Soil fertility management in semi-arid India: it's role in agricultural systems and the livelihoods of poor people

A synthesis review of field experiences, literature, and policies

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with contributions from

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ACRONYMS

APRLP	Andhra Pradesh Rural Livelihoods Project
BAIF	Bharatiya Agro-Industries Foundation
BIRD	BAIF Institute of Rural Development (Tiptur, Karnataka, India)
CBOs	Community Based Organisations
CPRs	Common Property Resources
DDS	Deccan Development Society (Pastapur / Hyderabad, Andhra Pradesh, India)
FYM	Farmyard Manure
ICAR	Indian Council for Agricultural Research
IGIDR	Indira Gandhi Institute for Development Research
KAWAD	Karnataka Watershed Development Project
KVK	Krishi Vigyan Kendra (agricultural development centres)
IK	Indigenous knowledge
INM	Integrated nutrient management
NPK	Nitrogen, Phosphorus and Potassium – fertiliser mix
NR	Natural Resources
NRM	Natural Resource Management
PDS	Public Distribution System
SFM	Soil fertility management
WSD	Watershed Development

PREFACE

This working document synthesises the findings of several sub-components of the NRSP project on " Human and social capital aspects of soil nutrient management, semi-arid India". This project is supported by the UK Department for International Development (DFID) through the Natural Resources Systems Programme (Project R7974).

The document aims to span issues relating to the role of soil fertility management in agricultural production (part 1) with an emphasis on rainfed cropping, and in the livelihoods of rural families (part 2) who may not have access to land, but are nevertheless involved in aspects of soil fertility management as producers, processors or traders of inputs. Although part 1 is focused on rainfed agriculture, it is recognised that in many areas there is a complex mosaic of irrigated and dryland land which are part of the same system and with important impacts on flows of nutrients. The second part of the review focuses on organic inputs, the use of which is less well understood and documented than inorganic fertilisers.

The review concentrates on Karnataka and Andhra Pradesh, two states with large semi-arid areas but both located in southern India, and which form the study areas for the project. However, information from other semi-arid areas in India is also utilised.

This document forms the basis for intensive discussions with collaborators and key stakeholders, so that potential options to address constraints can be identified. This will find written expression in the form of an "options" paper, which will outline the key social, institutional, technical and policy constraints confronting farmers, particularly the poorest farmers from the lower castes and registered tribes, together with a range of possible methods and strategies to address the constraints.

EXECUTIVE SUMMARY

(XXX THIS SECTION WILL BE WRITTEN AFTER COMPLETION OF THE PAPER).

I BACKGROUND

I.1 Purpose of the study

The project seeks to explore and understand the role of human and social capital in farmers' soil nutrient management strategies and practices in semi-arid areas. It will then use the knowledge and experience gained to investigate and develop new approaches to soil nutrient management that benefit the poor. The Sustainable Livelihoods framework was used to analyse and understand the role of human and social capital in the context of the ways in which poor people make a living and the factors that constrain or enable them to achieve their livelihood goals.

The project thus looked at both the way farmers use soil amendments to improve soil fertility and soil biophysical properties, and how the management of these soil amendments (often by landless individuals or households) contributes to the livelihood of these households.

Being a relatively short first phase project, the emphasis was on understanding livelihood systems and identifying constraints and opportunities. In a second phase, action research to develop and test opportunities will be undertaken.

I.2 Methodology

The study consists of four components: (1) literature review, (2) policy review, (3) stakeholder consultations, and (4) field work in two states. This document summarises the main findings from all four components under a common framework, using the sustainable livelihood approach.

I.2.1 Literature review

The literature review was carried out by John Butterworth (NRI) and P V Satheesh (DDS). It analysed a range of material from India and overseas, including field observations in SAT India (especially for part 2, as hardly any published information is available on these issues). The review was circulated to team members and comments were incorporated. The literature review provided the background information and conceptual framework for the present working document.

I.2.2 Policy review

This review was initially carried out by Prof Sudakar Reddy (IGIDR), and a draft review was produced, based on consultation of policy documents and other published sources. However, the team felt that the review was not addressing the key policies that are likely to influence farmers' decision making about soil fertility management. Therefore, M Indira (University of Mysore) and Anand Vadivelu (Institute of Social Sciences, Bangalore) developed a new document that incorporated some more relevant material. A first draft of this review will be available in mid-January 2002.

I.2.3 Stakeholder consultations

A number of stakeholders were invited to the inception workshop in April 2001, where they contributed valuable ideas and suggestions to the project. They were involved in developing the research questions which the project tried to answer. Correspondence with some of the workshop participants continued. This working document will be sent to a range of stakeholders to invite comments and suggestions, which will then be discussed during the workshop in March.

I.2.4 Field work

Field work was carried out in two sites: (a) in Medak District of Andhra Pradesh, by the Deccan Development Society, and (b) in Tumkur and Hassan Districts of Karnataka, by the BAIF Institute of Rural Development. The two collaborating partners were selected based on their interest in the study, their previous involvement / experience in soil fertility related research and development work, and their capacity in undertaking participatory research at village level.

In each site, fieldwork was undertaken in four villages. These were selected to represent both intervention- and non-intervention villages, in order to capture the impact of social mobilisation (such as sangha / self-help group formation) and introduction of improved NRM practices (such as vermicompost, agroforestry, etc.).

The study used different PRA tools, which were pre-tested in both sites, and are listed and briefly described in Table 1. In addition, a range of key informant interviews were carried out with agricultural researchers, extension staff, fertiliser dealers, and with individuals or companies involved in soil fertility related livelihoods (such as poultry farms, leaf litter collectors, etc.). The individual exercise protocols were compiled to make village-wise fieldwork reports. Based on the village reports and the key informant interview protocols, partners compiled one fieldwork report for each site.

Table 1 Methods used for fieldwork

Tool/Technique	Objectives and expected outputs	Participants
Introductory village meeting	To introduce the objective of the study to the villagers and encourage their participation To find out about livelihood options in the village and the number of families engaged in them To form groups for PRA exercises	All villagers
Soil mapping	To identify main topographic and geographical features of the village To identify soil types, cropping pattern, and soil fertility management practices in the village	All villagers
Matrix Ranking	To assess and prioritise farmers' SFM practices, according to farmers' own criteria To understand the diversity of SFM practices in the village and the reasons for it	Group of selected farmers Two PRA team members
Venn Diagram	To identify the agricultural information sources and their accessibility To find out what types of information on SFM are available, and whether this information is considered	Group of selected farmers Two PRA team members

	useful by farmers	
Time Line	To know the changes in key parameters over a period of time, such as livelihood opportunities, cropping pattern, yields, farming practices, etc.	Group of selected farmers Two PRA team members
Individual Farm Resource Flow Map / Case study	To visualise SFM practices on a particular farm To understand nutrient flows on farm To analyse management practices with the farmer and identify possible improvements	Selected farmer and family members Two PRA team members
Village feedback meeting	To share the findings of the different groups and get feedback from other groups for validation of findings	One presenter for each group (farmer) All villagers and PRA team members

I.3 Key challenges in rainfed farming

I.3.1 Overview

Rainfed agriculture remains high on the development agenda in India. Its contribution is vital to help avoid projected food gaps as a result of increasing populations (typically around 2%) and in supporting the livelihoods of the poorest farming families, who do not have access to irrigated land.

Green revolution gains in agricultural productivity, food security and reduced poverty were widely associated with irrigated areas, where the benefits of improved seeds and increased use of inorganic fertilisers could be realised. However, the potential for expansion of irrigated agriculture is decreasing as it is increasingly expensive to bring new land under irrigation (largely because water resources are limited) and there are widespread problems associated with overexploitation of groundwater. Groundwater is the most important source for irrigation. As a consequence rainfed agriculture will continue on over 50% of land in most Indian states (for example, irrigated areas were 21.6% and 38.4% in Karnataka and Andhra Pradesh states respectively in 1993-94), and it will remain the focus of much effort to increase productivity and avoid food gaps.

In addition to rising populations and projected food gaps (see for example Bhalla *et al*., 1999), major concerns associated with the future of rainfed agriculture in semi-arid India include decreasing yield growth and yields, negative nutrient balances, and sustainability. Section III.1.2 analyses farmers' perception of the relative importance of soil fertility as compared to other production constraints, and in relation to other livelihood options.

Sustainability concerns reflect both the need to increase returns to land and labour while maintaining soil productivity over the long-term, and concerns about and pollution. (XXX SURESH REDDY WILL ADD A PARA QUOTING EXPERTS (BERNARD?) ON THE IMPACT OF (EXCLUSIVE) USE OF CHEMICAL FERTILISERS ON DRYLAND SOILS. DAVEY JONES CAN ALSO COMMENT ON THIS. WHAT IS ACTUALLY THE EFFECT OF USE OF INORGANIC FERTILISER ON CROPS AND SOILS? WE ARE ELABORATING ON THIS UNDER THE "RESEARCHABLE OPTIONS", AS IT IS REALLY A MAJOR CONCERN OF SMALL FARMERS.)

Further concerns at macro-economic level include the ineffective targeting of the government's vast expenditure on agriculture (Bhalla *et al*., 1999). Most government expenditure goes to subsidies for farm inputs, particularly fertilisers, credit, water and electricity. Currently the expenses are around Rs. 112 billion for fertiliser subsidy and Rs. 202 billion for power subsidy, which together constitutes nearly 2% of GDP (Gulati and Narayanan 2000).

The policy responses to these challenges include: 'modernisation' of agriculture such as encapsulated in Andhra Pradesh's 2020 vision (including commercialisation, new varieties and GMOs, and continued irrigation development), watershed development programmes to improve the potential of land and develop water resources (some of these programmes are also becoming more poverty and livelihoods focused and include non-land based activities), and subsidies such as the fertiliser subsidy. Policy issues are addressed in more detail in the section on Key policies.

Other key reviews that have addressed soil fertility issues from a livelihoods perspective include NRSP project R7458 reviews focused on semi-arid India and global experiences (NRSP, undated; Tanner *et al.*, 2000).

I.3.2 Livelihood systems and strategies

Conroy *et al*. (2001) identified the following key livelihood systems in rural semi-arid India:

- medium/large farmers, primarily dependent on agriculture (mixed but crops usually more important than animals);
- small/marginal farmers, who are primarily dependent on a combination of agriculture (in some cases land may be leased rather than owned) and wage-labour;
- livestock-specialists, for whom animal husbandry is the principal livelihood activity; and
- landless labourers, who are primarily dependent on wage labour, which may be agricultural or not.

Although agriculture continues to be the backbone of the rural economy and rural livelihoods (see Box 1), there is increasing recognition of the role of non-farm (and non-NR) livelihood contributions. Supplementing agricultural income with casual wage labour is increasingly common as the relevant returns from such employment compared to agriculture improve. The poorest people are likely to be wage labourers and small/ marginal farmers - especially given recent price shocks - resulting in high levels of indebtedness and high suicide rates.

Box 1 The rural economy in Karnataka and Andhra Pradesh

Agriculture is the mainstay of the rural economy in Andhra Pradesh and Karnataka, and agriculture-related activities support the largest proportion of people and provide the largest share of total income to the people. But rice mills, flour mills, and oil presses sit side by side with motor repair shops, provision stores, drug stores and small hotels in the small rural towns. There are also granite and limestone mines in these parts, which provide employment to local labour but export the produce. By and large, private enterprise is dynamic in these rural towns. Transport industries are therefore important, but road links are not always good.

Local produce markets in district towns and tehsil towns are often controlled by market operators, and there are established codes of conduct which ensure the exploitation of those who either don't know or do not have the 'clout' to get a good deal. Commission agents buy produce on auction, and small farmers who venture to sell directly here have little negotiating power and have to take the offered price. Larger farmers have the leverage to negotiate good price with commission agents, often withholding their produce from the market till they get the right price (most usually done in cotton). Others may be able to market in other towns for better prices (for example, Bangalore farmers sold their tomatoes in Kurnool market during the cyclone of 1999, which destroyed a large part of the local crop).

Source: after James & Robinson, 2001

Livelihood strategies can be categorised in different ways. One approach is into intensification and extensification, diversification and migration. Intensification may involve increasing the number of crops and livestock per hectare per year e.g. a second (rabi) crop perhaps through access to irrigation, and/ or increasing the yield of crops and livestock products per hectare. Strategies to improve productivity include soil and water conservation (SWC), the use of high-yielding varieties (HYVs), irrigation, or use of animal feeds (Tanner, 1997). Extensification includes the extension of agricultural areas, for example into CPR lands, often wastelands or forests. Other farmers have extended their cropping into tank beds. Intensification (see for example Tanner *et al*., 2000) may be driven by population pressure and declining land area, or by markets reflecting increased demand. In reality, a combination of these forces is often at work. At the household level intensification requires more capital (to buy inputs) or labour to be invested (for example in crop rotations, cut and carry feeding etc). These strategies are also likely to be combined, but the poor are typically expected to intensify through greater use of labour (Tanner *et al.*, 2000).

Box 2 Characteristics of farming systems in NE Karnataka

In watersheds where the Karanakata Watershed Development Society (KAWAD) is working some of the key characteristics of farming systems include:

- Considerable **variation** between farmers (and farming families) according to location (between and within watersheds), size of farm, type of land (irrigated or rainfed), soil types and other factors, such as financial situation, aptitude, and family size, composition and health.
- Farming systems are generally **intensive**, with considerable recycling of internal inputs (for example, use of compost and manure, pongamia as green manure) and use of external inputs (especially seeds, hire of tractors and labour). All farmers in all categories used chemical fertilisers.
- Access to **water** for irrigation (even an acre) has a major impact on potential income and financial and food security
- Larger farmers produce a greater range of products and grow cereal grains for home consumption and sale, spreading **risk**. Small and marginal farmers are more vulnerable and mostly dependent on groundnut and off farm/ non-farm income for survival. These farmers often purchased staple foods from revenue from main cash crop. Serious impacts when poor returns to groundnut.
- Most marginal and small farmers, and some of the larger farmers, regularly use **loans** from landlords, merchants and co-operative societies at high interest rates. If harvest is poor there is a serious risk of indebtedness. Farmers who take loans are often forced to sell at harvest when prices are low.
- **Off-farm** and **non-farm activities** such as tailoring, labouring, commissioned sale of livestock, bicycle repair and hiring bullocks) are crucial to livelihoods of smaller farmers.
- Farming systems have evolved over a long period resulting in sophisticated **integration** of components. Cropping is dependent on manure (although all farmers used inorganic fertilisers) and draft from livestock, while livestock are dependent on crop straws as well as grazing of stubbles and grasses. House construction, cooking and the making of farm implements are dependent on

farm-grown trees. Some farms are less integrated than others with one weak component (e.g. few trees or no bullocks) making these families more vulnerable to stress (e.g. drought) and reducing the options available.
- A wide **variety** of food and cash crops are grown, but the number grown by marginal farmers in red soil areas can be as few as one (groundnut) grown in only one season (kharif). In contrast, a farmer with irrigation and black soils may grow up to 15 separate crops over all three seasons.

Many farming practices are traditional, but there is a keen desire to **learn** and **innovate**, especially amongst smaller farmers.

Source: Pound, 2000

Diversification both within agriculture, as well as including non-agricultural livelihoods, is an important strategy to reduce risk and cope with vulnerability, some of the key characteristics of livelihoods in semi-arid areas. Crop biodiversity provides farmers with a range of food and cashcrops. Permanagari China Narsamma, a woman farmer in Metlakunta village of Medak district, was growing 15 crops and 28 cultivars during kharif 2001 on a one acre plot, using farm yard manure, vermicompost, and neem cake. Innovative farmers like her could form the nucleus for farmer-to-farmer learning, that could involve researchers and extensionists in order to help bridge the gap between what farmers really need and are able to do, and the often inappropriate recommendations coming from the "official" R&E system (see Section IV for a further development of this idea).

