values. Instead a situation has been chosen where preventative or prompt veterinary intervention is called upon. The cost incurred is relatively high, but the mortality rate is then stabilised. It must however be remembered that this is not the choice made by many herders, who do not feel they can afford to opt for the preventative treatment. The ordinary net return is then slightly higher, but can fall to half of its value if a large part of the herd is wiped out. Along with the treatment for this particular disease, the veterinary cost includes more common medicine, such as that for worms.

The goat mortality rate is on average slightly higher than the sheep one (figure 32). Indeed, the goats more regularly face another threat: predators in the forest, as they are frequently taken deep into the forest.

3.6 PRODUCE

The products that are used or sold are manure, and the animals for meat (figures 34 and 35).

The animals

The old sheep and goats are sold for meat, once they reach 6 or 7 years. This is true of both the male and the females. They fetch a higher price than the young, because of their extra weight. It is however much lower than the price that can be obtained for a female at reproductive age. An alternative is therefore to keep all of the young females and sell them at sexual maturity, or when they are in one of their first pregnancies. This requires being able to wait for the financial return. It is not a situation considered here, although it is sometimes encountered in reality. More frequently, the size of the herd is increasing (§ 3.1).

The young animals can be sold very young, at 3 or 4 months old, if money is rapidly needed. More commonly though, they are kept until at least 6 months old and when possible, close to 1 year old or even 1.5 years old. The price fetched increases with the weight of the animal for all of the young sold for meat. It is also higher close to the main festivals, if the owner can wait. Here an intermediate situation is presented, with 1-year-old animals being sold. As many factors influence the return, 1300 R / animal is a rough average of that obtained.

Figure 33: Costs of inputs for the sheep and the goats

Sheep - costs and returns for 10 adult females and their offspring

Inputs

Food		Quantities used by different farmers	Common daily quantity	Period	Number of days	Yearly quantity	Unit	Unit cost range*	Selected unit cost*	Common cost for the herd*	Cost of own farm inputs*	Cost of outside inputs*
	Grazing	6-7 h minimum		all year	365	NQ				work		
extra food necessary for 1 adult male, and sometimes for a few of the females	Ragi flour		0.15	all year for the male and for the females, when have trouble producing milk	365	55	kg		5	274	230	44
	Horsegram grains		0.30		365	110	kg		8	876	876	
Total consumables										1150	1106	44

Services	Veterinary fees and medication	regular injections for all animals	3	visits / year				50-100	90	270	0	270
Total services										270	0	270
Total extra external production costs												314
Total production costs										1420		

** All prices are given in Indian Rupees*

Goats - costs and returns for 10 adult females and their offspring

Inputs

Food		Quantities used by different farmers	Common daily quantity	Period	Number of days	Yearly quantity	Unit	Unit cost range*	Selected unit cost*	Common cost for the herd*	Cost of own farm inputs*	Cost of outside inputs*
	Grazing	6-7 h minimum		all year	365	NQ				work		
extra food necessary for 1 adult male, and sometimes for a few of the females	Ragi flour		0.15	all year for the male and for the females, when have trouble producing milk	365	55	kg		5	274	230	44
	Horsegram grains		0.30		365	110	kg		8	876	876	
Total consumables										1150	1106	44

Services	Veterinary fees and medication	regular injections for all animals	3	visits / year				50-100	90	270	0	270
Total services										270	0	270
Total extra external production costs												314
Total production costs										1420		

** All prices are given in Indian Rupees*

Figure 34: Outputs and returns for the sheep under different management options

Sheep - costs and returns for 10 adult females and their offspring - stable numbers in herd

Outputs		Number / year	Unit	Price range per unit*	Selected price per unit*	Return*
	1-year-old Lambs	7.1	lambs	1000-1500	1200	8520
	Adult females	2	ewes	2000-4000	2500	5000
	Adult males	0.2	rams	2000-4000	3000	600
	Manure	2	tractor loads	250-400	300	600
Gross return						14720

Total cost and return of LS3*

For 10 adult females and their offspring	**Gross return**	14 720
	Production costs	1 420
	Net return	13 300
Work productivity (Rs/day)		36.4
Yearly increase in number of adult females (%)		0

Sheep - costs and returns for 10 adult females and their offspring - increasing numbers in herd

Outputs		Number or quantity / year	Unit	Price range per unit*	Selected price per unit*	Return*
	1-year-old Lambs	5.4	lambs	1000-1500	1300	7020
	Adult females	2	ewes	2000-4000	2500	5000
	Adult males	0.2	rams	2000-4000	3000	600
	Manure	2	tractor loads	250-350	300	600
Gross return						13220

Total cost and return of LS3*

For 10 adult females and their offspring	**Gross return**	13 220
	Production costs	1 420
	Net return	11 800
Work productivity (Rs/day)		32.3
Yearly increase in number of adult females (%)		17.7

Sheep - costs and returns for 5 adult females and their offspring - increasing numbers in herd - starting years

Outputs		Numberor quantity / year	Unit	Price range per unit*	Selected price per unit*	Return*
	1-year-old Lambs	2.7	lambs	1000-1500	1300	3510
	Adult females	0	ewes	2000-4000	2500	0
	Adult males	0	rams	2000-4000	3000	0
	Manure	1	tractor loads	250-350	300	300
Gross return						3510

Total cost and return of LS3*

For 10 adult females and their offspring	**Gross return**	3 810
	Production costs	710
	Net return	3 100
Work productivity (Rs/day)		67.9
Yearly increase in number of adult females (%)		27.7

Sheep - return generated by the sale of half the flock - 1 young male, 5 females, 1 young female

Value		Number / year	Value range per animal*	Selected value per animal*	Total value*
	Adult males	1	3000-4000	3500	3500
	Adult females	5	3000-4000	3500	17500
	Young females	1	1500-2500	2000	2000

Total value*		23000
Return obtained*	if sold urgently	11500
	otherwise	17250

Figure 35: Outputs and returns for the goats under different management options

Goats - costs and returns for 10 adult females and their offspring - stable numbers in herd

Outputs		Number / year	Unit	Price range per unit*	Selected price per unit*	Return*
	1-year-old kids	8	lambs	1000-1500	1200	9600
	Adult females	2	ewes	2000-4000	2500	5000
	Adult males	0.2	rams	2000-4000	3000	600
	Manure	2	tractor loads	250-350	300	600
Gross return						15800

Total cost and return of LS4*

For 10 adult females and their offspring	**Gross return**	15 800
	Production costs	1 420
	Net return	14 380
Work productivity (Rs/day)		39.4
Yearly increase in number of adult females (%)		0

Goats - costs and returns for 10 adult females and their offspring - increasing numbers in herd

Outputs		Number or quantity / year	Unit	Price range per unit*	Selected price per unit*	Return*
	1-year-old kids	6.4	lambs	1000-1500	1300	8320
	Adult females	2	ewes	2000-4000	2500	5000
	Adult males	0.2	rams	2000-4000	3000	600
	Manure	2	tractor loads	250-350	300	600
Gross return						14520

Total cost and return of LS4*

For 10 adult females and their offspring	**Gross return**	14 520
	Production costs	1 420
	Net return	13 100
Work productivity (Rs/day)		287.1
Yearly increase in number of adult females (%)		16.4