Farrington & James (2000) discuss the diverse ways in which the poor earn their livelihoods in rural India and how watershed development projects can support diversification through short-term employment, forestry, pasture development, livestock development and micro-enterprise development.

However, as far as non-agricultural livelihoods were concerned, a general trend towards a reduction in livelihood options could be observed in the study villages as a result of diminishing demands for traditional goods and services and easy availability of industrially produced goods. While many SC members used to earn a living as cobblers, potters, blanket and basket weaver, etc., they now rely on agricultural labour and farming. Such small farmers often cultivate *inam* lands gifted by their former landlords, ceiling lands assigned by the government, or CPR lands encroached by them and subsequently regularised. On the other hand, technical innovations and urbanisation have resulted in different opportunities for those with more education (see Annex 2), such as working as drivers, clerks, and various SMEs. Project intervention often lead to new livelihood options, such as wage work on conservation projects, collection of seed of indigenous tree species for the forest department, or sale of vermicompost.

In Karnataka, a close relationship between number of livelihood options and village size was observed, as well as village accessibility and proximity to urban centres. Malligere, being the largest and best accessible village, offered a much larger range of livelihood options than smaller villages such as Koppalu (see also village profiles under section II.1 for details).

Migration, often over long distances to major urban centres such as Hyderabad, Bangalore, and Mumbai, is an important off-season activity when alternative local employment is not available. **(XXX VATTURI SRINIVAS AND PULAK / DDS, PLEASE LOOK UP MEDAK DISTRICT STATISTICS ON MIGRATION].** In the Karnataka site, migration affected mostly young educated men, who were finding employment in urban centres, and

who were often sending remittances home. The connectedness of strategies is important, for example, the investment of income derived from migration in agricultural activities.

Farming, and in particular more intensified farming systems, is clearly the key livelihood system associated with soil fertility issues. Pound (2000) described farming systems in semi-arid Karnakata as "a mixed farming system, dependent on the integration of livestock, crops, trees and off-farm/ non-farm activities in both private and communal lands, and symbiosis between landless and farming families". This includes farmers who need labour and manure, and landless who depend upon land for employment, stubble-grazing and crop by-products for their livestock.

Box 3 Farmers and Labourers

Agriculture is the mainstay of the overwhelming majority of Indian villages. Most of the land, however, is concentrated in the hands of a few large and well-off farmers, while about 80% of the farmers cultivate about 20% of the land. These are the poor and marginal farmers with land holdings below 1 hectare (2.5 acres), who often have fragmented land holdings (because of sub-division on inheritance), frequently of poor soil quality, and with limited access to water. Such farmers typically cultivate only one rainfed crop in kharif (sown in June-July). Studies have shown that it is extremely difficult for a farmer with 1 hectare or less of land – even given the best of seeds, agro-chemicals and water - to earn enough in a year to keep a family of 5 (the average family size here) to keep them above the poverty line.

Hence most of these farmers (and definitely their wives and daughters) look for alternative sources of livelihoods when they cannot cultivate their own fields. Earlier most used to work on larger farmers' fields as agricultural labour, especially during the second (rabi) and third (summer) cropping seasons. Some used to migrate to nearby towns and cities in search of work. More recently, however, migration seems to have increased. Villages in Andhra Pradesh (Dhone mandal, Kurnool district) report a shortage of agricultural labour because they are migrating to factories in nearby towns.

But it is not just the small farmers and their families who work on larger farmers' lands or migrate in search of work. About 20% of the typical village population comprises landless labour, who were available to work on larger farmers' fields. During the off-season, they also work as truck loaders in neighbouring towns, returning to their villages with daily wages. Today, several of them migrate for longer periods of time search of work outside the village.

Source: after James & Robinson, 2001

Farming is part of a livelihood system, in which activities and strategies are inter-connected, and such that inputs from soil fertility may be funded from sources outside of income generated from agriculture – through remittances or through subsidised government, private and third sector programmes. Previous farming systems analysis, such as Pound (2000), examines linkages with activities and enterprises beyond the farm, and hence there is considerable overlap between farming systems and livelihood analysis. The next section (and Box 2) describe some of the key aspects of farming systems in semi-arid areas. It does not aim to be comprehensive but focuses on aspects of most relevance to later parts of this report focused on soil fertility management.

I.3.3 Key aspects of farming systems

Perhaps the most important characteristics of semi-arid farming systems are the objectives or motivations of farming families. These include food security, insurance against risk, and

profit maximisation (Conroy *et al*., 2001). Other studies and field experiences have also shown that household food security is a major concern of farmers when deciding on their cropping pattern.. Farmers do not want to purchase their entire food needs from the market or the ration shop for two reasons:

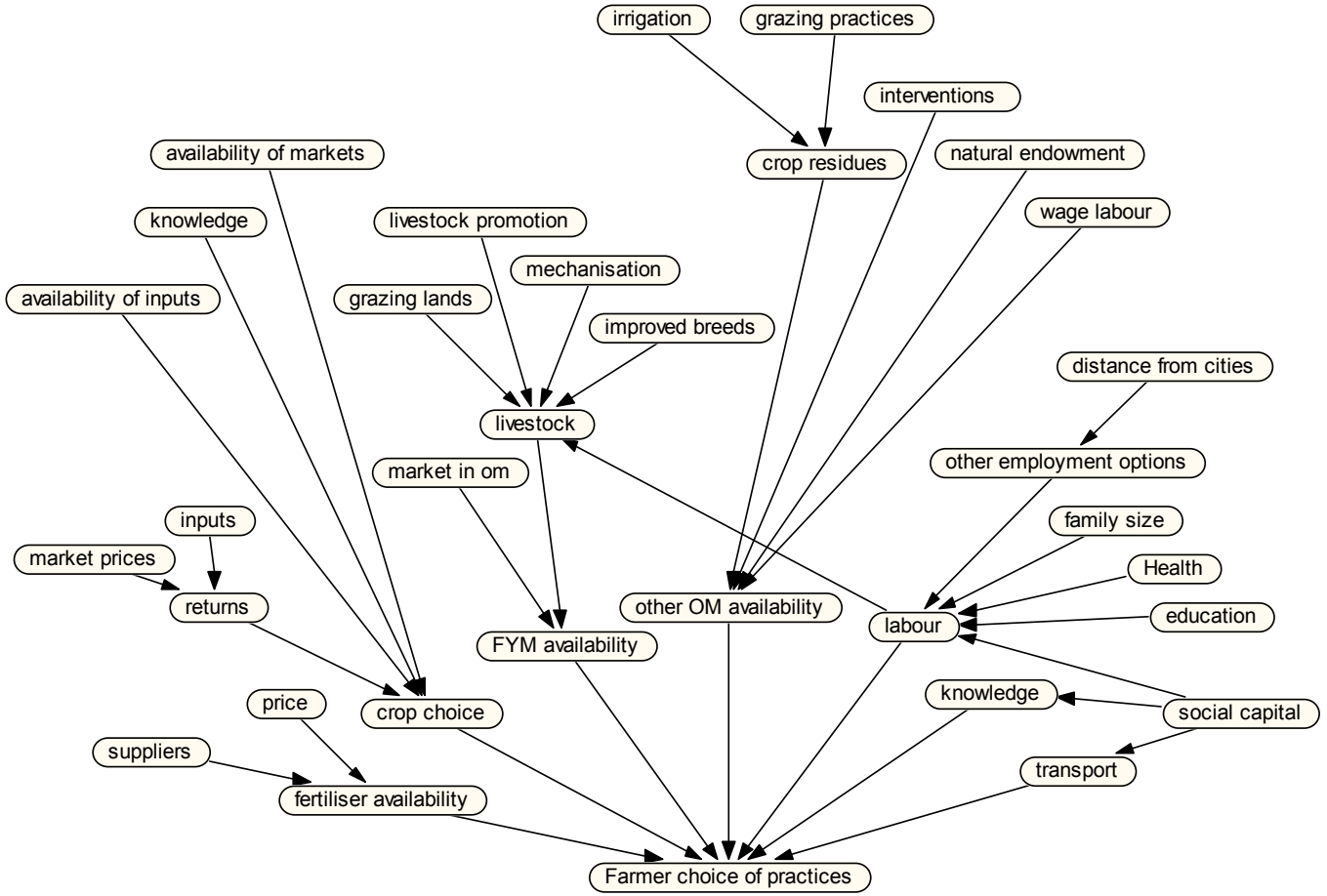
(1) Ration shops do not sell their preferred crops (sorghum in Medak and finger millet in Tiptur). The ration shops sell only rice and wheat, and even though rice is easier and faster to prepare than *roti,* and is often preferred by children, some farmers do not particularly like to eat it.
(2) Some farmers feel that these foods might not be safe to eat since they are not sure about the way they have been grown.

Therefore *most* farmers grow all the food they need. However, the case studies show that even small farmers (1 to 3 ha) are growing *some* cash crops, especially coconut in Tumkur, and often purchase some of their food grains from the market or through the PDS. Box 2 aslo shows that small farmers often grow cash crops and buy (some) of their food grain requirements.

Important risk spreading measures include diversification (Farrington & James, 2000). Gulati & Keeley (1991) showed that with respect to crops grown, farmers are on the whole most responsive to pricing factors. Prices for crops also determine the amount farmers invest in a particular crop, which has an important bearing on their soil fertility management strategy. In the study sites, farmers were growing both cash crops (in Karnataka mostly coconut, in AP mostly sugarcane), and food crops (in Karnataka finger millet and in AP sorghum). Small farmers are often able to plant a couple of coconut palms and water them manually, but sugarcane cultivation requires irrigation facilities, which are beyond the reach of small farmers.

The division into "cash crops" and "food crops" does not make much sense for small farmers in dryland areas, because they are most likely going to grow crops that can be both consumed by the family, or sold if there is a surplus. For farmers who sell very little of their produce, other factors (such as food requirements of the family and availability of labour) might be more important decision making criteria than price.

Figure 1 Factors affecting soil fertility management decisions (overview)



I.3.3.1 Access to land

The main land holding and tenure categories include land owners, tenants, share croppers, and encroachment on CPR lands. In both Karnataka and Andhra Pradesh past encroachment of wastelands has subsequently been regularised, and, in some cases, government investment utilised to improve these poor quality lands. The poor have smaller land holdings and are consequently more dependent upon wage labour and the use of common pool resources (CPRs for pasture, fodder, timber, and non-timber forest products. CPRs are diminishing in quantity and quality, which affects in particular the livestock specialists, who rely on CP grazing lands for their sheep and goat flocks. In both study sites, reduction in grazing lands (because of encroachment) emerged as one of the main reasons for the diminishing number of livestock, and in particular sheep and goats. Small ruminant herds are now being taken to far away grazing areas, reducing the availability of sheep and goat penning.

The average landholding in drought prone states is 2.6 ha (Conroy *et al*., 2001) but increasingly is not equally distributed. Most holdings are less than 2 ha in size and landholdings are often less than 1 ha. The poor have the least productive land and usually no irrigation so have generally not benefited directly from increases in land under irrigation (see Box 4). Landholdings are decreasing as a result of an increasing population, which provides pressure to intensify or diversify. There is a significant landless population, but the proportion varies from district to district. In the study villages in Karnataka, there were usually only a few landless families per village, but a large proportion of marginal holdings.

Land transactions are often linked to dowry payments and indebtedness. Farmers often have to sell land because of such crises.

A group of 15 farmers, the poorest group in the village Pastapur, came together to lease in a land of nine acres from a big farmer from the village, Mr Raghupati Reddy. All their life, these women had worked only rainfed lands, mostly marginal lands. For the first time, through the *sangham* they had formed with assistance from the Deccan Development Society, an NGO in the region, they had got access to credit to pay the lease amount of Rs. 27,000 @ Rs.9,000 per year which worked out to Rs.1000 per acre per year to the landlord to rent his land for three years.

This was truly dream come true. The land was large enough - nine acres. The soil was black. *Moga Bhoomi* – male soil as it is called in this region. There was an open well, which had a record of good water yields. The farmer was growing sugarcane, turmeric, ginger - all dream crops - on his land. Crops that are called *Moga pantalu*, male crops.

With dream in their eyes, the group took up agriculture on this land. They started growing potato on this land on the first year. In the summer of the second year, the water level in the well dipped badly. The well had to be deepened. This cost around Rs.9000. And then the motor pump got burnt. This meant a repair expense of Rs 2000.

The lease set back the women's group by five years. Not only that they did not get any profit, they had to invest some of their own previous savings to get out of the lease.

The conventional view held by development planners is that the absence of irrigation is the key hurdle in dryland farming and if irrigation is available it will save dryland farming from the obvious risks it faces. But the new and more formidable risks that accompany irrigation are overlooked: collapsing wells, falling groundwater levels in many areas, the undependable power supply and its dangerous fluctuations, frequent motor burnout and the costs involved. The mainstream development planners

have somehow ignored these aspects. But the experience of dalit women farmers of Pastapur village in Medak District of Andhra Pradesh disproves this conventional view.

Source: Deccan Development Society

I.3.3.2 Soils and land quality

The main soils in SAT India are alfisols (red soils) and vertisols (black cotton soils).

Key soil characteristics in SAT India include (Singh *et al*, 1998):

- Low soil organic matter levels due to rapid mineralisation, and inherently low fertility
- Nitrogen is universally deficit, followed by phosphorus, and then zinc deficiency on some locations. Potassium deficiency is rare in semi-arid areas.

The key question is whether soil fertility is really declining in SAT India, and if it is, whether this has any negative implications for people's livelihoods. Evidence from the literature suggests that soil productivity has improved, reflected in improved yields of dryland crops (Singh *et al*., 1998, see Annex 7). However, yield increases are not based on soil fertility alone, but reflect many other factors (such as better seed, better water management, etc.) and may be based upon 'mining' of nutrients. Also, the trends shown have been calculated across large areas, and it is well possible that areas with productivity decrease exist, but the overall trend is still positive due to high increases in other areas. They key question then is on whose land fertility might be declining - are they the poor and small farmers? A better question is where are people making SFM investments, what type of investments and what are the associated trends?

Farmers in the study villages did not complain about decreasing yields or declining soil fertility. However, year-to-year fluctuations in yields as a result of rainfall variation is likely to hide any medium- or long term trend in soil properties. These issues will be further discussed in section III.1.2).

I.3.3.3 Water

Water for irrigation is a resource of over-riding importance in terms of productivity, profitability and security (Pound, 2000). Irrigated yields and returns are much higher than for rainfed crops. Even one protective irrigation has a major impact. **(xxx SATHEESH IS HAVING SOME DOUBTS ABOUT THIS. JOHN, PLEASE CHECK WHETHER THIS STATEMENT COMES ALSO FROM BARRY'S TEXT AND WHAT THE EVIDENCE IS).** As well as greater returns to irrigated cropping, the number of crops during the year can also be higher. Batchelor *et al.* (2000) in NE Karnakata report irrigated vegetable net revenues of around Rs 10,000 per ha in rabi and Rs 18,000 in summer, compared to returns of around Rs 5,000 per ha for the most profitable rainfed crop - groundnut on red soils. They suggest returns on black soils are often less in this area, although these soils suit different crops.

However, farmers do not base their cropping decision only on the yield of the main crop, but also on secondary benefits such as fodder and other subsistence needs. For example, DDS reports higher potential returns for bio-diverse rainfed systems in Medak District, which place more value on non-grain components of production (such as edible weeds etc).

As discussed above, well over half of the land in SAT India is rainfed. Rainfed production produces more income and forms an important part of livelihood systems of a larger number of people (Batchelor *et al.*, 2000). Rainfed agriculture is also likely to be the largest user of rainfall (Batchelor *et al.*, 2000). Recommendations to improve the use of rainfall in rainfed arable cropping include reducing soil evaporation and increasing production per unit of water ("more crop per drop"), for example by selecting appropriate crops, and in-situ moisture conservation.

Access to irrigation can be an important route out of poverty for poor farming families, although there is the risk that higher returns will not compensate for the investments made in wells, pumps and other infrastructure. This is especially the case if rainfall is poor and groundwater levels fall due to overexploitation (see Box 4). However, for farmers without irrigation, access to irrigation is still the greatest dream. Watershed programmes have induced a false complacency that water resources could be vastly augmented to serve irrigated regimes in rainfed areas. The recent suicides committed by more than 500 farmers in Warangal district of Andhra Pradesh have been a shocking chapter in Indian agriculture. Small and marginal farmers, who invested in irrigation to grow cotton, were unable to suffer the losses as a result of low cotton prices and high input prices, and saw no way out of their dilemma other than to commit suicide.

I.3.3.4 Crop choices

In SAT regions, cereals are most important (59%) but declining in area, followed by oil seeds that have increased markedly to 23%, and pulses (18%) (Conroy, 2001). The rise of oil seeds, described as the yellow revolution, has received relatively little attention. However, the cost of oil seed production in India is relatively high, and producers have been hit hard in recent years by falling prices as the agricultural economy has been liberalised (Gulati and Keeley, 1991). There are also changing preferences, strongly influenced by the skewed promotional and lending policies of the government. These include shifts from coarse grains such as sorghum *(jowar),* finger millet *(ragi)* and maize to wheat (e.g. in Maharashtra) and rice (e.g. in Andhra Pradesh). But sorghum consumption still remains high in rural Karnataka and parts of Telangana district of Andhra Pradesh. Other trends include a shift towards cash crops (e.g. coconut in parts of Karnataka and sugar cane in Medak District of Andhra Pradesh).

What influences crop choice, and what is forcing change? Possible strategies include to minimise labour inputs (e.g. where there is an alternative income), economic decisions (e.g. market prices), food security, or strategies to mine nutrients from rented land, or to minimise water requirements/ maximise WUE (Seva Mandir, 2000 cited by Conroy et al. 2001).

The dynamics associated with changing crop choices and impacts are complex. In the study sites in Andhra Pradesh, diversity of cropping pattern was an important livelihood strategy, especially of resource-poor farmers. Contrary to Pound's observation in Karnataka (see Box 2), small and marginal farmers in Medak district often grow a larger number of crops than medium to large farmers. Some women utilised 20 to 30 different plants from a field of only 1 to 2 acres, including a number of uncultivated foods. The reasons they gave for this diversity are that it:

- Provides diverse and nutritive food to the family members at different stages of a season and throughout the year.
- Provides different kinds of fodder and feed to the livestock.
- Improves the soil fertility.

- Results in effective utilisation of farmland.
- Makes sure that under no conditions of unfavourable environment and climate, the whole crop is lost.

The differences between diversity in Tumkur and Medak might be explained by the fact that Tumkur is a wealthier district with larger proportion of people employed in non-agricultural activities, and higher returns to agriculture (especially from cash crops, such as coconut and areca nut). In Tumkur, the increasing area under coconut groves has had a direct impact on soil fertility management in drylands. Coconut has become a "prestige crop", and even small and marginal farmers attempt to grow at least a few trees in order to get cash income. Coconut groves also require less labour than dryland fields, making them an attractive option for families with labour shortage (for example, elderly people whose children have migrated). But they compete with dryland crops for organic matter (especially FYM). The decision-making processes related to allocation of organic matter between different types of fields and crops are discussed in section III.1.3.3.

Besides these inter-site differences, there is a large variation between farms within one village, depending on their family composition, holding size, and other assets.

I.3.3.5 Livestock

Roughly 70% of rural families in India own some livestock (Conroy *et al*., 2001). And at a national scale, livestock populations are increasing (and demand for livestock products is projected to increase strongly). However, at a regional scale, and within the semi-arid areas in particular, the situation is very different and much more complex. Within Andhra Pradesh for example, livestock increases are focused in coastal areas (and peri-urban areas). In both northern Karnataka and western Andhra Pradesh livestock populations are falling.

The poor favour small ruminants especially goats and local breeds of milch animals. Although poor families tend to own few cattle, the numbers of poorer families owning cattle are apparently increasing as a result of government and NGO schemes, especially for SC and ST families. Usually unsecured grazing rights are a major constraint, affected by expansion of cultivated lands into grazing areas. However, poorer people make up for this by bringing back fodder from the fields where they go for weeding.

Trends in Andhra Pradesh (Conroy *et al*., 2001) include an absolute decrease of large ruminants, but a relative increase in buffaloes as well as goats. Reasons include the lesser importance of animals as a source of draught power in cultivation (although they remain vital for poor farming families) and pumping water, reduction in farm size, declining area of CPR lands (Conroy *et al*., 2001) and changing patterns in labour availability. This has important implications for the availability of manure. In NE Karnataka, Pound (2000) reports a large reduction in all livestock from the 1940s to present associated with increased intensification. Tanner *et al.* (2000) describe a shift to stall feeding as cropping is extended. This impacts on access of the poor to manure, because they can no longer collect manure from common grazing lands.

These trends were confirmed during fieldwork. An overall decrease in livestock populations at the village level was accompanied by a "re-distribution" of livestock within the community in both sites. Larger farmers generally reduced the number of livestock because of (a) increased availability of mechanised tillage, (b) shortage of labour for herding because of social changes (increased scholarisation at all levels of society and decreasing prevalence of

bonded labour-type relationships, accompanied by increasing "emancipation" of parts of the so-called "weaker sections of society"), (c) diminishing areas of grazing lands for sheep and cattle, and forests for browsing of goats, and (d) in some areas insufficient milk marketing facilities (even though demand for milk in urban areas is increasing). At the same time, small farmers often managed for the first time to acquire one or two heads of livestock and were able to stall-feed these animals. The increased ownership of bullocks by small farmers in Medak district has enabled them to lease in land for cultivation from larger farmers, who do not have enough labour and livestock to cultivate these lands.

I.3.3.6 Inorganic fertiliser use

Increased fertiliser use has been one of the main drivers in productivity gains in agriculture in India. India-wide, use has increased from a total 0.07 million tonnes NPK (N+P2O5+K2O) arond 1950 to 18.4 million tonnes in 2000 (http://www.fadinap.org/india/consumption-n.htm accessed 2/8/01). This was equivalent to 0.55 kg/ha in 1950 compared to 90 kg/ha in 1999 (http://www.fadinap.org/india/perhectare-con.htm accessed 2/8/01). The major fertilisers by volume consumed are urea, SSP, MOP, and DAP. However, consumption has been heavily focused on irrigated areas.

Singh *et al.* (1998) reviewed studies that have assessed inorganic fertiliser use in dryland SAT districts. Inorganic fertiliser use has increased but remains generally low on rainfed crops. Approximately only 10% of total use (or 10 kg NPK/ha/yr on average) is on rainfed crops. Higher application rates are typical for some cash crops such as cotton. However, there is generally poor information on actual (inorganic) fertiliser use rates, and also on information on actual organic inputs.

In the fieldwork sites, almost all farmers used inorganic fertiliser on their dryland crop, mostly NPK at low rates of application (NEED TO ADD SOME FIGURES FROM CASE STUDIES). Fertiliser use has increased as a result of expanding areas under cultivation, increased cropping intensity, easy availability of fertiliser even in remote villages, and reduced availability of traditional nutrient inputs such as FYM. This is further discussed in section III.1.3.1.

Fertiliser production costs are high (and producers inefficient) and the government subsidises producers in order to make sure fertiliser is available to farmers at low controlled prices (even so prices have risen and are out of reach of many farmers). Decontrol of the fertiliser industry is currently an important political issue. Potassium and phosphate fertilisers have already been decontrolled.

Other issues associated with fertiliser use include:

- Adulteration concerns - fertilisers are often reported to have lost their 'potency'.
- The important links between use of fertilisers and other inputs such as improved seeds and irrigation.
- Concerns of farmers about the loss in soil quality in drylands when chemical fertilisers are used.

Money to buy inputs (seeds, fertilisers, pesticides etc.) is often obtained as loans from moneylenders at high interest rates. Farmers are often obliged to sell back crops at low prices, and indebtedness to moneylenders is a major problem (Conroy *et al.*, 2001). In the study

areas, farmers often sold valuable FYM in order to meet cash needs, and using part of the income for the purchase of chemical fertiliser. This trend reflects the high value given to organic inputs, especially for certain high-value crops such as spices, ginger, vegetables, potatoes, etc., and the easy availability of subsidised chemical fertiliser, which induces people to sell a valuable resource they would otherwise have utilised on their own land. (SATHEESH TO ADD BOX "***LISTEN TO FARHATPUR PENTAMMA*** ")

Chemical fertiliser is subject to aggressive promotion by the government and commercial salesmen. It is associated with government-promoted interventions that include the introduction of chemical responsive varieties in crops like sugarcane, sunflower, potato, cotton etc. Most of the seeds and subsidies for these crops come with a package of fertilisers and pesticides. If one accepts the crop, one also accepts the package. This leads to a treadmill effect, from which to escape is nearly impossible. Coupled with these interventions are the financial lending policies. Only if a farmer grows the crops prescribed by the government can he or she get credit. And if one grows the prescribed crops, one has to follow the prescribed package. **[xxx SURESH, PLEASE LOOK AT THE FOLLOWING:**

- **WHAT SUBSIDIES AN PACKAGES DOES CANE DEVELOPMENT COMMITTEE IN ZAHEERABAD OFFER?**
- **WHAT ARE THE NABARD'S RULES FOR CROP LOAN? WHAT CROPS CAN A FARMER GROW AND WHAT NOT TO MAKE HER/HIM ELIGIBLE FOR THE LOAN. IF SHE/HE APPLIES FOR AVAILABLE LOAN, WOULD IT MAKE IT NECESSARY FOR THE FARMER TO FOLLOW A PACKAGE?**
- **IN GOVERNMENT PROGRAMMES LIKE, DRDA, DPAP ETC., WHAT ARE THE CROPS ENCOURAGED AND WHAT DOES THE AGRICULTURAL DEPARTMENT RECOMMEND? SINCE THE DRDA AND DPAP GO BY THE ADVICE OF THE AGR DEPARTMENT, HOW MANDATORY IT IS FOR THE FARMER TO ACCEPT IT?**
- **WHAT ARE THE AREAS IN WHICH THE AGRICULTURAL EXTENSION AND AGRICULTURAL RESEARCH FOCUSSED UPON?**
- **WHAT DOES ICAR ASKS K V K s TO DO IN TERMS OF AGR EXTENSION?**

Moreover, every time a natural disaster like excessive rains or floods or famine affects the farmers, the relief that government makes available comes only in the form of so-called improved seeds and a bag of chemical fertiliser. One of the most important facilities that farmers perceive in the chemical fertiliser use is the ease of operation. It does not need raising a heap all through the year, no need to hire a bullock cart to transport it to the field, no need to hire labour to load, unload and spread it on the field. In comparison chemical fertilisers are easy to use. The bags can be transported to the field on a bicycle or sometimes even on people's backs, and one person can spread it on the field. Moreover, it can be purchased on credit at a subsidised rate.

However, farmers in the study sites were highly aware of the negative impacts of the exclusive use of chemical fertilisers on soil properties and yields. Their observation included that (a) the soils become "addicted" to fertiliser and that no crop will grow any more without fertiliser application, (b) increases in pest and disease incidence and reduced "resistance" of the plant to this, (c) negative impact on people's health as a result of consuming crops grown with chemical fertilisers, (d) . PAGE: 15 (XXX I THINK THERE WERE SOME MORE ISSUES RAISED BY FARMERS - NEED TO CHECK THESE.)

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I.3.3.7 Markets and prices

As discussed earlier, prices and markets for produce influence farmers decisions related to cropping pattern and cropping strategy. While markets in SAT India are well developed for most agricultural produce, recent price trends have impacted on incomes from dryland farming.

Key market factors include:

- Crop prices have often not met rising costs of production, resulting in lower margins for example the cost of urea increased from Rs2760 (exclusive of local taxes) in 1992-93 to Rs 4000 in 1998-99 http://www.fadinap.org/india/Retail.htm.
- Prices of oil seed crops in particular have fallen with severe impacts on farmers, for example, groundnut farmers in Anantapur (Conroy *et al.,* 2001).
- Irrigated agriculture remains much more viable although costs are also increasing and risks are high.
- Coconut (copra) prices have dropped in Southern Karnataka, resulting in farmers storing copra on-farm beyond the optimum storage period (often leading to reduction in quality), and cash income from copra dropping radically.
- The non-availability of dairy co-operatives or milk selling points in the more remote rural areas is one of the contributing factors to the reduction of livestock numbers, which impacts directly on FYM availability.

I.3.3.8 Key policies

(XXX THIS WILL NEED TO BE SUPPLEMENTED BY FINDINGS FROM THE POLICY REVIEW, WHICH IS STILL BEING WRITTEN.)

Some of the key policies influencing soil fertility management strategies are:

- Changes in cropping pattern as a result of market forces, changes in food habits, government programs to promote oil seed production, etc.
- control of fertiliser prices – the fertiliser industry receives the subsidy, not farmers (who benefit from lower prices), however there is pressure to reform system and decontrol prices,
- subsidies on feeds (Tanner, 1997),
- food policies (e.g. the public distribution system that can facilitate switches to cash crops),
- irrigation development,
- electricity pricing – especially the availability of cheap electricity for pumping groundwater (there is the major use of electricity in India).
- WTO-related policies, impacts on crop prices and choice

I.3.3.9 Institutional issues / AKIS

Institutional support in terms of generation and dissemination of appropriate technological options is a key factor in sustainable soil fertility management.

(XXX NEED TO INCLUDE:
- RESEARCH (SRINIVAS' REVIEW)
- SOIL TESTING FACILITIES (EXTENSION STAFF RECOMMENDATION)
- ATTITUDE ISSUE (AWARENESS CREATION, LITERACY VS. GOOD ACTUAL PRACTICES)

II VILLAGE PROFILES

II.1 Karnataka

II.1.1 Overview - Karnataka state

Karnataka State, situated in Southern India, is the eighth largest, both in size and population, of the 28 States. It spans the South Western portion of the Deccan Plateau including a Southern portion of the Western Ghats and has access to the Arabian Sea of the Indian Ocean. Following are the minerals that are mined in the State: Iron, manganese, copper, limestone, gold and silver. Industries produce or process the following products: iron & steel, cement, paper, sugar, *vanaspathy*, soap, sandalwood, cotton cloth, silk, cigarettes and urea. About 75 percent of the work force in the state are engaged in agricultural sector. About 50 percent of them work on their own land, the balance are landless and primarily work as seasonal labourers (DES, 1993) Land holdings are characterised by strong fragmentation resulting in small farm sizes.

Karnataka State is divided into nine agro-climatic zones namely, North- Eastern Transitional Zone, North -Eastern Dry Zone, Northern Dry Zone, Central Dry Zone, South- Eastern Dry Zone, Southern Dry Zone, South Central Dry Zone, Northern Transitional Zone and Coastal Zone

Around 8 percent of the 19.1 million hectares under cultivation in Karnataka are cropped more than once per year. Only 1.6 percent of the land under cultivation is dedicated to perennials (fruits, plantation crops etc.). about 16 percent of the land are dedicated to forestry and most of these lands are owned by the Government. Of the 2.3 million hectares under irrigation, 53 percent are irrigated from dams and tanks, 34 percent rely on subterranean supplies (bore holes, wells etc.) and 13 percent on other sources. Major crops grown in the State are Paddy, Sorghum, Finger millet, Pearl millet, Pigeon pea, Green gram, Groundnut, Coconut, Cotton, Sugarcane, Chilli and Tobacco. (DES, 1993).