Goats - costs and returns for 5 adult females and their offspring - increasing numbers in herd - starting years

Outputs		Numberor quantity / year	Unit	Price range per unit*	Selected price per unit*	Return*
	1-year-old kids	3.2	lambs	1000-1500	1300	4160
	Adult females	0	ewes	2000-4000	2500	0
	Adult males	0	rams	2000-4000	3000	0
	Manure	1	tractor loads	250-350	300	300
Gross return						4160

Total cost and return of LS4*

For 10 adult females and their offspring	**Gross return**	4 460
	Production costs	710
	Net return	3 750
Work productivity (Rs/day)		82.2
Yearly increase in number of adult females (%)		21.4

Goats - return generated by the sale of half the flock - 1 young male, 5 females, 1 young female

Value		Number / year	Value range per animal*	Selected value per animal*	Total value*
	Adult males	1	3000-4000	3500	3500
	Adult females	5	3000-4000	3500	17500
	Young females	1	1500-2500	2000	2000

Total value*		23000
Return obtained*	if sold urgently	11500
	otherwise	17250

Manure

The sheep or goats produce approximately 1 basket of droppings per day for a herd with a total of 25 animals (10 adult females). This turns out at about 2 tractor loads of manure per year, if no further organic matter is added other than a little refuse straw. This is indeed usually the case, as discussed about the cows (§ 1.6). Sometimes this manure will be sold. Often it will be applied to the family's own fields.

3.7 ECONOMIC RETURN

The return depends on the number of animals sold. There are several options open to the owner (figures 34 and 35). One is to keep just enough young females to replace those that die or are sold and function with a herd that has approximately stable numbers. This is what is presented first and gives an idea of the return that can be generated by a herd of this type.

However, as the owners tend to use goats or sheep as a cash reserve for difficult times or particular needs such as their daughters' weddings, many herds are increasing in size. This can be in expectation of such an occasion, or after one, when the herd is being reconstituted. These situations are therefore also presented here, with 2 different herd sizes: an ordinary sized one, on a saving type of management; and a small one, either just after purchase of the herd, or after the sale of a large part of the herd to free up the invested capital. The management whereby the young females are kept until their first or second pregnancy is not discussed here. As these females are sold to other herders, or future ones, it is financially more interesting if buyers can be found. Other herders tend to depend only upon their young to renew their animals and new herders are not that common.

The goats generate a slightly higher return than the sheep, because of the higher prolificacy level. For a stable herd with 10 adult females, the number most frequently encountered in the zone amongst the larger herds, it corresponds to an average annual return of over Rs. 14 000 per year for the goats and over Rs. 13 000 per year for the sheep. If the herd is on the increase, the return is lower, as extra young females are kept rather than being sold. The difference is however not that important, dropping by about Rs. 1500 per year, which means 10 to 15 % less for an increase of over 15 % of animals per year. This increase in animal numbers will be transmitted to the net return within two years (the females becoming productive after an extra year and the young kept one year before being sold).

The other main size of herd in the area is a very small one. This is usually the case when the owner has acquired the animals recently: it is frequent for the new herders to start out with around 5 or 6 adult females. A situation with 5 is presented. The females are often young ones, so that none will be sold for a few years. This along with the small number of animals means that the net return is low. The strategy is often to keep all of the young females, if it is financially possible. The yearly net return if they are all kept is: just over Rs. 3000 per year for sheep and Rs. 3500 per year for goats, with an over 25% increase in the numbers of sheep and over 20 % for the goats. Again, the consequent increase in net return is delayed by 1 year at the start, as the females have to be kept for approximately 1 extra year to reach sexual maturity. The price to pay for an initial herd of this size is between Rs. 11 000 and Rs. 18 000.

For a herd of 10 adult females, the work productivity is very low: Rs. 30 per day. If a shepherd must be paid on a Rs. 10 000 per year, the activity is not really worthwhile, unless a much larger herd or flock is kept. However, sharing the sheep or goat keeping with a neighbour with similarly low numbers of animals is a possibility that is only rarely observed. This would double the work productivity.

4 LS 5 - HIGH MILK PRODUCING COWS

The high milk producing cows are cross-bred. Two main European dairy breeds are used, Jersey and Holstein-Friesian. These have been crossed with local Zebu breeds. They appeared in the area with the set-up of dairies.

4.1 WORK

The work is of the same nature as that for the Hallikar cows. But there is no watching to do: the cross-bred cows do not much like walking in the heat or going off to the forest. If strained, their milk yield drops quickly. During the day, they are usually tied on bunds or on fields set aside. The work is therefore just the routine daily work, which includes finding somewhere to tie the animals. It is approximately 2 hours / day.

The work load will depend on whether there are other cows as well. If not, it can be estimated at 2 hours per day with one animal and an extra hour per extra animal. It is the same time as for 2 Hallikars or 2 buffaloes, as these animals have less food distributed to them and produce less manure. The cross-breds also systematically need water brought for them, to dissolve their concentrate feed in. With other cattle, it can be estimated as an extra hour, as the cleaning task can be done for all the animals together, one milk pail used for them all, one trip to the dairy be made, so that not all the tasks require extra time. The times are only estimates, as many of them depend on the distances to the dairy, to the manure heap, to the straw-stack and to the grass bunds: the transport time makes up the biggest part of the work time.

4.2 FOOD

The main food of the cross-bred cows is bought-in concentrates. They will also be fed food similar to the Hallikars in the mornings and evenings. In the day they graze in fields.

Grazing

As the cross-bred cows do not go off to the forest, they must have other places to graze. Their owners set aside a field for them for the rainy season, which will be their main source of grazing material (figure 37). This is usually a small acre per cow. If there are plentiful bunds, it can be less. In the dry season, the grass there can get very sparse. The cows can then be tied on bunds when the grass grows again after a shower, to relieve the pressure on that area. There are also common areas that stay more humid, near the small streams for example, and that can provide sufficient grazing material at difficult times.

Other food

The cows are fed concentrates in the morning and evening. The main ones in the area are purchased directly from the cooperative dairy. Groundnut cake is given to the cows while they are lactating, but many farmers do not use it at other times as it is expensive. Sweet-corn flour is another common feed. Some farmers combine it with ground wheat grains. Specially prepared mixed feed is also available at times, but most farmers do not use it regularly.

The quantities fed to the cows are very different from one farmer to the next. The farmers with cows that produce more milk feed their animals higher levels. But as the other elements of the diet vary, both seasonally and with the resources available to the farmer, it is difficult to give a precise amount required. Hence the nutritional values of the different feeds and fodders used have been checked to see if they are coherent with the rations distributed (figure 36).