Tumkur is located in the eastern belt in the southern half of the state with an area of about 10598 sq. km. The landscape consists mainly of undulating plains interspersed with a sprinkling of hills. There are two parallel hill ranges running North to South; the first of these in the eastern portion passes through Pavgada, Madhugiri, Koratgere and northern part of Tumkur taluk. The second range mainly composed of shistose rodes, passes through the western parts of the district in the taluks of Chiknayakanahalli, Sira and Gubbi. There is another cluster of hills covering the middle and the southern part of Kunigal taluk.

Finger millet (ragi) is the most extensively cultivated crop of the district. It is grown in all the taluks as rainfed crop. The other crops grown include paddy, sorghum (jowar), horse gram, pigeon pea (red gram) etc. Coconut, groundnut, chilli and mulberry are the main commercial crops. Areca, tobacco, chickpeas (Bengal gram), castor are also raised in some parts of the district.

The other study district Hassan, is located in the south western portion of the State with an area of 6814 sq. km. The landscape consists mainly of undulating plains with a general elevation between 780 to 930 Mts. The district lies partly in the southern malnad region of the state. It also contains a transition zone termed as semi-malnad region. The malnad is a hilly

forest characterised by a heavy to very heavy rainfall. The southern malnad is bounded by 650 m contour and characterised by a higher degree of slope.

Of the total geographical area 59.5% is cultivated area. Coffee, cardamom, pepper, Arecanut and coconut are the main cash crops. The main agricultural crops include Ragi, paddy, pulses, sugarcane, groundnut, potato and Chilli. The district is noted for the production of fruits and vegetables. Mango is an important fruit crop. Banana and orange are grown in large quantities in Manjarabad and Belur taluks. The taluks, Arkalagudu, Hassan, Arsikere and Holenarsipura are noted for vegetable production. Tobacco, Bengalgram, Castor are also raised in some parts of the district. Some additional statistics of the study districts is presented in the table below:

Tble 2 Some background statistics on study sites in Karnataka

Parameters	Tumkur	Hassan
POPULATION (no.)		
Total	2,305,819	1,569,684
Rural	1,923,656	1,296,962
Urban	382,163	272,722
Male	1,177,233	785,144
Female	1,128,586	784,540
Growth rate (%) {1981- 1991)	16	15
Population Density (per sq.km.)	218	230
Literacy (%)	54.48	56.85
RAINFALL (in mm)		
Normal	688	1031
Actual	694	1284
LAND UTILISATION (ha.)		
Forest	44,984	54,039
Land put to non-agricultural use	547	75,487
Barren	67,539	31,550
Cultivable waste	66,388	21,332
Permanent pasture	101,477	36,532
Fallow land	78,712	71,784
Net area sown (NAS)	602,967	365,570
Area sown more than once	35,868	47,449
Total cropped area	638,835	413,019
AREA UNDER DIFFERENT CROPS (ha.)		
Paddy	40,801	63,942
Finger millet	188,242	126,719
Sorghum	5,241	4,009
Total millets	243,132	199,715
Gram	495	3,510
Pigeon pea	13,659	2,880
Other pulses	48,505	52,503
Total pulses	62,659	68,893
Ground nut	184,671	4,972
Coconut (no. in 1000)	80,216	NA
Total oil seeds	204,005	NA
Cotton	1,000	5,652
Sugarcane	1,755	3,342
IRRIGATION (ha.) ***Net irrigated area by:***		

Parameters	Tumkur	Hassan
Canals	4,383	30,502
Tanks	21,186	24,385
Wells (include borewells)	517,364	12,778
Other sources	231	5,739
LIVESTOCK (1997 provisional nos.)		
Cattle	578,305	615,161
Buffalo	259,622	203,646
Sheep	874,598	202,422
Goat	364,627	111,018
Total ruminants	2,248,583	1,226,280
Poultry	876,204	760,307

Source: SPINFO – Karnataka Information software, *Dist. Gazetteers of India*

II.1.2 Bommenahalli

Bommenahalli is one of the project villages for BAIF and as such several technologies have been introduced to this village. In addition, the labour force in the village is highly diversified in their skills. The occupation for majority of the population continuous to be agriculture on their own land, as one family is landless. 30 families still continue to earn wage labour in addition to their own agriculture. Neem seed collection and sale is a unique feature in this village. Opening of the dairy cooperative society a few years back has given an opportunity for 20 families to get engaged in milk production. Because of want of access to bank or cooperative societies the farmers continue to depend on moneylenders for the credit needs.

II.1.3 Malligere

This is fairly a large village. There are good educational facilities created over time. There are good transportation facilities created and there are several busses passing through the village daily. The market place is also with in 3 Km at Matthigatta. The village also attracts a large number of people from out side because of a famous temple in the village. This has induced a very different culture of cosmopolitanism in the village.

Several educated persons from the village have migrated to big cities like Bangalore. More than 100 families depend on the salaried jobs either in the big cities or in the near by towns. Such farmers have leased out their lands to others in the village. 26 families depend on the leased lands for heir sustenance. There are also a few small-scale industries in the vicinity, which have diverted the agricultural labour to non-agricultural employment. These contacts with the outside world have helped the people to broad base there livelihood opportunities.

There are several shepherds' villages in the area. The farmers used to depend on sheep penning to a great extent for fertilising their fields, especially coconut gardens. Though this practice is still prevalent in the village the dependency on sheep penning has come down due to accessibility of other options and reduction in the sheep flocks in the area. The village also boasts of 4 tractors. These tractors are playing a very important role in agricultural operations such as transportation of manure and silt to the fields. Even the families who cannot afford to maintain bullocks and a cart many times depend on hiring the tractors for ensuring timely supply of these critical inputs their fields. The tractors are also hired for ploughing the fields and transportation of the agricultural produce to the market. Introduction of tractors and borewells into the area has impacted on the pattern of cropping and employment in the area.

Some farmers have intensified the cropping especially in the coconut orchards with water facilities. It is interesting to note that introduction of more submersible pumps in the area have stimulated to open shops for repair of the failed pumps in the area. 6 families depend for their livelihoods on this occupation.

Cattle keeping is a very important avenue for earning livelihood for many families. There is also good marketing access for the milk produced in the village.

II.1.4 Laxmanpura

The following factors have had significant influence on the livelihood patterns of villagers of Laxmanpura:

- Increased education level
- Decreased forest area
- Increased prices for coconut
- Decreased ground water situation
- Changed cropping pattern
- Adequate infrastructure facilities like roads,
- Access to milk marketing avenues

In Laxmanpura village people used to have access to the nearby forest area from where they used to get fuel, non-timber forest produce, fodder (Grazing), etc. The cattle and other livestock population in the village is slowly declining for want of access to grazing facilities as the nearby forest area was declared as reserved forest and entry was restricted. This has resulted in loss of employment opportunities through livestock maintenance and increased dependence on outside inputs for fertilising their fields. The mass grazing practices in the villages have come down. Off late opening of a dairy society in a nearby village has opened up opportunities for sale of milk. This is likely to trigger induction of more crossbreds into the village. At present only 10 families are dependent on sale of milk for their livelihood. Only 10 families are keeping sheep and goat. This activity is restricted to only those families where spare manpower (especially old people) is available to herd the small number of sheep and goat in the village commons.

The villagers have access to education facility with a primary school in the same village and high school in the nearby village within 3 km. This has resulted in large number of educated youth who seek out opportunities of employment outside. Consequently the labour force available in the village is not adequate enough to address the labour requirement for carrying out the routine dryland agricultural operations. There is increasing trend for people to convert their drylands into coconut orchards, which requires less labour for maintenance. This is also triggered by easy access to credit for investment in water resource development, which is crucial for promoting coconut orchards. This increased coconut cultivation has created specialised employment opportunities for 20 families to get engaged in harvesting of coconut and de-husking of dried coconut.

This is a project village of BAIF and hence people have ready access to information and other critical inputs for improving their farming conditions. Almost 50 families produce vermi compost.

None of the villagers are presently engaged in minor forest produced collections except collection of beedi leaves for beedi making. 6 families are engaged in this occupation.

II.1.5 Koppalu

This is a village situated quite interior away from main road. They don't have regular access to many civic facilities such as schooling etc., Access to dairy society has made about 30 families to depend on dairy activity for their livelihood. There are not many other vocations available for employment in the village except depending on traditional agricultural crops, agricultural labour. Almost every family depends on agricultural labour in addition to working in their own agricultural fields. Goat rearing is also not popular except in 3 families as there are no village commons available for grazing.

- Village background (make sure does not overlap with 1.3) - including dynamics, such as changes in cropping pattern etc.
- Livelihood strategies (and changes over time)
- Soil fertility management strategies (and changes over time)
- Point out differences between villages and within villages (different types of farmers)

II.2 Andhra Pradesh

The Deccan Development Society, one of the partners in the research, selected four villages for the study, in the Zaheerabad region of Medak district of Andhra Pradesh where the organisation is operating. The area lies in the heart of the semi-arid tract and is highly representative of the issues that the study wants to address.

II.2.1 Medak District of Andhra Pradesh

II.2.1.1 Location

Medak, one of the ten districts of Telangana region of Andhra Pradesh, lies between 17^0 27'' and 18' 18" Northern latitude and 77^0 28" and 79' 10" Eastern longitude**.**

The total geographical area of the district is 9,699 Sq. km, accounting for 3.5% of the total area of the state. The district has 1265 villages and ten towns, with a population of 22,64,124 (1991 census). The district is surrounded in the North by Nizambad and Karimnagar districts, on the East by Warangal and Nalgonda districts, on the South by Ranga Reddy district and on the West by Bidar district of Karnataka state.

II.2.1.2 Geographical Profile

Medak district forms part of the tableland of the Deccan Plateau, and is crossed by different ranges of hills. The land is made up of plains, gentle slopes and undulating hills. Isolated peaks and rocky clusters lie scattered all over the district. The elevation of the ground in the district is between 500 m – 600 m with occasional hills up to 638 m above Mean Sea Level.
The hills that are of considerable size in the forest division are in a state of erosion because of reckless felling and indiscriminate grazing.

<u>Soils</u>

The soils of the district are mainly red earths comprising loamy sands, sandy loams and sandy clay loams. Red laterite soil is predominant in Zaheerabad taluk. Black cotton soils comprising of clay loams, clays and silty clays are found in Sangareddy, Andole, Narayankhed, and Narsapur taluks.

The red soils are generally non-saline and non-alkaline while the black soils are moderately alkaline with a highly soluble salt content.

Rivers

The district does not have a main river. The Manjira, a tributary of the Godavari, is the only important river. Manjira rises in Bidar district of Karnataka State, and enters Medak district in the South-East. The river touches the district headquarter town of Sangareddy, takes a 'U' turn and joins the Godavari in the adjoining Nizamabad district, making a journey of about 100 Kms in the district. There are three projects constructed across the river. The oldest project is the Manjira barrage near Sangareddy. It has been constructed mainly to store water for the drinking water needs of Hyderabad city.

Recently, another reservoir called the *Singnoor project*, 30 Kms upstream of the Manjira barrage, has been completed. The water stored is being used to meet the drinking water needs of Hyderabad and adjoining areas.

Irrigation Sources

The chief sources of irrigation in the district are the Ghanpur Ayacut, the Rayanpalle project, the Gangakathwa project, the Beglempalli (Bogulapalle) project, and the Peddavagu project. The undulating character of the terrain of the district, lends itself favourably to irrigation from canals, tanks, wells, and streams. The Net irrigated area in the district is 1,27,617 hectares, of which canal irrigation accounts for only 3.3 percent; the remaining irrigation is through open wells and bore wells.

Climate

The climate of the district is characterised by a hot summer and generally dry weather, with some pleasing showers, expected during the south-west monsoon season. The year may be divided into three seasons, viz., Winter season (November-February), Summer season (March-May) and South-West monsoon season (June-October).

Rainfall

The rainfall during the South-West monsoon months amounts to about 84% of the annual rainfall. July is the rainiest month. The average annual rainfall in the district is 896.7 mm. The heaviest rainfall in 24 hours recorded at any station in the district was 307.3 mm at Sangareddy in September, 1908.

Temperature

May is the hottest month with the mean daily maximum temperature of about 40^0 C. With the onset of the South-West monsoon in the middle of June, temperature decreases appreciably and the weather becomes more pleasant.

December is the coldest month with a mean daily maximum temperature of about 29^0 C and a mean daily minimum temperature of about 14^0 C. During the cold season, the night temperature may some times go down to about 6^0 C.

II.2.1.3 Ecological Profile

Forest Vegetation

The district forests are of Southern Tropical Dry deciduous type (Champion & Seth, 1968), and account for 9.9% of the total geographical area. The forests are grouped into only one division i.e. Medak, which includes 6 ranges.

The forests are further classified into Dry mixed deciduous type, Dry deciduous type and Dry savannah type. Locally, the forests are sub-classified by the forest officials as teak type (Teak over 40%), mixed teak type (Teak 10% to 30%), and mixed type (Teak less than 10%), depending on the abundance of teak in the forests.

Uncultivated foods

The Common weeds/Uncultivated foods of dry and cultivated fields, and dry irrigated fields aquire importance in terms of soil fertility and crop management since they are directly related to the fertility of the soils and the kind of fertility practices employed. Lands on which chemicals are used, uncultivated foods are absent. Those lands where crops are grown organically also host a range of uncultivated foods which include: *Amaranthus polygamus, solanum nigrum, Merremia emarginata, Alternanthera sessils, cassia tora, Trigonella foenumgraecum, Oxalis corniculata, Achyranthes aspera, Leucas aspera, Trianthema decandra, Boerhavia diffusa, Amaranthus viridis, Abelmoschus ficulneus, Acanthospermum indicum, Acalypha indica, Ageratum conyzoides, Alysicarpus rugosus, Amaranthus spinosus, Amischophacelus axillaris, Argemone mexicana, Celosia argentea, Cleome gynandra, Chenopodium album, Corchorus aesuans, C. fiascicularis, C. trilocularis, Crotalaria laburnifolia, C.retusa, Cynodon dactylon, Cyperus rotundus, Desmodium triflorum, Digera muricata, Eragrotis atrovirens, E. viscosa, Euphorbia geniculata, E. hirta, E. indica, Justicia spp., Lagascea mollis, Leucas aspera, Melilotus indica, Merremia emarginata, Panicum repens, Partehium hysterophorus, Phylanthus amarus, Physalia minima, Portulaca oleracea, Rorippa indica, Sphaeranthus indica, and Trianthema portulacastrum* etc.

Agro Ecological Zone

The district of Medak falls under zone III and IV of the agro ecological zones classified in Andhra Pradesh. These two zones are characterised by hot and dry summers and very mild winters. The mean annual rainfall ranging between 700 mm to 1000 mm covers 42-60% of mean annual evapo-transpiration potential of 1000-2400 mm. The moisture availability period ranges between 120 to 150 days.

II.2.1.4 Cropping systems of Zaheerabad region

Zaheerabad region of the Deccan area hosts an enormous agricultural diversity/ On an average, each acre of farm expressly those belonging to small and marginal farmers, hosts 8-10 varieties of various crops. Even today, there are women farmers like Manemma of Gangwar village, Permangari Narsamma of Metlakunta village, Anjamma of Gangwar village, Ramulamma of Shamshuddinpur village who cultivate nearly 20 - 30 varieties of crops in an area of 1-2 acres each. The reasons for this huge diversity in their farms as explained by the farmers are as follows:

- Provides diverse and nutritive food to the family members at different stages of a season and also throughout the year.
- Provides different kinds of fodder and feed to the live-stock.

- Improves the soil fertility.
- Results in effective utilisation of farmland.
- Make sure that under no conditions of unfavourable environment and climate , the whole crop is lost.

Different farmers follow different cropping systems depending upon their situation. They can be classified into *high diversity* farms, *medium diversity* farms and *low diversity* farms. The following cropping systems are prevailing in red and black soils in Kharif and Rabi season under rainfed conditions gives us an idea about the amount of agro-biodiversity in the region.