Figure 36: Nutritional requirements of the cross-bred cows and values supplied by their rations

Nutritional needs of the cross-bred cows

Approximate weight of the cows (kg):			400
	UFL (2)	PDI (3) (g/day)	Max IDM (4) (kg)
Upkeep	3.2	240	10
12 L milk / day	4.56	720	3.36
16 L milk / day	6.08	960	4.48
Total 12 L	7.76	960	13.36
Total 16 L	9.28	1200	14.48

Nutritional values of food stuffs

Nature	DM (1)	UFL / kg DM	PDIN / kg DM	PDIE / kg DM
Sweetcorn flour	0.87	1.28	88	120
Wheat granules	0.87	1.2	80	110
Oilseed cakes	0.88	1.1	370	250
Ragi straw	0.85	0.4	20	40
Sorghum straw				
Elephant grass	0.19	0.6	49	70
Regrowth grass	0.2	0.8	50	70
Flowering grass	0.6	0.6	40	60
Straw type grass	0.9	0.5	30	50
Sorghum	0.2	0.6	50	60

Dry season

Nature	Quantity (kg)	DM (1)	UFL (2)	PDI (3)
Sweetcorn flour	1	0.87	1.1136	76.56
Wheat granules		0	0	0
Oilseed cakes	1.3	1.144	1.2584	423.28
Ragi straw	4	3.4	1.36	68
Flowering grass	16.5	9.9	5.94	396
TOTAL		13.3	9.672	963.84

Dry season - but with irrigated fodder grass

Nature	Qty (kg)	DM (kg)	UFL (1)	PDI (g) (2)
Sweetcorn flour	1	0.87	1.1136	76.56
Wheat granules		0	0	0
Oilseed cakes	1.13	0.9944	1.09384	367.928
Ragi straw	1.8	1.53	0.612	30.6
Elephant grass	10	1.9	1.14	93.1
Flowering grass	16.5	9.9	5.94	396
TOTAL		13.33	9.89944	964.188

Wet season

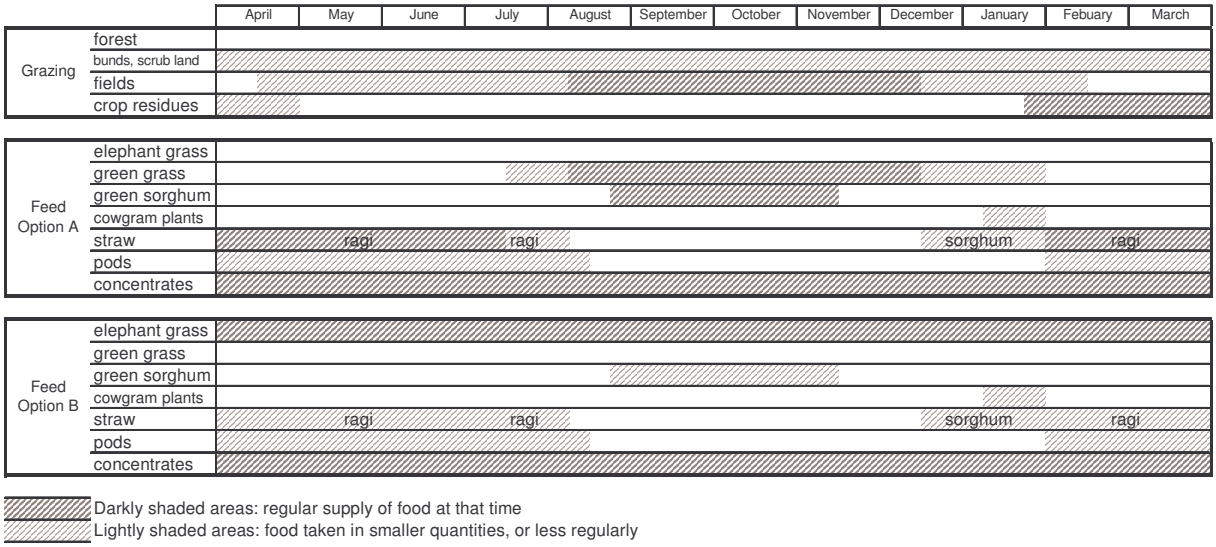
Nature	Quantity (kg)	DM (1)	UFL (2)	PDI (3)
Sweetcorn flour	1	0.87	1.1136	76.56
Wheat granules		0	0	0
Oilseed cakes	0.7	0.616	0.6776	227.92
Regrowth grass	55	11	8.8	550
Sorghum	10	2	1.2	100
TOTAL		13	11.7912	954.48

(1) Dry matter *(2) Energy unit for cows*

(3) Digestible protein *(4) Maximum ingestible dry matter*

Two principal scenarios are presented for the cow's source of fodder and feed (figure 37): the purely dry-land farmers and the farmers with irrigated land. The animals belonging to the first category still rely heavily on straw during the dry season to cover part of their nutritional requirements. This will be added to the energy and protein that they can get from grazing, remembering that at this time of year, the grass often has a low nutritional value. The available protein will be the limiting factor in all cases, unless high quantities of oilseed cake are fed to the animals, but as this is expensive, it is not what happens in practice.

Figure 37: LS5 - cross-bred cows - sources of food throughout the year



The quantities of straw and grass have been worked out to respect the maximum quantities of dry matter that can be ingested for cows of this size producing an approximate 12 L of milk. When the grass is dry and less nutritious, over 1 kg of groundnut cake is necessary for the cow to produce 12 L of milk (figure 36). If the quantity of grass becomes low and extra straw is fed to the animals, the amount of groundnut cake needed is higher still. In the wet season, when green grass and sorghum are plentiful, the necessary amount of oilseed cake drops well below 1 kg.

The farmers with irrigated land either grow sorghum throughout the year or elephant grass. Their animals are thus ensured a supply of green food throughout the year. In the dry season, with the same quantity of grass grazed during the day, but one small bundle of elephant grass distributed to them, they require just a small quantity of straw and just over 1 kg of oilseed cake (figure 36). In the wet season, they are in a similar situation to other farmers' cows.

On average therefore, one can consider that 1 kg of sweet-corn and 1 kg of oilseed cake is required for the cows during lactation. This, along with 4 kg of ragi straw in the dry season and 10 kg of green sorghum, elephant grass or other fresh green grass the rest of the year, to complement the food grazed. On such a ration the cow can produce approximately 12 L of milk per day. For the cows with a potentially higher milk yield, greater quantities of concentrates are required. When the cows are not lactating, the farmers continue to feed them the corn flour, but even this is not really necessary from the nutritional analysis, as long as some green grass is still available for grazing.

The cross-bred cows' food will also be supplemented with some gram pods and crop residues at times when they are available. However, due to the use of concentrates, this is a less important source of food for these cows than for the Hallikars.

Figure 38: Reproductive and numerical data for the cross-bred cows

Average local data for the cross-bred cows

Reproduction		
Age of first pregnancy	2.5	years
Average calving interval	14	months
Number of young per delivery	1	calf
Interrupted pregnancies	10	%
Calf mortality	10	%
Age at weaning	10-11	months
Adults		
Age of the end of career	13	years
Mortality of animals over 1 year old	5	%
Career of one cow		
Age at first calving	3.5	years
Number of pregnancies over next 9 years	7.7	pregnancies
Interrupted pregnancies and calves that die	0.9	loss
Total number of calves born	7.8	calves
Total number of calves reaching weaning	7.06	calves

Milk			
Daily quantity produced by various cows	8-16 L	for	10-11 months
Average daily quantity consumed by calf	1-2 L	for	2 months
	0.50 L	for	8 months
Average daily quantity obtained	8.5 L	for	2 months
	10.5 L	for	4 months
	6.5 L	for	4 months
Average yearly quantity (milk for 10 of a 14 month cycle)	2186 L		
Cycles without milk (interrupted pregnancy)	10 %		

Livestock system based on one adult female

Number of adult females	1
Average yearly data	
Numerical productivity at weaning	
Number of calves per year reaching weaning	0.69
Sales and losses	
Number of adult females sold	0.1
Number of adult females dying	0.05
Number of young females kept (accounting for their mortality)	0.16
Number of young calves (1 year old) sold	0.53
Total animals in herd	
Adult females	1
Young females kept for renewal (1-3 years old)	0.32
(1 kept every 3 years, for an extra 2 years before reaching sexual maturity)	
Young calves (0-1 year old)	0.69
(4 every 3 years)	

Zootechnic unit	Equivalent nutritional requirements (ENR)	N°	ENR
Adult cow	1	1	1
Young females (1-3 years old)	0.7	0.32	0.23
Young calves (0-1 year old)	0.25	0.69	0.17

4.3 REPRODUCTION

The number of cows owned and the recent introduction of these animals in the area makes it difficult to accurately estimate the reproductive parameters. Where no evidence of the contrary was found, the same parameters as for the Hallikars have been kept (figure 38).

The insemination of the cross-bred cows is done artificially. The local vet is called upon when the cow is on heat. He brings semen in a portable liquid nitrogen refrigerated pot and injects it to the cows.

Without any problems during the pregnancy, the calving interval is very frequently 14 months. The cows often came on heat earlier, but to prolong the milk production slightly, which often stops quickly in the 7th month of pregnancy, the vet is rarely called upon before the 4th month after calving. The cows being fed concentrates, the delays in the cows coming on heat are few. There were however several occasions when the calving interval was longer, but not sufficient interviews were carried out to estimate a more precise average value. Hence, this has been included in the percentage of pregnancies presenting problems. These, along with the calf mortality are very rough estimates. They are based on the interviews conducted, but this represents too few cows over too short a period to be reliable.

An average over the career of one cow, with losses taken into account is 7 calves in 10 years. The males will be sold very young at a low price. The females are often kept and sold at their first or second pregnancy. Keeping one female to replace the cow when it gets old, and taking into account the mortality and eventual reproductive problems of the young females, this leaves 2 females to be sold over the career of the cow.

4.4 END OF CAREER

The same age of selling for old age causes has been included as for the Hallikars, for want of any better estimates. The same is true for veterinary services other than for the insemination.

4.5 PRODUCE AND RETURNS

The main product is milk this time. The high milk poducin capacity of the cows means that the gross retun obtained is very high. The cost of the concentrates must be considered, giving a net return of over Rs. 16 000 (figure 40): about the equivalent of 2 buffaloes.

Figure 39: Costs of inputs for the cross-bred cows

LS5 Cross-bred cows - costs and returns for 1 adult animal and its offspring

Inputs

Food		Daily quantities used by different farmers	Common daily quantity	Period	Number of days	Yearly quantity	Unit	Unit cost range*	Selected unit cost*	Common cost per animal*
	Grazing	6-7 h minimum		all year	365	NQ				work
extra food necessary for 1 cow,1 calf (0-1 y-old) every other year, 1 calf (0-3 y-old) 3 y out of 6 y	Green grass		0.63	mid-July to January (1)	112	70	bundles		NQ	work
	Sorghum		0.63	end August to mid-November (1)	180	113	bundles		NQ	work
	Cowgram plants	NQ	NQ	some days in January	15	NQ			NQ	NQ
	Ragi straw		0.63	Febuary-July and a little at other times (2)	210	131	bundles		10	1313
	Sweetcorn flour		1.00	all year	365	365	kg		7.2	2628
	Groundnut cake		1.00	during lactation: 8 of 14 months	257	257	kg	11-12.5	12	3086
	Water		NQ					Not Applicable	Not Applicable	Not Applicable
Total consumables										7026

Services	Insemination fee	1 time every 14 months				0.86	visits / year	20-30	25	21
	Veterinary fees and medication	when there are problems - rarely				1	visits / year	10-50	20	20
Total services										41
Total extra external IC										
Total IC										7068

** All prices are given in Indian Rupees*

(1) Green grass is the main food source for one period of approximately 6 weeks (0.5 bundles/day/adult cow), before and after sorghum is available; while sorghum is available, about 11 weeks, both sorghum and green grass will be used, depending on the quantities available (estimate of half and half); at the start and end of the green grass season, some green grass is available for close to 9 weeks (estimate of half of the cow's food over that period)

(2) 6 months and a few extra days

(3) 4 months and a few extra weeks. Approximately 2 shares per week for an adult cow, but depending on quantity available.

Figure 40: Outputs and returns for the cross-bred cows

LS1 Halikar cows - costs and returns for 1 adult animal and its offspring

Outputs		Daily quantity produced by different animals	Common daily quantity	Period	Number of days	Yearly quantity	Unit	Unit price range*	Selected unit price*	Return*
1 cow,1 calf (0-1 y-old) every other year, 1 calf (0-3 y-old) 3 y out of 6 y	Milk			8 of 15 months between 2 births		2180	L	9-10	9.6	20928
	Calves					0.5	1 year-old calf	2000-5000	3000	1500
	Manure		0.62 baskets	daily		1.25	tractor load	250-350	300	375
Sales	Old cows			1 every 10 years		0.1	cow	4000-5000	5000	500
Deaths	Adult cows			1 every 20 years		0.05	cow		0	0

Large farmer - own money, several cross-bred cows

Initial investment (Rs): 15000

		Total cost and return of LS*
For 1 adult cow and its calves	**Gross return**	23 303
	Production costs	7 068
	Net return	16 235
Work productivity (Rs/day)		**177.9**
Extra land productivity (Rs/acre)		**8 118**

average of 1 acre for grazing, 1 of straw, although there can be 0.25-0.5 acres of elephant grass

** All prices are given in Indian Rupees*

Annexe 8 - Irrigated cropping systems

Two irrigated cropping systems are presented here: mulberry and banana.

1 CS 6 - MULBERRY

Mulberry is now grown in the area under irrigated conditions for silk production.

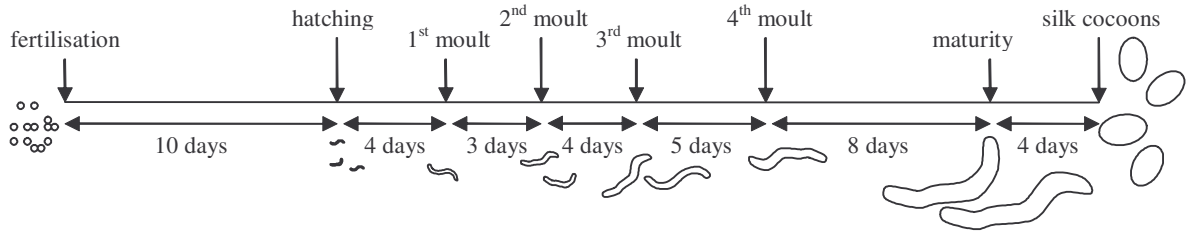
1.1 THE SILKWORM CYCLE

The silkworms (*Bombyx mori*) are not bred by the farmers, but are purchased, either as eggs, or just after hatching, from Kanakapura. All the farmers around Kanakapura use the same type: they are a hybrid species of the "bivoltine" worm. Further north, the climatic conditions are suitable for the rearing of pure race bivoltines that are used for egg-production in very controlled conditions.