Table 3 Crops grown in different types of farm in Andhra Pradesh

Farm type	Crops grown on the farm
1. Red soils: Kharif rainfed	
High diversity farms	1. Redgram (4 varieties: *Erra thogari,Tella thogari,Nalla thogari and Burka thogari*) + Jowar (5 varieties: *Gundu jonna,Thoka jonna,Tella mallejonna,Garib jonna and Erra Jonna*) + Field Bean (3 varieties: *Tella Anumulu,Erra Anumulu and Nalla Anummulu*) + Cow pea (2 varieties :*Tella Bebbarlu and Erra bebbarlu*) + Hibiscus(3 varieties: *Erra pundi, Nalla pundi and Tella pundi*) + Bajra + Sesamum + Niger + Foxtail millet (3 varieties: *Tella Korra,Erra korra and Nalla korra*) + Finger millet + Kodo millet + Horse gram.
	2. Jowar + Bajra + Red gram+ Hibiscus + Field bean + Cow pea + Green gram + Black gram.
	3. Green gram + Jowar + Field bean + Cow pea + Hibiscus
	4. Ground nut + Jowar + Field bean + Cow pea + Gingelly + Hibiscus.
Medium diversity farms	5. Jowar + Bajra + Hibiscus.
	6. Gingelly + Jowar + Red gram
	7. Dry land paddy + Finger millet
Low diversity farms	8. Niger
	9. Bishop's weed (Voma)
	10. Sun Hemp
	11. Horse gram
Black soils - Kharif rainfed	
High diversity farm	1. Redgram (4 varieties: *Erra thogari,Tella thogari,Nalla thogari and Burka thogari*) + Jowar (5 varieties: Gundu jonna,Thoka jonna, Tella mallejonna, Garib jonna and Erra jonna) + Field Bean (3 varieties : Tella Anumulu,Erra Anumulu and Nalla Anummulu) + Cow pea (2 varieties :Tella Bebbarlu and Erra bebbarlu) + Hibiscus (3 varieties: Erra pundi ,Nalla pundi and Tella pundi) + Green Gram (4 varieties: Kidki Pesari ,Theega Pesari,Baandari Pesari and Manchi Pesari) + Black gram (3 varieties: Manchi minumu,Sarkar and Nunupu minumu) + Bajra + Sesamum + Foxtail millet (3 varieties: Tella Korra,Erra korra and Nalla korra) + Finger millet + Kodo millet + Horse gram.
Medium diversity farms	2. Red gram + Jowar + Field bean + Cow pea + Black gram
	3. Red gram + Jowar + Field bean + Cow pea + Hibiscus + Green gram
Low diversity farms	4. Black gram + Manchi Pesalu + Gingelly + Hibiscus
	5. Green Gram + Saijonna (for fodder only)
	6. Sunflower

Livestock

Next in importance to crop agriculture is the livestock wealth in the district. It consisted of animals used for production of milk and draught power in agriculture. The cattle population has decreased in number from 5,95,163 in 1987 to 5,12,700 in 1993-94, about 14% reduction within seven years. The unpublished live stock census data for the year 2001 further confirms this reduction in cattle population. The decline directly affects the various agricultural processes and the availability of farmyard manure whose scarcity is negatively affecting the soil fertility by depleting soil nutrients and organic matter content, thereby lowering the overall soil productivity.

II.2.1.5 Socio Economic Profile

Medak has a total population of 2,269,800 persons of whom 1,117,720 are female constituting a percentage of 49.24. Of this population, 1,941,310 live in rural areas, constituting a hefty 85.52%. The district registered a population growth rate of 2.56, bringing a population density of 234 persons/sq.km. Dalits [the caste which occupies the bottom of the socio economic hierarchy of the Indian caste system] form 17.5 % of the population in the district and scheduled tribes are 4% of the population. In the Zaheerabad region where the study was taken up, dalits form nearly 20% of the population and STs 2.75%.

Medak has a huge work force, which stands at 47.78 %, almost half the population. Of this, 78% are agricultural workers, making soil fertility a major livelihood issue. The irrigated area as percentage of cropped area is less than 30%. Of this canal irrigation is a miniscule 3%. The only river that flows through the district is dammed to supply drinking water to Hyderabad, depriving the local people of the benefit of irrigation. In spite of all these handicaps, and the predominance of rainfed agriculture and semi-arid environment, the district produces 160 kg per capita food grains, which is a testimony to the strength of the farming systems practised by the farmers.
An overview of key features of study villages in Andhra Pradesh is shown in Table 4 on the next page.

Table 4 Background data of study villages in Andhra Pradesh

No.	Item of information	Name of the villages				District
		Yedakulapally	Metlakunta	Gopanpally	Lingampally	
1. a)	Population • Male • Female • Adults • Children	2120 1145 975 1736 284	3165 1692 1473 2641 524	2513 1316 1197 1879 834	1681 899 782 1305 376	2,269,800 1,152,080 1,117,720 Growth rate : 2.56%
1. b)	Caste • O.C • B.C • S.C	 652 849 619	 501 1579 1085	 288 1279 946	 247 807 627	
2.	Livelihoods (major)	Agriculture Agricultural labour			Agriculture Agricultural labour Stone cutting	Agriculture Agricultural labour.
3.	Crops grown and cropping pattern, changes over time	Cereals: sorghum, dry sown paddy, millets (fox tail millet, finger millet, pearl millet, kodo millet, little millet) Pulses: pigeon pea, black gram , green gram, horse gram, cow pea, field bean Oilseeds: Niger, Sesame, safflower, sunflower, groundnut, linseed Fibre crops: mesta and sunhemp Cash crops: Sugar cane, turmeric, ginger, potato and chillies				Cereals: Sorghum, maize, dry sown paddy, millets (finger millet, pearl millet) Pulses: Pigeon pea, black gram , green gram, horse gram, cow pea, field bean Oilseeds: Sesame, safflower, sunflower, groundnut, linseed Fibre crops: mesta, sunhemp and cotton. Cash crops: Sugar cane, turmeric, and chillies (crops other than in Zaheerabad region)
4.	Area under green manure crop	Not Available				
5.	Varieties/ Diversity	Separate sheet is enclosed				
6.	Proportion of dry land/ irrigated land	8:2	9:1	9.5:0.5	9.5: 0.5	9 :1

Table 4 - continued

No.	Item of information	Name of the villages				District
		Yedakulapally	Metlakunta	Gopanpally	Lingampally	
7.	Soil types and their characteristics and their relative proportions	• Rocky hillocks • Shallow black Marginal soils • Loamy Soils • Saline Soils • Red Soils	• Rocky hillocks • Shallow black Marginal soils • Sandy Soils • Saline Soils • Limerick Soils	• Shallow black soil Marginal soils • Loamy soils • Sandy soils • Lateritic red earths	• Rocky hillocks • Shallow black Marginal soils • Saline Soils	• Shallow black • Marginal soils • Saline Soils • Red Soils
8.	Livestock	Cows : 28 Bullocks : 180 Buffalo : 168 Goats : 430 Sheep : 140	Cows : 82 Bullocks: 146 Buffaloes 117 Goats : 452 Sheep : 150	Cows : 42 Bulocks : 294 Buffaloe: 131 Goats : 283 Sheep : 358	Cows : 31 Bullocks : 86 Buffaloes: 115 Goats : 183 Sheep : 45	Cattle : 5.2 lakhs Buffaloes : 1.15 lakhs Sheep : 2.83 lakh Goats : 2.37 lakh
9.	Sources of information related to SFM (major source)	Elders Landlords	Elders Landlords	Elders Landlords	Elders Landlords	Elders Landlords Radio and private companies.
10.	Credit availability	Money lenders : all types Banks : cash crops	Money lenders : all types Banks : cash crops	Money lenders : all types Banks : cash crops	Money lenders : all types Banks : cash crops	Money lenders : all types Banks : cash crops Coperatives : long term loans Grammena bank : short term crop loans
11.	Institutions at village level	Gram panchayat Sangham DWCRA Groups Water users association	Gram panchayat Sangham DWCRA groups Dairy cooperative Water users association	Gram panchayat Sangham DWCRA Groups Self Help groups Water users association	Gram panchayat Sangham DWCRA Groups Self Help Groups Water users association	
12	Contract farming	-	-	-	-	-

III ANALYSIS OF FINDINGS

III.1 Soil fertility management in semi-arid farming systems

This section aims to address the following key questions:

1. What are the key components of rural livelihoods, and how are these changing?
2. In semi-arid farming systems, how important is SFM to the livelihoods of poor farmers, compared to other constraints?
3. What are the current nutrient management practices used by farmers in SAT India?
4. What are the key constraints faced by farmers in improving SFM?
5. What are the most effective interventions or best opportunities to support farmers to improve SFM (within existing or improved policy / institutional context)?

It is written with a livelihoods framework in mind and in each section consideration is given to the assets available to farmers (natural, social, human, physical, financial), the vulnerability context (for example, the semi-arid climate and drought risk) and other external factors - policies, structures and institutions. Special emphasis is given to human and social capital issues. Human capital comprises the skills, knowledge, ability to work and good health that together enable people to pursue different livelihood strategies and achieve their livelihood objectives. Social capital reflects the resources upon which people draw in pursuit of their livelihood objectives including networks, membership of groups and relationships of trust, reciprocity and exchanges.

It is difficult to find agreement amongst the literature or stakeholders on most of these questions and an initial attempt is made to contrast different views between stakeholders such as government scientists and NGO workers, poor farmers and less poor farmers. This aims to promote discussion, and it must of course be recognised that a wide range of views exists within each of these types of organisations.

III.1.1 What are the key components of rural livelihoods, and how are these changing?

(XXX ACTUALLY THERE IS QUITE AN OVERLAP BETWEEN THIS SECTION AND THE ONE IN CHAPTER I ON LIVELIHOOD STRATEGIES. WHERE DO YOU THINK THE LIVELIHOOD ISSUES SHOULD GO?)

Rural livelihoods in SAT India in general, and in the study areas in particular, are heavily relying on natural resources, in particular on farming. Even though a large range of non-agricultural activities are carried out by people in rural areas, the main source of food and income remains agriculture - either as producer, or as agricultural labourer, or both (see Annex 2 and Annex 3 for details on livelihood activities in the study villages).

Many traditional trades such as cobblers, basket and blanket weavers, and potters are not in demand any more due to the low costs and easy availability of industrially manufactured goods (see also section I.3.2). Wage work (agricultural and non-agricultural) is becoming more important, with more non-agricultural employment opportunities being available in urban centres and even in rural areas (see Box 1).

However, these opportunities are generally available to a certain section of the population - those who are healthy, young(ish), and have some formal education. A large proportion of

rural households continues to rely heavily on agriculture. Because of the difficulties associated with dryland farming, such as erratic rainfall, high costs of agricultural inputs, and labour shortage, many small and marginal farmers are trying to get out of farming, in particular in areas without project interventions. Migration is an important livelihood strategy, which helps people to cope with seasonal shocks (such as drought, or indebtedness due to wedding expenses or medical expenses).

In areas where agricultural development projects have intervened successfully, migration has generally reduced (e.g. in BAIF and DDS project areas), because the project generated employment and enabled people to attain new assets such as skills (e.g. vermicomposting, thrift and credit groups) and physical assets (e.g. bullocks, implements). Many project intervention are in fact geared specifically towards increasing livelihood opportunities in rural areas in order to mitigate the negative consequences of migration (e.g. family break-up).

Households are constantly adapting their livelihood strategies in response to assets available to them, and external pressures and incentives, such as price fluctuations, subsidies, etc. Many examples of such adaptations could be observed in the study sites, which had an immediate impact on SFM:

- Farmers selling livestock in response to changes in family composition (children leaving for off-farm employment, high wage rates for herders, and shortage of grazing lands.
- Farmers increasing the area under cash crops, because food grains are available through the PDS (Public Distribution System).
- Farmers leaving their land fallow because of low local prices for food grain as a result of the availability of PDS rice and wheat (e.g. in Medak district of Andhra Pradesh)**.**
- Landless people making a living from selling FYM and vermi-compost, in response to the increasing demand for organic matter.

Box 5 What should the future bring? Goals and visions of farmers in Andhra Pradesh study villages

Farmers' visions and aims for the future were one of the issues addressed during this study. There were differences between the aims expressed by resource poor farmers / landless etc. and by better-of landowners. The following issues came up:

- Those who are really struggling to survive often only wanted enough food for their families. Only once this basic needs is met are they thinking of improving their asset base (such as owning a house, a piece of land, or livestock).
- Small and marginal farmers are often keen to purchase more land for cultivation in order to grow more food. Those who don't own bullocks are hoping to purchase a pair for ploughing, in order not to rely on hired draught power any more.
- Transport emerged as a major constraint to soil fertility management, many farmers hope to purchase a bullock cart for transportation of tank silt, compost, manure, etc.
- Other investments in agriculture, such as stopping erosion by constructing gully checks and field bunds, or purchasing better implements, was also mentioned by those farmers not facing an immediate survival battle. The need for loans to purchase inputs was also mentioned.
- For their children, most farmers hope to be able to give them a good education. At the same time, farmers expressed their wish to be supported by their children in agricultural activities. It was observed that young school leavers or graduates are often not interested in farming and in helping their parents in the field; therefore more education might actually lead to less involvement of children in farming. However, this depends obviously on the expected returns from farming.
- Improving the quality of life in general also emerged as a goal of farmers, e.g. by constructing / expanding / repairing the house.

- Farmers are often quite competitive and aim at overtaking their neighbours in input use and crop yields.

Source: Field work in Medak District (DDS)

In Bommenahalli, (K) large and educated farmers were keen to learn more about new technologies, especially those related to intensification (e.g. farm ponds, fruit / forest plantation, fertiliser application, composting, crop rotation, and green manuring). Medium/ large farmers are more likely to have some irrigated land, which gives them a larger range of options. Many small and marginal farmers expressed their wish to try and follow the large numbers of farmers who have been able to drill a borewell and irrigate part of their land – perhaps the fastest way to intensify (but associated with significant risks - see Box 4).

In both Karnataka and Andhra Pradesh there appears to have been a significant decline in the number of livestock specialists (i.e. families who focus on raising a herd of sheep or goats). For example, in B. Koppalu village (K) only one family (out of 33) keeps a herd of sheep. These families are often getting involved in cropping or agricultural wage labour. Some of the reasons cited for the decline in the number of 'shepherd' families were: (a) low income from grazing other people's animals, (b) less grazing lands available due to encroachment on CPR grazing lands by villagers and programmes banning grazing, such as JFM / WSM, and (c) wild animals threatening sheep (possibly as a result on decreasing size of habitats for wild animals).

At the same time, more small and marginal farmers now have a few cattle. The trends in livestock populations that are reflected in the district and state data (see Livestock section in the Andhra Pradesh background chapter).

To summarise, livelihoods are diverse and dynamics, with a multitude of factors influencing them. This will be further discussed in the following sections with special reference to SFM.

III.1.2 In semi-arid farming systems, how important is SFM to the livelihoods of poor farmers, compared to other constraints?

Although not as dramatic as changes due to the 'green revolution' on irrigated lands, yields of dryland crops have increased significantly during the latter 20th century (Singh et al., 1998; and Annex 7). Agricultural productivity has grown rapidly in rainfed as well as in irrigated areas (Fan & Hazell, 1999). This has been confirmed by farmers in the study villages (see timeline exercises in fieldwork reports).

These statistical trends do not suggest an immediate crisis in soil fertility levels or the productivity of soils. However, the data is compiled over larger areas (states and districts) and does not reflect variations within these units, which can be very large. Fieldwork data suggests that there are large differences in soil fertility management practices within the same village and even within the same household, as nutrients are concentrated on specific parts of the farm.