The bivoltine worm is so-called because it normally only has 2 cycles a year. Research has enabled worms to be produced that can be reared all year. The bivoltine gives very good yields and good quality silk. It is preferred to the multivoltine worms (Krishiworld).

If the farmers purchase eggs, they must keep them in a cool dark place until they hatch and there is a risk that not all of them will do so properly. Some say they buy the more costly 1-day-old worms, as it is less chancy, but those who prefer purchasing eggs claim they rarely have any trouble with the hatching. A more common reason for choosing one or other is the delay before hatching: if they have not been able to anticipate and the mulberry leaves are ready to be picked, farmers opt for 1-day-old worms. However, it is not quite that simple, as these baby worms are only available on certain days and if they have been "ordered" before hand, meaning there is usually at least a 1 week delay. The eggs are available any day.

Figure 41: The silkworm life cycle



From the hatching onwards, the cycle is 28-30 days long (Figure 55). It is split into 6 phases of different lengths, the first 5 being separated from one another by approximately 1 day where the worms moult. During each successive phase of the development, the worms must be fed fresh green mulberry leaves, picked no more than half a day earlier, except on the moulting day. For example, after hatching, leaves are picked and fed to the worms for 3 days. The first moulting occurs approximately on the fourth day and at that point the worms stop eating. The following day the picking of leaves to feed the worms will resume for another 2 to 3 days, before being stopped again for 1 day when the second moulting starts. Throughout the first 5 stages, as the days pass and the worms grow, they must be fed larger and larger quantities. At first, the leaves will be torn into tiny pieces. By the last fever, not only are they fed whole to the worms, but they need not be separated from thinner stalks.

After the fifth stage, which usually lasts 7-8 days, the worms reach maturity: they stop eating leaves and start spinning silk. They need to be in the light at this point and are transferred

from their racks or trays, kept inside, to stands that will be placed outside for the next 4 days. Every day these stands are faced towards the sun for approximately half an hour in the morning, then turned so that they are in partial shade. At night they will be taken inside again. By the fourth day, a good many of the silk cocoons will be ready to remove from the stands. The worms that mature later may still need an extra half a day or a whole one until they have finished spinning.

The duration of each phase can vary slightly. Even within one batch, there are some 24 h differences between different worms. This is especially noticeable when the worms reach maturity and must be placed on one of the specially designed stands. They will be picked off of their rack individually, as they "ripen". Those not yet ready to spin will be left for another half a day or so. This explains why this transfer operation is such a long one and requires several people, to determine which of the worms have reached maturity.

Once all the silk cocoons are spun, they will be taken by bus to Kanakapura to be sold at a specialised market there. The farmers are given a stall where they negotiate a price with the buyers. The price depends on the quality of that particular batch of cocoons, but also on the quantity being offered that particular day. If the climatic conditions have been favourable in the area and the yields high, the market will be full of silk cocoons and the rates drop.

1.2 SILKWORM HEALTH

The silkworms must be kept in a highly protected environment. They are placed on trays or on racks in a particularly clean house or shed, under mosquito netting, which is used to prevent attacks from predators, especially ants. At night, a candle will be lit or a light switched on to keep away mice and rats.

The silkworms are very susceptible to temperature changes and various health problems. Protozoa, fungi, viruses and bacteria can all spread infectious diseases to the worms. To prevent some of these, 2 different powders are used. Lime is sprinkled on the trays at every moult and then every day after the fourth fever, until the worms are ready to spin. The other is a ready-prepared powder, specially for silkworms. It is also used during each moulting, but just before the farmer starts feeding the worms again. Depending on the climatic conditions, different quantities of each of these powders are used. The amount also depends on the family rearing the worms.

Previously, the worms were placed on woven trays that need to be cleaned off every 2 or 3 days. These are still used today while the worms are small. But many of the farmers rearing silkworms have racks consisting of netting on which the worms are laid as soon as they are big enough. The racks are several metres long and because of the netting, the waste does not accumulate on them. They do not need to be cleaned until the end.

The worms also need careful attention as to the quality of the leaves they are fed. These must be very fresh, not drying out or turning yellow; neither must they have soil or dirt on them. For this reason, the leaves growing from the base of the bush are removed.

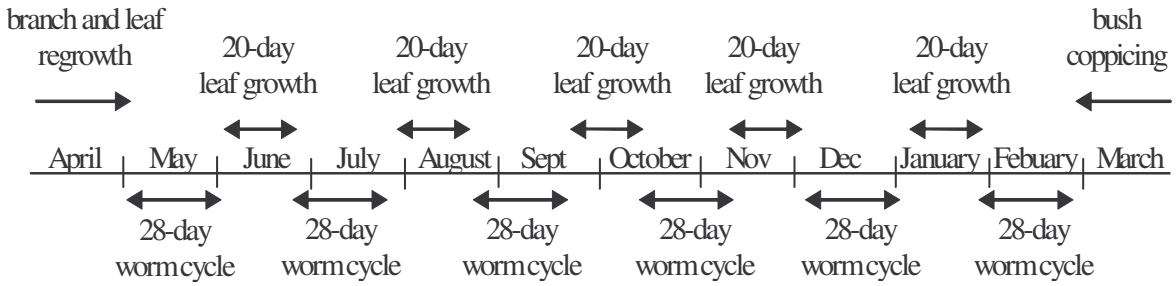
1.3 SIX BATCHES A YEAR

Most farmers buy a new batch of 1-day old worms, or eggs every 2 months. Indeed, as the farmers can judge the number of worms correctly, at the end of one silkworm cycle, all of the leaves have been stripped from the mulberry bushes. It takes approximately 3 weeks for the leaves to grow back sufficiently to be able to start the next batch. One-day-old worms are

purchased once the leaves are ready, or else eggs can be bought some 8-10 days before, so that they hatch around this time.

There is an alternative. Some families split their mulberry bushes into two sections. They will use the leaves from the first section, for a batch of worms. But then, rather than having to wait a few weeks for the leaves to grow back, they can purchase another batch straight away, by using the leaves from the second section. In this way, they can obtain a roughly monthly production. It spreads out not only the income, but also the work. On the same level of external labour, they can rear twice as many worms across the year. As farmers have other crops to look after as well, this practice s not a very common one.

Figure 42: Yearly management of the silk production



Once every year, or every 2 years, the branches need to be cut back to the ground. At this period, cow manure is spread around the plants and the ground is ploughed to aerate the soil, turn in the weeds and bank the soil around the base of the plants to cover the manure. Next the earth is dug and banked to make plots and tiny canals, to permit the irrigation. Taking this into account, and in the situation where a new batch of worms are purchased a little more regularly than once every other month, the family can produce around 6 batches of silk per year (figure 42).

1.4 WORK REARING THE WORMS AND WORK MAINTAINING THE BUSHES

The silkworm farmers must maintain their mulberry bushes throughout the year and must take care of the worms while they have one batch on the go. Keeping the worms involves: picking mulberry leaves in increasing quantities for the worms' 3 daily meals; carrying them home, feeding them to the worms (tearing up the leaves when the worms are small); cleaning out the trays on which the worms are sat while they are small,; and short jobs such as keeping a check on the worms, adding lime or the special silkworm powder on the moulting days, putting on a light in the evenings…

The tasks of transferring the worms onto the stands for spinning, once the worms have reached maturity, and picking off the cocoons when the spinning is finished must be done quickly. The worms must be transferred as they reach maturity, to prevent them from spinning in amongst the leaves and themselves, where the silk will get damaged. For this, they are picked off individually by carefully looking over the bed of worms and selectively picking out those that have reached the mature stage. At the end of the spinning, the cocoons are taken off of the stand and quickly cleaned, by removing any dirt that has become attached to them. If they are left, they dry out and their weight decreases. They are usually taken to the market the following day, to avoid obtaining a lower return because of reduced weight. All in all, 2 trips must be made to Kanakapura, one to purchase the eggs or 1-day-old worms and one to sell the cocoons. Work times for these different operations have been given (figure 43).

The operations to be carried out on the mulberry bushes can be divided into 2 categories: those that need doing once a year and those that are more frequent. Most farmers cut their plants back to the base once a year, although the interval can be as long as 2 years. This is usually done in the summer season, when there is little risk that it will rain, so that the leaves to not get splattered with soil particles. After this, the opportunity will be taken to add cow manure to the plants. The ground is then ploughed between the plants, to cover the manure and aerate the soil. It also turns in the weeds. Next the plots will be remade. The soil is scrapped with the local spade, which is held more like a rake, and piled into small bunds delimiting channels and plots around the plants. During the irrigation, the same spade is used to open and close passages in the bunds, allowing each plot to be watered successively.

At the end of each silk crop, the plants are left bare and are given urea to help the leaves grow back quickly, ready for the next batch of worms. Without the shade of the leaves, weeds grow fast and one weeding is also done before the next worms are purchased.

Watering is not usually necessary in the rainy season. At other times, the frequency varies. When there is no rain, some farmers water their plants every week, others just once a fortnight. Younger plants are usually watered more frequently, but it does depend. Those watering less frequently do not seem to suffer any later development of the leaves, but this is something that would need more detailed investigation.

The watering is done using the earth channels and plots. The soil is selectively moved to block one channel or open another. To water 1600 plants on an ordinary pump flow rate, it takes around 10 hours. This cannot be done in 1 day, as the current is only on for 6 or 7 hours in most of the villages (morning one week, afternoon the next).

1.5 INPUTS, OUTPUTS AND INVESTMENTS

Once the mulberry crop is installed, the necessary inputs for the mulberry bushes are water, cow manure and urea. No other chemicals are applied to the plants. The quantity of manure added varies, but for 1600 plants, it is often close to 4 tractor loads. A few of the larger land and animal owners have their own manure, but many farmers have to purchase extra. If they can not afford it, they apply the manure they would otherwise have applied to their dry-land crops. The quantity of urea applied varies heavily. Many of the organic farmers in the area grow mulberry. They of course do not apply urea, but replace it with mulching, vermicompost and *jeevamrutha* applications. The others apply an average of 1 bag of urea after each silkworm crop for 1600 plants.

The other inputs are those necessary for the worms: the worms or eggs themselves, the lime and the other powder used (*A powder*).

As to the outputs, the yields are very uncertain (figure 44). As there are several crops a year though, the average yearly yield obtained tends to even out. There are often approximately 3 reasonable crops a year (60-70 kg of cocoons per 100 units) and 3 poor ones (40-50 kg). The yields can be quite a bit higher, with 80 kg not uncommon. The prices too vary greatly.

The investments (figure 45) are those necessary for a pump and an open-well, or a bore-well for those without any land with the potential for an open-well. Farmers with land close to the river can just purchase a pump, some pipes and have the pump connected up to the mains. For them, the investment is much lower, but it remains above what many families can afford.

Figure 43:Crop and worm maintenance work times for 1600 mulberry plants on 1600 m² - enough to feed an average of 100 worms per batch

Mulberry bush care

Operation	Qty of work	Frequency	April	May	June	July	August	September	October	November	December	January	Febuary	March
Cutting branches	3 md	1 x / year												3
Carrying branches	3 wd	1 x / year												3
Applying farmyard manure	6 ld	1-2 x / year												6
Ploughing	1 md	1 x / year												1
Making plots	6 md	1 x / year												6
Applying urea	2 x 2 lh	1 x / 2 months	1		1	1		1		1		1		
Weeding	5-6 wd	1 x / 2 months	5		5		5	5		5		5		
Watering: 1x/week(1)	2 x 5 lh	1 x / 1-2 weeks	5	2	2	2				2	5	5	5	5
Mulberry-bush care			11	2	8	3	5	6	0	8	5	11	5	24

Worm care

Operation	Time	N° of people												
Fetching eggs	1 d	1 person		1		1		1		1	1		1	
Picking leaves, feeding				27		27		27		27	27		27	
Cleaning racks	4*1 h	1 person		0.5		0.5		0.5		0.5	0.5		0.5	
Full cleaning	3 h	3 people		1		1		1		1	1		1	
Placing worms on stands	2*0.5 d	4 people		4		4		4		4	4		4	
Keeping watch	2.5 d	1 person		2.5		2.5		2.5		2.5	2.5		2.5	
Picking off cocoons	1 d	4 people		4		4		4		4	4		4	
Taking cocoons to market	1 d	1 person		1		1		1		1	1		1	
Worm care			0	41.1	0	41.1	0	41.1	0	41.1	41.1	0	41.1	0
Total number of labour days per month			11.0	43.1	8.0	44.1	5.0	47.1	0.0	49.1	46.1	11.0	46.1	24.0

Total number of labour-days per year 334.4

Detail of leaf picking time for 1 cycle of 28-30 days

Phase	N° 1	N° 2	N° 3	N° 4	N° 5
Number of consecutive days of leaf picking	3	3	3	5	7
Time required for leaf picking (h / day)	3	4.5	7.5	10.5	17
Travel (h / day) - 0.5 h / trip / person	1	1	1.5	1.5	2.5
Feeding the worms (h / day) - 3 meals x 45 mn	0.75	0.75	0.75	0.75	0.75
Total work time (h / phase)	**9**	**13.5**	**22.5**	**52.5**	**119**

Total picking and feeding time per cycle	
216.5	**h**
27.1	**days**

Figure 44: Inputs and outputs for CS 6 -Mulberry

CS Mulberry - costs and returns for 100 units of worms

Mulberry plants and silkworms - data for 100 units of worms							Total cost		
Inputs		Quantities used by different farmers	Most common quantity	Unit	Unit cost range	Selected unit cost	Common input version *	High input version*	Organic version*
For the plants	Farm manure	2-10	4	tractor load	250-400	300	1200	1200	1200
	Urea	0-12	6	50 kg bag		280	1680	3360	0
For the worms	Lime	0.5-10/batch	30	kg		8.5	255	255	255
	A powder	0-4/batch	6	kg		50	300	300	300
	Eggs	100 units/batch	6	100 units	350-600	450	2700		2700
	1-day-old worms	100 units/batch	6	100 units	700-900	750		4500	
Total consumables							6135	5115	4455
Services	Manure loading	2-10	4	tractor loads	75-100	80	320	320	400
	Manure tractor fee	2-10	4	tractor loads	150-200	200	800	800	1000
	Stand rental	30-80x4days	240	days		1	240	240	240
np	Bus charge		6	2 trips, 1 with load		150	900	900	900
Total services							2260	2260	2540
Total IC							**8395**	**7375**	**6995**
Total proportional IC							7495		
Total non proportional IC							900		