Is there a long-term decline in soil fertility? While there must be concern that soil nutrient stocks are being mined, as productivity has increased and while inputs of inorganic fertilisers remain low and the availability of organic manure is apparently declining in rural areas, there

is a real lack of reliable nutrient balance data at appropriate scales. Singh et al. (1998) note the paucity of data on organic matter inputs and review partial nutrient balance data (at SAT India scale) suggesting deficits equivalent to around 55-75 kg NPK/ ha. These deficits do not take into account organic inputs that are likely to meet a considerable proportion of the 'deficit'. The resource flow map case studies in Andhra Pradesh and Karnataka (see Annex 6) suggest that farmers are adding a range of nutrients to their soils - including farm yard manure, compost, and tank silt.

The high level of investment in SFM indicates that farmers consider soil fertility to be very important. Farmers invest large amounts of time and resources to purchase, process, and transport soil amendments. They also practice a range of conservation measures to reduce soil erosion (such as field bunds and ridges).

The government also realises the importance of SFM, and soil fertility is specifically mentioned in the National Agricultural Policy as a means to achieve growth in the agricultural sector. It mentions specifically "Special measures for conserving soils and enriching their fertility" and " Promotion of balanced and optimum use of fertilisers together with the use of organic manures and bio-fertilisers" (XXX INDIRA, PLEASE ADD THE REFERENCE FOR THIS - IT IS FROM THE POLICY REVIEW). NGOs are involved in the promotion of agroforestry trees and vermicompost to increase organic matter in the soil.

But soil fertility it is not the first constraint that farmers identified during fieldwork. Poor returns associated with rising input costs and low prices are mentioned by them as important constraints. Credit and indebtedness prevent many farmers from investing in their farms, including in SFM. **[LOOK AT THE CONSTRAINTS MORE CAREFULLY. CORRELATE BOTH THE A P AND KARNATAKA STUDY AND COME TO FINAL CONCLUSIONS]** Water also likely to be mentioned first. And labour. These issues are closely related or include aspects to SFM of course. SFM practices are changing as a result of changes in crops and falling livestock numbers reducing manure availability (although more small and marginal families now own some livestock). Rather it is one element of a complex system, all parts being crucial, but SFM perhaps not being the issue of most pressing concern.

Farmers in Medak District of Andhra Pradesh ranked soil fertility among the 5 most important resources required for farming, but after land, rains, and bullocks for ploughing. It thus still features quite prominently and is considered to be one of the main inputs that farmers can manipulate (other than e.g. rainfall).

Pound (2000) identified 13 constraints to improved production in parts of semi-arid Karnataka:

- limiting groundwater resources
- limiting rainfall amount, distribution and reliability
- soil limitations to arable production
- insufficient fodder for livestock
- limited awareness of technical options on the part of [watershed development] project staff
- limited access to reliable sources of information for farmers
- top down introduction of new options, which limits understanding by farmers of concepts that underpin the options
- limited access to some inputs required for adoption of existing options
- indebtedness (and cost of borrowing) for all categories of farmers

- high cost of medical care
- weak collective action (e.g. in management of common lands or in addressing worsening groundwater situation)
- dependence on government
- limited non-farm employment opportunities in rural areas

Only one of these is directly soil-related, although a number of others such as limited access to information and indebtedness could encompass soil fertility related aspects.

To conclude - it is important to recognise that soil fertility concerns are not the most pressing issues faced by smallholder farmers, and improving soil fertility is at best only one of several options for which there is genuine demand.

III.1.3 What are the current nutrient management practices used by farmers in SAT India?

There are a large number of options available to farmers to improve nutrient management, and most of these are well documented either through the conventional scientific literature or alternative sources such as the Honey Bee Network (http://www.sristi.org) which documents indigenous knowledge and the experiences of farmer innovators. Options broadly include strategies to (classification after Hilhorst and Muchena, 2000 - in the box):

- add more nutrients into the farm system,
- minimise unproductive losses of nutrients from the system (through processes such as volatilisation, and leaching)
- maximise the recycling of nutrients within the farm
- increase the efficacy of nutrient uptake.

III.1.3.1 Adding nutrients

Nutrients added to the farm system may be in the form of inorganic (e.g. fertilisers) or organic materials (e.g. manure and composts), and include animal feeds and fodder and other materials collected from CPR lands (which lead to increased manure supply). Nutrients may of course be sourced from outside the farm (e.g. chemical fertilisers bough from dealers) or from within (e.g. FYM from a manure heap). The recycling of nutrients within the farm is dealt with in a later section.

Inorganic fertilisers

Inorganic fertilisers get a lot of attention in some circles. They are relatively easy to research, and in many cases are seen as the only way to provide the amounts of nutrients required. Organic materials are simply not available in large enough quantities in some locations, or labour inputs are prohibitive. As noted above fertiliser use remains relatively low but is increasing in rainfed areas. Inorganic fertilisers are not sufficiently accessible to poor and marginal farmers due to cost, and many farmers are also concerned about impacts on soil quality (water pollution concerns are a further issue). Lack of affordable credit is a major constraint. Loans are often at high interest rates, and result in high levels of indebtedness during poor years.

Types of fertilisers, rates of use etc.

Organic fertilisers

A wide range of organic inputs are utilised. These include: composts, vermicompost, manure (stored as FYM or from herding animals on arable lands), crop residues, by-products such as coir dust (Selvaraju *et al*., 1999), urban waste, and green manures. These inputs may be derived from materials within the farm or from elsewhere. Typically organic inputs require labour intensive processing to provide nutrients in the right quantities and form, and transport.

Opportunities exist to maximise the use of organic inputs through good management: practices such as mixing in manure to improve decomposition or residues (see Box 6). However, management often appears to be poor. (XXX NEED TO THINK ABOUT WHAT WAS DISCUSSED AT NRSP - DO FARMERS USE MANURE MAINLY IN IMPROVE SOIL STRUCTURE AND MOISTURE HOLDING CAPACITY, OR TO ADD NUTRIENTS?) Associated labour requirements are one key factor, especially for larger farms. Tanner (1997) reports potential losses associated with stock-piling and broadcasting, probably due to labour constraints associated with more precision placement. Transport is another important constraint. Typically storage facilities are not a constraint and space is traditionally made available in villages. Everyone is permitted to use some space in the village for compost. However bigger farmers have traditionally captured some common lands and have greater access for space for manuring, fodder keeping etc. Most of this manure is used for their own agriculture and not sold. Even the poorest and the most deprived are not grudged a manure space of their own. Sometimes it may be a bit far from their house. This may inhibit composting to some extent, but not significantly. Strong social rules also prevent theft of manure (see Box 6). Animal husbandry practices are important e.g. using bedding to absorb urine.[XXX SATHEESH TO INCLUDE FARHATPUR PENTAMMAS STORY HERE AS A BOX]

Key issues associated with the use of organic fertilisers include:

- access to manure is tightly controlled (Tanner, 1997),
- links between livestock owners and arable lands. Tanner (1997) reports a decline in traditional shepherding arrangements due to high prices charged by pastoralists,
- Interactions between energy and agricultural needs - competition for dung, crop residues (Parikh & Ramanathan, 1999). Dung cakes often saved for the rainy season.

Competing uses: But for the rainy months, all the dung is normally used to shore up the manure heap. It is a highly valued commodity and is not wasted. All of it must go into their agriculture for fertilising soils. Another major use of dung is in smearing the housefronts. This is a cosmetic, ritual and anti-pest activity rolled into one. At least once a week all front yards are cleaned up and smeared with dung. A lot of dung is used as fuel during the rainy months especially in villages where the fuel wood crisis is high. There are also people, mostly landless, who sell dung cakes to the cartwheel makers who are a major user group for this. There are not many reported cases of successful biogas interventions. There were big efforts in the eighties but most failed. Later small volume biogas plants came on the scene. But for want of adequate technical support at the village level, they also disappeared. Since then there are not many cases of use of dung for biogas production.

- importance for specialist crops where taste is a key factor e.g. spices,
- role in helping prevent pest and disease losses,

- sources of materials are limited especially in areas where CPRs provided key sources due to decline in area and productivity of CPRs (Jodha, 1986, Pasha, 1992)
- limited manure supply is a widespread problem (e.g. Tanner, 1997) and competition for use as energy source
- uptake of some interventions may be heavily linked to subsidies e.g. vermicomposting. Not that there is anything wrong with this (chemical fertilisers are heavily subsidised)
- inputs to system in purchased feeds (Tanner, 1997)
- other amendments (not really just organic) include the application of fertile soils from de-silting of tanks which is a traditional practice e.g. in Karnataka (see Box 7). This is affected by changes in policy which encourage desilting by contractors, although its use by farmers is not explicitly encouraged.

(XXX NEED TO STILL ELABORATE THESE POINTS)

Application of tank silt and other soil amendments

Village tanks form a key part of traditional water harvesting systems throughout India. They provide drinking water for livestock, and irrigation water for intensive cultivation of paddy rice and other crops. But the tanks are also important sources of fertile sediment, which is collected and returned to the land. It is used to maintain soil fertility, particularly in the areas where high-value and important crops are grown. In Karnataka, the sand and silt deposits are often collected and applied to coconut gardens. Sediments are also used for other productive activities including brick-making. Sometimes the sediment is 'sold' by village watershed committees with the revenue being used to fund development activities and provide loans to villagers. There are numerous programmes (Neeru Meeru in AP) underway to desilt tanks – although focused on trying to improve water storage capacity and to provide employment, rather than to improve soil fertility. Transport is a major constraint in using available silt.

In the study area, addition (to what?) of red soil is a widespread practice. Why?

N-fixation

legumes that fix nitrogen (often much of plant is harvested, but typically some residues are returned).

III.1.3.2 Minimising losses

Controlling erosion, runoff and leaching (soil conservation measures get high rates in matrix ranking)

Erosion contributes to a loss in soil fertility, especially as the organic and finest (and most fertile) soil fractions are susceptible. Soil and water conservation (SWC) works such as bunding to control erosion will therefore help maintain soil fertility, and can provide an incentive for investment in soil fertility (use of fertilisers etc) often associated with more intensive cropping. Watershed development projects focus largely on soil and water conservation measures, usually physical structures and tree planting. Land configuration practices (such as tied ridges) in combination with improved nutrient management can also significantly improve productivity (Selvaraju *et al*., 1999). ?? In Bihar/ West Bengal, Tanner (1997) reports on a SWC strategy to improve soil fertility linked to knowledge of upland/ lowland nutrient flows.

- cultivation of trees to access nutrients from deeper soil layers

- cultivation of cover crops

III.1.3.3 Maximising nutrient cycling

Practices include:

FYM

By and large the social capital neither supports nor negates the FYM business. However close the kin is, one does not get the manure for free or on loan. Whatever else, plough bullocks, plough and other agricultural instruments or seeds, maybe accessed on loan or as a help. But never FYM. Probably the underlying belief is that a person who can't even grow his manure is worth no help. But in transportation and spreading manure, the kinship relations are a great use. They may lend a bullock cart for transportation, if there are a lot of people in the family, the activity will be easier and faster. All these factors help significantly.

Box 6 Theft of manure: an unthinkable crime

As one walks down any village in the dryland India, one does not fail to spot dotted rows of compost heaps lined on the roadside, at the backyards of houses and in specially enclosed *kallams* compost yards. Sometimes the heap is separated from its owner by several hundred meters. But the fact that such a heap is in wide open and is not supervised by anyone does not result in the theft of any part of the compost. One of the most significant social rules that governs grown FYM in rural India is that stealing the compost is the most heinous of all crimes. There are hardly any recorded thefts of the manure from the heap.

Source: Deccan Development Society

Composts

However there are cases where people have brought in other skills to improve their compost. For e.g. bringing in dry leaves, adding lime into the compost, adding wastes not found in their own household rubbish etc. Such enterprising people in the village have a recognition for themselves.

Box 7 FYM, compost and culture

Managing FYM and making compost is not, in general, a highly skilled job. People do not perceive it as an intelligent person's task. In fact many names like *Pentappa* or *Pentamma* in Andhra Pradesh, *Tippaiah* or *Tippamma* in Karnataka or *Kuppuswamy* or *Kuppamma* in Tamil Nadu are indicative of total surrender : telling the God that I am like a compost heap, of no value of no skill. On the other hand, FYM is the most treasured part of farming, comparable only to seeds. In fact the beginning of the farming season in the Deccan is marked by the worship of the manure heap : *Penta Pooja*. The woman of the house lights a lamp, breaks a coconut, sprinkles vermillion and turmeric [*Kumkum* and *haldi*], two most reverential tools of workship and does an *haarti*, turning a lighted lamp in circular motion in front of the heap. Exactly the way she worships the most important god in the Hindu pantheon. This indicates that the status of the FYM heap is the same as the status of the family god. These two opposing positions are living and simultaneous, a mysterious contradiction of the people's culture.

Source: Deccan Development Society

- crop residues

- green manures,
- crop rotations,
- tillage practices,
- ??improved fodder supplies leading to more livestock (strategy reported by Tanner, 1997).

III.1.3.4 Increasing efficiency of nutrient uptake

See John's book
- Strategic use of inputs (e.g. on high-value crops, low risk)
- Add substances that increase nutrient uptake / breakdown (e.g. biofertiliser)

III.1.3.5 Integrated nutrient management (INM)

INM (or integrated soil fertility management) is widely accepted in international and Indian scientific circles as the most appropriate SFM strategy for rainfed farmers. Patra *et al*. (2000) for example report better herb and oil yields with INM practices compared to use of organic or inorganic inputs alone. Scoones and Toulmin (undated) review recent thinking on the role of INM (see also Brinn *et al*., 1999). Importantly as well as mixing organic and inorganic inputs, INM is associated with a broader philosophy. This emphasises the need for context-specific and adaptive responses necessitating new skills and new partnerships between researchers, extensionists and farmers. However, it can be argued that INM is targeted at symptoms and not causes (Tanner *et al*., 2000). The approach also requires good quality organic materials.

It is also important that INM recommendations take into account the holistic fashion in which farmers combine soil fertility management with other aspects of their farming systems. Often research in soil fertility uses a reductionist approach and ends up fragmenting the problems and addressing them in a fragmented manner. Because of this very fact, the recommendations arising out of such research do not make sense to the farmers who like to think in a much more inter-connected style. It would be interesting to see whether the social and human capital framework in the current study can provide a direction to such holistic understanding of farmers SFM.

III.1.4 What are the key constraints faced by farmers in improving SFM?

Research scientists efforts generally focus on providing new knowledge to farmers (to add to human capital) and to improve genetic material (to improve natural capital). Plant and soil scientists, most importantly within the extensive ICAR system:

- generally focus on achieving productivity gains,
- usually acknowledge plant nutrition constraints such as N, P, K deficiencies or lack of micronutrients as the key constraints (as well as water stress) to improving productivity in rainfed lands,
- often argue that farmers do not adopt recommendations, although the possibility that this may be because recommendations are not appropriate or specific enough to local circumstances is increasingly recognised (Swarup & Gaunt, 1998), and that farmers may have better practices.
- generally believe that new technologies or practices are required e.g. better recommendations, new crop varieties including GMOs, and biofertilisers,

- sometimes promote participation of farmers, but usually only at initial stages in identification of problems and needs and less commonly in developing solutions,
- increasingly recognise INM as the most appropriate approach (e.g. Singh *et al.,* 1998) and that organic inputs are of vital importance (but are harder to quantify and study).

Although the NGO sector represents a broad range of organisations with many different philosophies and approaches, NGOs:

- are often driven by a strong ideology,
- recognise both 'formal' scientific knowledge (from research stations etc.) as well as farmers knowledge – often based itself upon good science,
- focus on what works and is the felt need of with farmers, who they generally are close to,
- often subsidise interventions, and 'hard sell' options (farmers are either in or out of the programme, and membership can be associated with acceptance of conditions). Arguably such approaches are necessary to counter propaganda from the government and mainstream science that promotes corporate interests with the powerful backing of the media,
- recognise poverty as key overriding constraint, access to assets such as water, grazing lands etc. and are likely to acknowledge impacts of price shocks,
- often emphasise training and skill development,
- are more representative of civil society e.g. food futures citizen jury for example (IIED, 2001),
- promote organic methods e.g. vermiculture and in some cases may actively discourage use of inorganic fertiliser,
- have limited access to information on options in suitable forms,
- often, with some notable exceptions, encourage little critical reflect on uptake, and there is a danger to focus on 'bean counting' e.g. number of farmers involved, number of pits for vermiculture etc.