CS Mulberry - costs and returns for 100 units of worms

Outputs		Crop yield range	Crop yield	Number of crops per year	Yearly yield	Unit	Unit price range*	Selected unit price*	Return*
Ordinary scenario	Cocoons	30-90	60	6	360	kg	90-180	120	43200
	Organic matter				2	tractor load	250-350	300	600
	Wood								200
High price	Cocoons		60	6	360	kg		150	54000
Low price	Cocoons		60	6	360	kg		100	36000
Organic	Cocoons		60	5	300	kg		120	36000

Total cost and return of CS*

		Ordinary cultivation	High return	Low return	Organic cultivation
For 100 units of worms/batch	**Gross return**	44 000	54 800	36 800	36 800
	Production costs	8 395	8 395	8 395	6995
	Net return	35 605	46 405	28 405	29 805
Work productivity Rs/day		105	137	84	88
Land productivity Rs/acre		89012.5	116013	71012.5	74512.5

* All prices are given in Indian Rupees

Figure 45: Necessary investments for CS6 - Mulberry

Total cropping system investments and depreciation

	Nature	N° required (range)	N° required	unit	min price	max price	selected price	cost	lifespan	depreciation
np	digging borewell	**1 to 3**	1	attempts	20000	40000	**30000**	**30000**	50	600
np	**pump**	1	**1**	**pump**	**15000**	**40000**	**20000**	**20000**	**10**	**2000**
np	vertical pipes	5 to 15	10	10-m pipes			1500	15000	50	300
np	**horizontal pipes**				**3000**	**5000**	**4000**	**4000**	**20**	**200**
np	**electricity extension**				**10000**	**25000**	**20000**	**20000**	**50**	**400**
np	**wiring**				**500**	**1500**	**18000**	**18000**	**10**	**1800**
np	**spade**		**2**	**spades**	**50**	**60**	**60**	**120**	**5**	**24**
p	fence posts	100-200	100	posts		0	40	4000	20	200
p	fence wire							3000	20	150
p	post transport		2	trips	250	500	350	700	20	35
p	post transport labour		2	md			200	400	20	20
p	fencing labour		8	md			50	400	20	20
p	**plants**		**1600**	**plants**			**1**	**1600**	**10**	**160**

	Open-well		Bore-well		
	low cost	high cost	low cost	high cost	common
Total replacement sum	4584	5009	5484	5909	5889
Total investment	64120	72620	109120	117220	116820

p proportional
np non proportional

All prices are in Indian Rupees

Figure 46: Work times for planting 1600 mulberry plants on 1600 m²; example with planting in August

Preparing plot and planting mulberry

Operation	Qty of work	N° of times	April	May	June	July	August	September	October
Ploughing	2 md/acre	3 x				0.8	1.6		
Collecting weeds	2 wd/acre	2x					1.6		
Harrowing	6 mh/acre	2x					0.6		
Planting	8 md						8		
Adding manure	6 ld						6		
Making plots	7 md						7		
Preparing plot and planting mulberry plants			0	0	0	0.8	24.8	0	0

2 CS7 - BANANA

Banana plants are another of the crops that can only be grown by farmers with their own pump, who have access to water throughout the year. They produce fruit once a year. In this respect, they are less advantageous than the mulberry, but they require less work.

There are 2 different varieties grown in the area: the long Pach and the small Elaki. Elaki is preferred, because of its flavour and fetches a higher price. The work for both is very similar.

2.1 WORK PLANTING BANANA PLANTS AND WORK MAINTAINING THEM

Banana plants are usually planted for 3 years in the area. The plants are able to stay in much longer and keep producing good levels of fruit according to the organic farmers, and several of them have plantations that are in their fourth or fifth year. The other farmers claim that the plants are worn out after these 3 years. In fact many of them rip out their plants sooner, because of serious drops in yields, or because many of the plants are affected by disease.

The difference between the organic and non-organic practices can be understood by the fact that farmers applying fertilisers are applying high levels (figure). This stretches the plants to their maximum and empties the soil of certain nutrients. Consequently, the plants are more prone to diseases and often only produce one or two good crops, and sometimes none at all.

Planting banana plants

Due to this, the planting of new plants comes around regularly and the necessary work has been given for a 1 acre banana plantation (figure 47). It can be compared to the work for planting 0.4 acres of mulberry bushes, the surface that is generally looked after by 1 family.

The basic work is the same. The land must be first prepared. As it is very important that the plants get well established, all is done to ensure that as few weeds as possible grow. The land is therefore ploughed at least 3 times, and weeded once or more. Usually the weeds that have been turned in will also be removed by at least one passage of the long-toothed heggunte, followed by another collection of the weeds. This passage with the cow-drawn implement also roughly levels the ground.

Next, holes are dug for the plants. This is a much longer task for the bananas than for the mulberry, if comparing the time for a given number of plants, as a proper deep hole is dug for the banana plants, whereas the mulberry cuttings just need pushing into the soil. The digging is done by men. For the bananas, manure is sometimes added in the hole. However, this can favour the activity of worms which can damage the new bulb. The other option is to apply manure just before the plots are made, which means that it can be covered when the soil is banked to create the plots and small ditches for irrigation. Making the plots is also usually a man's job. The times listed here do not include the fetching of the plant material: many farmers fetch their own banana shoots or mulberry cuttings from other farmers nearby. This means cutting them or digging them up and transporting them home.

Like for mulberry, the maintenance work on the plants includes tasks of different frequencies. As with the mulberry bushes, once a year the land will be ploughed and the plots will be remade, as they progressively wear down and can no longer hold in the water to allow the irrigation. On this occasion, farmyard manure is usually applied to the trees. Some farmers apply it twice a year, some use only chemical fertilisers. Fertilisers are usually applied in at least 2 separate sessions across the year.