Box 8 Visions of small and marginal farmers in AP

The key conclusions reached by a citizens jury – reflecting their 'vision' – included a desire for:
- Food and farming for self reliance and community control over resources.
- To maintain healthy soils, diverse crops, trees and livestock, and to build on our indigenous knowledge, practical skills and local institutions.

And opposition to:
- The proposed reduction of those making their livelihood from the land from 70%-40% in Andhra Pradesh
- Land consolidation and displacement of rural people
- Contract farming
- Labour-displacing mechanisation
- GM Crops - including Vitamin A rice & Bt cotton
- Loss of control over medicinal plants including their export

Source: IIED (http://www.iied.org/agri/IIEDcitizenjuryAP1.html) accessed 3/8/01

Some of the constraints recognised by farmers are summarised in Box 8.

Policy-makers in government:
- are focused on food security at macro-level, modernisation and economic development,

- tend to focus on more easily understood and quick fix inorganic options to improve crop productivity,
- pay little thought given to impacts of interventions, such as the 2020 vision in Andhra Pradesh, on complex farming systems and livelihoods.

What are the reasons for poor uptake of technologies and recommendations? Two key issues and gaps that fieldwork could focus on are labour requirements and access to information:

III.1.4.1 Labour requirements and returns to labour

Organic methods such as vermicomposting tend to be labour intensive, but labour requirements and returns to labour are not well understood. Often the impacts are on women's time. Returns may be insufficient for practices (and improved methods) to be viable in many circumstances unless subsidised. Subsidies may be provided in some cases, and this could be a policy recommendation.

III.1.4.2 Access to information

Is information not available or not appropriate? And what are the most effective mechanisms by which farmers gain information? Pound (2000) reported that other family and farmers were the most important sources of information. And what are the reasons for limited access of particular groups to knowledge about nutrient management practices and other inputs?

A third gap emerging, is perhaps the consequence of interventions on the systems, through complex interactions and relationships. This would include the factors driving declining livestock populations, often labour related, and the consequences for SFM.

III.1.5 What are the most effective interventions or best opportunities to support farmers to improve SFM (within existing or improved policy / institutional context)?

Options to support farmers to improve nutrient management include:

- development of new technologies and practices – for example fertiliser recommendations that include mixed organic and inorganic inputs (including clear analysis of costs and benefits), land configuration measures and fertiliser inputs, and new varieties. Whilst still important, given past levels of uptake, development is only justified if access to reliable and impartial information is improved.
- improving access to information (both farmer and 'externally-derived' technologies) – opportunities exist to expand indigenous knowledge and farmer innovation (following approaches such as the Honey Bee Network), improve the extension system to include farmer's manuring practices etc. and to utilise the media to disseminate this information,
- improving access to inputs and services (infrastructure, credit, fertilisers) including enhancing the role of the private sector, and improving rural roads and transport to help input supply and market access. A level playing field by giving the same credits and subsidies to organic fertilisers as to the industrially produced fertilisers would enhance the options farmers available to farmers.
- reforming markets (crop and input prices) to promote stability and sustainability, including supporting farmers to develop local markets over which they have more control and influence.

- watershed development and integrated rural development initiatives – impacts in well-implemented programmes include improvement in human and social capital, and improved crop yields (Kerr *et al*., 2000).
- promoting biodiverse systems that can provide higher overall returns than are often recognised.
- land tenure and security for farmers providing incentives to invest.

III.1.5.1 Research and extension services

An emerging hypothesis is that 'there aren't effective mechanisms to get technologies arising from the research system to farmers (even if technologies are appropriate)'.

III.1.5.2 Fertiliser subsidies

In the context of the present crisis in dryland agriculture, a better policy instrument would be to make it possible for farmers to access credit with equal ease to purchase whichever form of fertiliser they want: FYM, vermicompost or synthetic fertiliser. This would go a long way in helping small and marginal farmers to steer clear from purchasing synthetic fertilisers only because they are available on credit and/or government supplies them in every case of distress. Every time there is a crop loss or natural disaster, one of the first thing government offers is free chemical fertilisers. This steers the smallholder farming into a direction, which may not be to the liking of farmers and may be against their interests.

III.2 The role of the soil fertility 'business' in the lives of poor people in semi-arid India

The role of nutrient transactions in generating income earning opportunities for the landless whilst enhancing nutrient cycling efficiency has been recognised in Eastern/Western KRIBHCO Indo-British rainfed farming projects (Tanner, 1997). For example, the shift to stall feeding as cropping has been extended affects access of poor to manure who can't collect from grazing lands. But these families can get involved in processing for example, women buying manure and selling compost. Tanner *et al.* (2000) also includes a case-study of nutrient transactions between herders and arable farmers.

This part of this review considers the 'soil fertility business' from the perspective of different groups involved. It focuses on organic fertilisers, and is based upon experience from Medak District in Andhra Pradesh.

It addresses the following questions:

- Who is involved in soil fertility management business?
- How, and where, are markets for organic fertilisers emerging?
- On what terms do farmers sell organic fertilisers (as a coping strategy?)
- What opportunities exist to maximise benefits to the poor from the growing SFM business?

III.2.1 People involved in management of organic fertilisers

In the villages of the Deccan, a variety of farming systems and livelihoods are dependent upon manure production and manure management. And new markets are emerging. They

form an amazing matrix of the rural society and in some ways reflect in a microcosm other existing social relationships. Categories of people involved in the organic fertiliser business include:

- Landless people without livestock
- Landless cattle owners
- Small holder farmers
- Shepherds
- Collectors
- Middlemen and consultants

III.2.1.1 Landless people without livestock

This is a major category of people for whom composting is an important income source. They build their compost heaps with their household wastes which include kitchen wastes, ash and the normal rubbish which collects inside the home as well at the house front and some cow dung residues from the smearing of the house front as ritual activity.

Box 9 Moving herds: shifting cattle ownership in drylands

Over the last two decades, cattle ownership has dramatically changed hands in the dryland region. Historically bigger farmers were the owners of the largest herds, sometimes between 50-70 animals. A majority of them were raised not so much for their milk or draught power but for their manure since all farming was non-chemical and the soil fertility value of the dung was high.

The large herds were looked after by labour who could be either bonded or hired on a cheap annual contract. Most of the time, the poorer people borrowed money from their landlords, the Kaapus [saviour] to meet their emergencies. Most emergencies were either in the form of a wedding in the family or illness. Unable to repay the debt that was constantly compounded by rising interest, the poor would work as dedicated servants, looking after the herds, cleaning the cattle shed, collecting the dung and dumping it in the heap. The duty of up to 4-5 servants in the kaapu's house was only to look after the cattle. By and large these herders were from the scheduled castes and were mostly older children in the age group of 10-15.

Over time, the period of such an abundant supply of dedicated servants came to a halt. Government laws and social education as well as activist work forced parents to admit their children in schools. This created labour scarcity in the villages, especially in the 'cattle-care' sector. Concurrently adult labourers were confronted with a wider labour market providing other options than being be bound to one farmer or to a single contract. Because of these reasons labour for cattle-care has become scarce. As a result, most big farmers have sold away their herds and now hardly own one or two pairs of cattle.

While the bigger farmers were being impacted negatively by government policies, a reverse trend was taking place in relation to the scheduled caste people who form the poorest sections of the rural society. A series of welfare and affirmative programmes initiated by the government gave them subsidies and credits to purchase cattle, both milk animals like buffaloes and draught animals like plough bullocks. Increasingly more of them became cattle owners. They had the social capital to take care of the cattle in terms of family or group labour. If one poor family had 3-4 cattle, one person in the family usually an older child would graze them. Many of their neighbours would also hand over their one or two animals to this person to graze. In return he would be paid some money every month. This system worked to both people's advantage. In the process of taking care of his family cattle, he also earned an extra income looking after his neighbour's cattle.

Fodder was no problem either for the new cattle owners. They are invariably the farm labour in the village and therefore are regularly invited to weed the fields. They have the right to carry home the grass and weeds they uproot. At the end of the day's work, they collect enough fodder for their cattle. These twin capitals: human and social, offer them natural right to own cattle in the village.

Since these people own no or very small pieces of land, they do not have much use for the manure their cattle generate. Consequently they have become the biggest source of FYM for the village.

Source: Deccan Development Society

Altogether an average household may generate about two cartloads of waste per year. The demand for the product is slightly lower than other composts because of the absence of catalytic agents like cattle dung and urine. But since the compost content itself is not something that needs much breaking down, the price does not differ much from the other forms of FYM. Such materials get 20% less price per cartload in comparison to the normal heap. The price for a cartload of FYM in Zaheerabad region for example varies from village to village and depends upon demand and supply. The lowest price in the year 2000 was around Rs.50 cartload (about a tonne) and the highest price commanded was around Rs.120.

III.2.1.2 Landless cattle owners

Mostly belonging to the Scheduled Castes, there is a significant category of landless cattle owners. Perhaps 50% of them have become cattle owners over the last decade. A majority of them have been benefited by the welfare programmes of the State which concentrated on helping the SCs to own milk and draught animals throughout 1970s and 80s (Box 9).

The very nature of their occupation makes it easier for them to rear cattle. All people in this category go wage labouring (weeding) in other farmers' fields. This helps them collect enough fodder for their animals. Every woman returns from weeding with a headload of fodder. This is the grass she has weeded from the field through the day. In irrigated areas, labourers are also usually allowed to cut green fodder (such as sugar cane leaves).

This category is the major supplier of the FYM. The high concentration of dung in their FYM attracts a good price and on an average they can earn up to Rs.100-120 per cartload every season. An average heap can collect about ten cartloads if they have one animal, or up to about 15 cartloads if they have two per year. Therefore they earn up to Rs. 1000 – Rs.1500 per season equivalent to roughly about the amount of wage they earn in a month or 45 days depending upon the part of the region they belong. Near Zaheerabad town in the region, which is the sugarcane belt, lean season wages are around Rs.20-25 for women and Rs.35 for men. About 25 km from the Zaheerabad town, wages are as low as Rs. 15 for women and Rs.25 for men.

However cattle ownership amongst poor families is also being threatened because all the children in the house are now encouraged going to school. While this is undoubtedly a very welcome measure to liberate children from having to work as family labour and to lose their schooling, it also has a serious implication both for farming and livelihoods. This probably needs a reorganisation of the village labour or educational system (see Box 10).

III.2.1.3 Small holder farmers

This is another major cattle owning population. But most part of their FYM is used in their own farms. Very few of them are in a position to sell their manure. However through the activity of accumulating FYM, they are able to save about 50% of their farming expenses every season. This is a major gain.

A majority of these farmers do not use chemical fertilisers in their agriculture. They all share a perception that application of chemical fertilisers will reduce their dry, rainfed lands to the status of ash by burning it out. Hence the hesitation to apply chemicals on their farms.

Projected into future, this practice of relying completely on natural fertilisers for their farming can be the major source of their possible prosperity if organic foods get a premium price as evidenced in the present food consumption trends.

III.2.1.4 Shepherds

Shepherds are the source of the best quality FYM. There are two variations in the community. The pure pastoralists who keep moving with their herd in search of water and fodder and hence have no time for farming. By the very nature of their occupation, they cannot stay at one place for a long time, time enough to collect the manure from their herds and raise an FYM. But their earning from the manure is even better.

They are the most welcome guests in any harvested field and are invited to graze their animals. And they get paid for that! In fact for each day their herd stays on the land, they are paid around Rs.50 per herd (the herd size is often 20 to 50 animals) as well as their food for the day.

Box 10 School or cattle? Hard livelihoods and harder options

Tuljamma from village Potpally was too frail for her 12 years of age. Always shy and withdrawn it was very difficult to make life spring out of her. She was enrolled by her village sangham into *Pachasaale*, the Green School run by the Deccan Development Society for older working children who have missed the chance of going to the regular school. Tuljamma was a regular student for almost a year and blossomed beautifully. One day she stopped coming to the school. A week passed and she was not to be seen.

I went to her tiny one roomed thatched hut to talk to her parents. Her 30-year old mother Anjamma, looking ten years older than her real age was cooking rice on a wood stove. The six feet square kitchen had hardly any place for me to walk in and sit. Therefore I sat on the threshold to ask her why Tuljamma had been taken off the School. Anjamma told me that her younger daughter had been admitted into the village school because the schoolteacher had come and said that it was compulsory to enrol her child into the school. Consequently there was none to take care of the animals at the home. Therefore she had withdraw Tuljamma from the Green School even though she did not like it one bit.

The next hour was spent in talking to her and arguing why she should put Tuljamma back in the school. She had no hard arguments to support her action. She was feeling guilty but she had no option. The play on her face of the red and yellow light from the fire burning in her stove clearly delineated the cruel dilemma she was going through. At the end of an hour's pleading, she finally said she would try to send back Tuljamma to the school.

Two days later Tuljamma turned up at the School. I was delighted. I asked her how did it happen? She said in a flat voice that her mother had sold away their livestock. My delight died on the spot. Was the school a solution or a problem for Anjamma? I have never resolved the question yet.

But one person who seems to have brilliantly resolved this question is Lalu Prasad Yadav, the much maligned, constantly ridiculed former Chief Minister of the state of Bihar in North India. Yadav who comes from the family of traditional cattle herders can clearly empathise with the dilemma of people like Anjamma. Therefore he started what he called *Charvaha School* in Bihar. The cattle herding children could drive in their cattle into these schools. The schools would stock fodder, offer grazing land, drinking water and caretakers for the cattle within the school campus even while the children attended their classes. In the evening when the children returned homes they could drive back their cattle with them. It was a win-win situation for parents, children, cattle and education.

That the experiment was never headlined in the national media and policy circles, was allowed to fail and Lalu Prasad Yadav continues to be ridiculed are proof enough to the elitist ways the affairs of the country is conduced with no grassroots understanding of the Indian countryside. The policy makers are always full of urban solutions for rural problems. And they work against people.

Source: Deccan Development Society

There are instances of bigger farmers paying up to Rs.10,000 for ten acres (Rs.1000 per acre) to let the herd stay on their lands. This activity would involve penning the herd (if the size of the herd is about 100) on different patches of lands over a period of about a month. Each night the herd of 100 animals can fertilise about one quarter of an acre. Therefore to cover an acre it would roughly take between three to four days.

The second category among the shepherds is the settled people who have smaller herds between 25 and 50. Invariably they are landowners in their own right. Therefore, in the Zaheerabad region, shepherds are not known to sell their FYM. Most of the time, they use it for their own lands. However when they decide to sell any part of their manure heap, they attract the highest price, sometimes up to Rs. 150 per cartload.

III.2.1.5 Collectors

In the midst of all these categories coexists another amorphous category of collectors whose job is only to collect the dung and let the others to do the processing. *Junglee*, the village herdsman, is the person who herds the village cattle by charging between Rs.20 and Rs.30 per animal per month. In his herd he has between 20-50 animals on an average. This means he gets an income of up to Rs.500-1200 per month by herding and grazing these animals on the village commons.

This person herds only a limited number of buffaloes and cows. He is not given the charge of grazing the family bullocks since the bullocks are too precious to be handled by a *common* person. It has to be the exclusive charge of a member of the family or an exclusive servant.

The *junglees* also derive a significant part of their income from the dung of the cattle they herd. Normally it is the man and the woman who together go with the herd. While the man herds the cattle, the woman's exclusive job is to collect the dung as and when it is deposited by the cattle. She carries a basket with her and follows the herd all through their journey. When the basket gets filled, it is immediately put in a heap on the ground. Once the animals start their journey homeward, the woman starts bringing all her small heaps together into a bigger heap. Her heap is *pure dung* and hence is most valued.