Figure 47: Work times for maintaining and for planting 1 acre of CS7 - Banana

Crop maintenance for 1000 banana plants on 1 acre (4000 m²)

Maintaining banana plants

Operation	Qty of work	Frequency	April	May	June	July	August	September	October	November	December	January	Febuary	March	
Cutting bunches	2 md	4x in 3-4 months				2	4	2							
Cutting back plants	7 md	1 x / year						7							
Applying farmyard manure	6 ld	2 x / year						6							
Ploughing	2 md	1 x / year						2							
Making plots	10 md	1 x / year							10						
Applying fertilisers	2 x 2 lh	3x / year			0.5				0.5				0.5		
Cutting young shoots	5 md	2x / month	10	10	10		10	10	10	10	10	10	10	10	
Weeding	15-30 wd	1 x / 1-2 months	15	15	15	15			15	15	15	15	15	15	
Watering	2 x 5 lh	1 x / 1-2 weeks	5	2	2	2				2	5	5	5	5	
Maintaining banana plants			30	27	27.5	19	14	27	35.5	27	30	30	30.5	30	

Preparing plot and planting bananas

Operation	Qty of work	N° of times												
Ripping out trees	10 md													
Ploughing	2 md	3 x				2	4							
Collecting weeds	2 wd	2x					4							
Harrowing	6 mh	2x					1.5							
Digging holes	20 md							20						
Planting (adding manure)	10 md							10						
Making plots	10 md								10					
Preparing plot and planting banana plants			0	0	0	2	9.5	30	10	0	0	0	0	0	
Total number of labour days per month			30.0	27.0	27.5	21.0	23.5	57.0	45.5	27.0	30.0	30.0	30.5	30.0	

Total number of labour-days per year for maintenance 327.5

Yearly, the plants must also be cut back. This is done after fruiting. As the shoots planted are cut from other banana plants, they are all of slightly different ages and the bananas will ripen in stages over a couple of months. They are often picked in at least 2 or 3 separate sessions, but the plants will usually be cut back all at once, after the last picking. The organic farmers leave the leaves on the ground as a mulch, although some may be used as green material for producing vermicompost. The other farmers remove them.

More regular work includes the weeding, which is usually done once a month. The young shoots that push up must also be cut back, to prevent them competing with the main stalk that will be the one carrying the fruit. This task is done at least once a month, sometimes once a fortnight. The watering is similar to that for the mulberry bushes: not required during the wet season, but at the driest points, some farmers water their plants weekly, while others leave gaps of about 2 weeks between watering. The time required takes into account the fact that someone must be present throughout the whole duration of the watering: to block and unblock the different channels and allow the sequential filling of each of the plots, in which there will usually be approximately 9 plants.

2.2 INPUTS, OUTPUTS AND INVESTMENTS

Different levels of inputs have been considered, to show the variability between farmers. For example, it can be seen that for a banana cropping system, organic practices can divide the cost of inputs approximately by two (figure 48).

The returns obtained are very variable. This is both due to extremely large differences in yields and in prices throughout the year and from one year to the next (figure 48). Such variations are without taking into account losses to the plants, which increase even further the risk that is presented by such a crop in the case where a high loan was taken for example.

The investments are very similar to those necessary for a mulberry cropping system. Indeed, the main part of the investment is the installation of the well and pump (figure 49). Once farmers own these, they can progressively diversify their irrigated crops. This is what is observed amongst most farmers who have had their own pump for over four or five years.

Figure 48: Inputs and outputs for CS 7 - Banana

CS 7 Banana - costs and returns for 1000 plants

Banana - data for 1000 pants on 1 acre							Total cost		
Inputs	Quantities used by different farmers	Most common quantity	Unit	Unit cost range	Selected unit cost	Common input version *	High input version*	Organic version*
Farm manure	4-10	8	tractor load	250-400	300	2400	2400	2400
Urea	0-12	8	50 kg bag		280	2240	2800	0
Complex fertiliser	0-12	8	50 kg bag		500	4000	5000	0
Pesticides, fungicides						0	800	0
Total consumables						8640	11000	2400
Services Manure loading	4-10	8	tractor loads	75-100	80	640	640	720
Manure tractor fee	4-10	8	tractor loads	150-200	200	1600	1600	1800
Total services						2240	2240	2520
Total IC						**10880**	**13240**	**4920**

CS 7 Banana - costs and returns for 1000 plants

Outputs		Range of qty produced per crop	Yearly quantity	Unit	Unit price range*	Selected unit price*	Return*
Ordinary cultivation	Bananas	4000-13000	6000	kg	6-20	10	60000
	Shoots		500	units		1	
	Leaves	contract of 20 000 R/year					
High return	Bananas		9000	kg		15	135000
Low return	Bananas		4000	kg		7	28000
Organic cultivation	Bananas	5000-13000	6000	kg		10	60000

Total cost and return of CS*

		Ordinary return	High return	Low return	Organic cultivation
For 1000 plants	**Gross return**	60 000	135 000	28 000	60 000
	Production costs	10 880	10 880	10 880	4920
	Net return	49 120	124 120	17 120	55 080
Work productivity Rs/day		150	379	52	168
Land productivity Rs/acre		49120	124120	17120	55080

* All prices are given in Indian Rupees

Figure 49: Necessary investments for CS 7 - Banana

Total cropping system investments and depreciation

	Nature	N° required (range)	N° required	unit	min price	max price	selected price	cost	lifespan	depreciation
np	digging borewell	**1 to 3**	1	attempts	20000	40000	**30000**	**30000**	50	600
np	**pump**	1	**1**	**pump**	**15000**	**40000**	**20000**	**20000**	**10**	**2000**
np	vertical pipes	5 to 15	10	10-m pipes			1500	15000	50	300
np	**horizontal pipes**				**3000**	**5000**	**4000**	**4000**	**20**	**200**
np	**electricity extension**				**10000**	**25000**	**20000**	**20000**	**50**	**400**
np	**wiring**				**500**	**1500**	**18000**	**18000**	**10**	**1800**
np	**spade**		**2**	**spades**	**50**	**60**	**60**	**120**	**5**	**24**
p	fence posts	100-200	140	posts		0	40	5600	20	280
p	fence wire							4000	20	200
p	post transport		2.8	trips	250	500	350	980	20	49
p	post transport labour		2.8	md			200	560	20	28
p	fencing labour		10	md			60	600	20	30
p	**plants**		**1000**	**plants**			**1**	**1000**	**10**	**100**

	Open-well		Bore-well		
	low cost	high cost	low cost	high cost	common
Total replacement sum	4524	5111	6011	6011	6592
Total investment	63720	75460	108720	119860	119260

p proportional
np non proportional

ABSTRACT

Due to the Green Revolution's drawbacks in India, organisations like Green Foundation have emerged, promoting agro-ecology and helping farmers escape dependence on external inputs and suppliers. This six-month study assessed the needs and possibilities of integrated organic farming and Green Foundation's projects in and around Veereianadoddi (Bangalore Rural District, Karnataka). The biophysical characteristics, historical evolutions and current farming practices in the area were determined from field investigations and interviews with farmers. A classification of the different farmers was elaborated to understand their current situation, aspirations and constraints.

External inputs have only appeared in the last thirty years, in this cut-off semi-arid area. Many farmers produce principally food for the family, the most widespread cropping system being ragi with intercrops. Progressive irrigation opportunities have changed the situation for some. They use more external inputs and commercialise more produce from irrigated fields. Today significant differences in access to land, water and other capital, reflect past inequalities and remain linked to families' caste.

The differences in the economic situation of the family and the functioning of their farming systems, mean that not all are equally able and willing to follow Green Foundation's suggestions. The long-term availability of water and good quality soil clearly calls for organic farming practices and Green Foundation must pursue their work. However, other projects should be developed to support the small dry-land farmers. They currently benefit little from organic practices, for which the outcome on dry-land remains uncertain in the area. Besides, the problems that many families face go beyond Green Foundation's possibilities and require interventions from other actors of rural development.

Key-words:

rural development project, integrated organic farming, agrarian diagnosis, project evaluation, farmer interviews, Karnataka - South India, semi-arid zone, rainfed farming, finger millet, intercrops, irrigation