Anyone needing a part of the heap or full heap can negotiate with the *junglee* and buy it from the person. If the herd size is around 50, the *junglee* collects about one cartload of dung per day. This brings him a monthly income of up to Rs.2000. Ramappa, a *junglee* in Pastapur

village, because of the proximity of Zaheerabad town, earns up to Rs.3000 per month by supplying a cartload of dung at Rs.100/- to roof layers in house construction who need cattle dung.

The transactions do not always take place in terms of cash. Sometimes the bigger farmers can also get some small amounts of this heap for a variety of favours returned, which may include:

- small loans,
- access to vegetables in their farms,
- small timber,
- fodder, and
- thatching material

There are also another set of collectors who are probably a more recent phenomenon. These are special boys and girls employed by bigger farmers exclusively to collect the dung at spots wherever cattle come together for grazing. This is mostly done with the dung of the smaller herds grazed by the servants of the landlords. Such collectors may be employed at up to Rs.600 per month.

III.2.1.6 Middlemen and 'consultants'

As the market for FYM is growing, it has also given rise to a new category of middlemen. These people advance money to purchase FYM heaps in the village and collect them in season to sell it to major buyers. They offer a number of services:

- purchasing a heap at competitive prices,
- hiring a truck/cart/tractor etc.,
- getting the manure loaded with their own labour,
- finding a buyer and unloading in the designated destination with their own labour.

In the bargain they earn up to Rs.100 as their commission per heap. If in a season they are able to negotiate up to 20 heaps, they make an earning of up to Rs.2000, which may equal two months of average wage earnings. This practice is still at a small scale but might emerge as an important enterprise especially where there are specialist markets for organic fertilisers, such as in ginger growing areas.

There are also consultants in the profession. People who know the size of the various heaps because they constantly observe them from the time the compost pit is dug. Hence they are aware of its depth and the volume of manure it can hold. With this knowledge, they advise the buyers of what the manure quantity and quality in the pit would be. This helps the buyers not to make a blind guess and offer a price that is commensurate with the quantity of the manure in the heap. In return for their advice, the consultants get a small fee, probably Rs.20-30 per heap.

III.2.2 Markets for manure

As described earlier, raising manure composts is a major activity. But most of the time this is done on a small scale. There are no known industrial-size activities in the region (also these may become important in peri-urban areas). And most manure is not sold. But when sold, one cartload of FYM sells for between Rs 75 to Rs 120. In an average village like Pastapur with its 450 households and a population of about 3500 persons, there are at least 400 FYM pits and a total generation of about 5000 tonnes of FYM. This means that the total value of FYM is around Rs.300, 000 to Rs.350, 000. This is almost double the budget allotted to the Panchayat (the Village Council) by the government.

Trade is increasing, as larger and specialist farmers have less FYM of their own. In recent years, ginger growers have become major buyers of FYM. Most of them are large farmers who do farming for cash. Since ginger attracts a good price they see this as a very profitable venture. When their chemically grown ginger started getting rejected in the market for its *bad smell* or lack of aroma, as well as getting damaged by root rot, they rediscovered the virtue of FYM and started buying it in good measure. In recent times, horticultural consultants have also been advising grape growers to use FYM in place of chemical fertilisers in order to get a better price for the grapes. If this trend catches on, it can mean another major market for FYM in the region.

Sale of manure may be for cash or in exchange for:

- small timber
- green fodder
- part of the produce from the land for a certain number of years.

Thereby sale of FYM serves many purposes including construction of houses/cattle sheds, animal husbandry and food security. However, the trade is not necessarily ‘desirable’ for all sellers, who are well aware of the loss of nutrients involved. Many small and marginal farmers who do sell manure, see this very much as a coping strategy in the face of undesirable circumstances such as medical expenses for a sick member of the family.

IV RESEARCHABLE ISSUES - SOME INITIAL IDEAS

(XXX THIS SECTION WILL BE WRITTEN AFTER CONSULTATIONS WITH PARTNERS IN INDIA IN THE WEEK STARTING 21 JANUARY 2002).

A number of key problem areas and opportunities emerged from the study so far. During the next weeks, these areas will be developed further by all project partners in consultation with stakeholders in India.

Farmer innovation in SFM

- Identify farmer innovators and their response to changes e.g. access to FYM, cropping patterns (Farmer adaptation etc: new opportunities, example of woman growing 15 different crops fully organic, couple growing all their food on one acre.)
- Engage farmers in evaluating innovations, support process of farmer-to-farmer dissemination
- Make use of existing uptake pathways: Self-help groups, Honey Bee network, GFAR projects etc (work with existing groups because of lack of time and resources, and sustainability)
- Build new partnerships: organic/ inorganic, NGOs/ research/ extension (build bridges between ideologically rigid partners through joint learning approach)

Crosscutting: USE OF VIDEO

Maximising benefits from the "nutrient business"

- Understanding emerging markets for nutrients (beyond current study area)
- Maximising benefits to poor (landless, small/ marginal farmers)
- Screening possible interventions: e.g. transport, methods, subsidies

Responding to poor farmers concerns over inorganic fertilisers

- Understand better what fertilisers are actually doing - to soils, and to farmers (vulnerability)
- Explore alternatives: links to organic/ specialist markets, sustain and improve availability and use of OM
- Soil fertility trends
- Understanding long-term on-farm trends, impacts on livelihoods and response of poor farming families
- Impact on policy and research

Criteria for prioritisation

- Poverty focus of benefits
- Livelihoods focus and impact
- Impact on policy
- Achievability (cost, interests and capacity of partners, timeframe)
- Replicability

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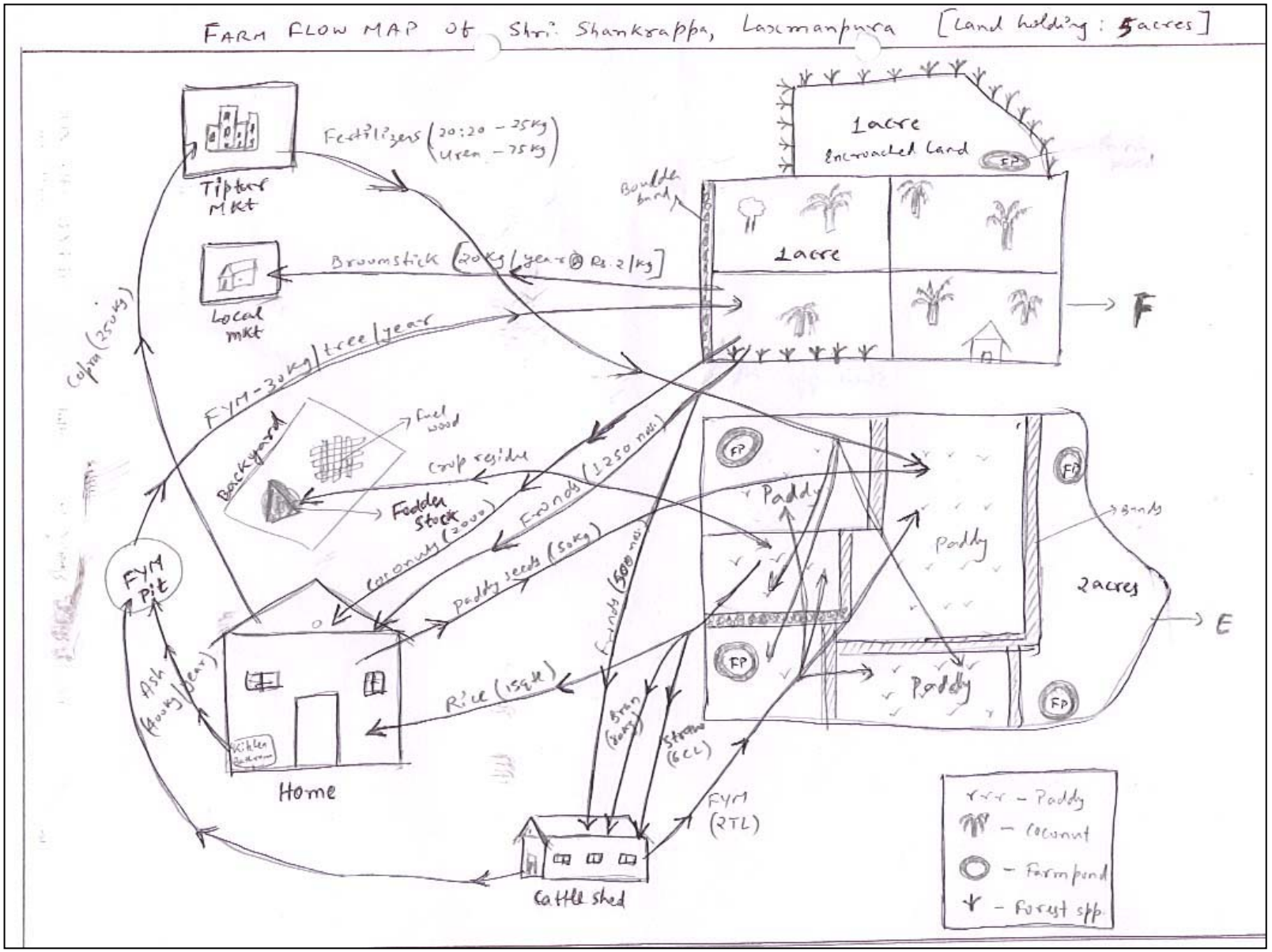
Annex 1 Farm flow map (Mr Shri Shankarappa, Laxmanpura, Tumkur District, Karnataka)



Annex 2 Livelihood activities of farmers in Karnataka study villages

No.	Types of Livelihood	No. of families involved in activity			
		Bommenahally	Malligere	Laxmanapura	Koppalu
	Total no of families in the village	60	220	85	33
1	Crop cultivation	59	200	70	33
2	Wage labour in village	30	100	60	33
3	Wage labour in surrounding villages	25	-	20	33
4	Collection of Neem seed	10	50	20	-
5	Dairy activity	50	150	10	33
6	Goat rearing	10	17	10	3
7	Selling of farm yard manure/compost	10	-	3	1
8	Land leasing	-	26	3	1
9	Share cropping	10	-	3	1
10	Production of vermi-compost	30	30	50	-
11	Collection and selling of castor seeds	60	-	10	3
12	Collection of Beedi leaves	-	-	6	-
13	Collection and selling of Pongamia seed	10	-	5	6 (1-2 months)
14	Selling of vegetables	2	6	11	3 (own vegetables)
15	Selling of fruits	5	-	5	10 (Mango, Banana, own fruits)
16	Carpentry	-	5	5	4
17	Masonry	8	5	-	2
18	Blacksmith	1	-	-	1
19	Blanket weaving with sheep wool	-	-	5	4
20	Collection of Butea leaf for making leaf plates	-	10	-	1 (32 families for own use)
21	Announcer	-	6	-	-
22	Collection and selling of fish and crabs	Own use	15	-	-
23	Rearing of local fowls	20	3	50	33 (own use)
24	Tailoring	2	20	6	-
25	Leather selling	-	5	3	-
26	Provision store	1	-	3	-
27	Tea hotel	-	3	-	-
28	Selling of toddy(Neera)	-	-	1	-
29	Washing of cloths	1	6	-	-
30	Barber shop	-	1	2	-
31	Broomstick making	11	40	50	-
32	Pottery	-	-	5	-
33	Selling of tamarind fruits	80	-	30	10
34	Harvesting of tamarind /mango/coconut (nuts) fruits.	10	3	10	-
35	De-husking of coconut	80	8	10	-
36	Mat making	80	25	85	(33 own use)

Annex 2 - continued

No.	Types of Livelihood	No. of families involved in activity			
		Bommenahally	Malligere	Laxmanapura	Koppalu
37	Money lending / pan brokers	15	-	10	-
38	Flour mill	-	2	1	-
39	Middleman	2	50	-	2
40	Stone crushing	4	-	-	-
41	Chaval mannu (Saline soil) collection and selling	-	-	85	-
42	Cook (common cooking for ceremonies)	3	4	-	-
43	Mike set (Sound system)	-	1	-	-
44	Arrack shop	1	-	1	-
45	Sale of tender coconut	-	3	-	-
46	Contractor	4	-	-	-
47	Government Employee	25	110	-	-
48	Driver	4	15	-	-
49	Labour (Canal work)	20	-	-	-
50	Priest	1	6	-	-
51	Sale of Butter	20	-	-	-
52	Piggery	-	8	-	-
53	Stone pitching	-	10	-	-
54	Petty shop	-	5	-	-
55	Painter	-	1	-	-
56	Dish Antenna	-	2	-	-
57	Common Garbage collection	-	1	-	-
58	Factory	-	20	-	-
59	Motor Rewinding	-	6	-	-
60	Shamiyana hiring	-	1	-	-
61	Tractor	-	4	-	-
62	Coir rope making	-	3	-	-
63	Bullock cart hiring	-	7	-	-
64	Welding	-	2	-	-
65	Hand pump repair	-	1	-	-
66	Photographer	-	2	-	-
67	Traditional Birth Attendance	-	5	-	-
68	Traditional Healer	-	6	-	-
69	Astrologer	-	5	-	-
70	Electrician	-	4	-	-
71	Brick making	-	12	-	-
72	Band set	-	11	-	-
73	Bus agents	-	4	-	-
74	Water man	-	2	-	-

Annex 3 Livelihood activities of farmers in Andhra Pradesh study villages

No.	Types of Livelihood	No. of families involved in activity				Approximate periods during which practices
		Yedakula-pally	Metla-kunta	Gopan-pally	Lingam-pally	
	Total no of families in the village					
I Livelihoods on which villagers are dependent for several month per year						
1.	Cultivation of crops in kharif and rabi seasons	95% of village households	90-95%	80-90%	50- 60%	9-10 months in an year
2.	Wage labour	75-90%	80-90%	80-90%	90- 95%	Throughout the year.
3.	Wage labour in surrounding villages	15-30	10-30	20-50	10-20	1-2 months
4.	Dairy activity	50-60	70-80	20-30	10-15	Throughout the year
5.	Goat rearing (one or two goats per family)	50- 75%	40-60%	30-40%	10-15	Throughout the year
6.	Selling of Farm yard manure	15-20	20-30	20-30	10-20	Once in a year
7.	Land lease	30-35	20-30	15-25	5-10	5-10 months in a year
8.	Stone cutting	-	3-5	2-5	75-85%	6-8 months in a year
9.	Migration during paddy harvesting season.	15-20	10-15	-	-	45 days- 60 days in a year
II Livelihoods on which villagers are dependent for a few days or weeks per year						
10.	Production of vermicompost	6	9	-	-	Throughout year
11.	Collection of selling of neem seeds	75-100	100-125	80-90%	20	15-30 days in a year.
12.	Collection and selling of seeds of green manuring trees glyrecedia.	50-75	-	-	-	7-15 days in a year
13.	Collection and selling of castor seeds	5-10	24	2-3	-	7 days in an year
14.	Collection and selling of Seeds of medicinal plant called locally as " Bavanchalu"	5-10	60-75	-	-	15-30 days in a year
15.	Collection of Beedi leaf	10-15	40-50	5-10	-	7-20 days in a year
16.	Collection of seed called "Katcha kaya"	-	15-20	-	-	7 days in a year
17.	Collection and selling of Pongamia seeds	-	20-25	-	-	7-15 days in a year
18.	Selling of vegetables	2- 3	5-10	2-4	1	30-45 days in a year
19.	Carpentry	1	2	1	1	Throughout the year

Annex 3 - continued

No.	Types of Livelihood	No. of families involved in activity				Approximate periods during which practices
		Yedakula-pally	Metla-kunta	Gopan-pally	Lingam-pally	
20.	Masonry	2-3	4	2	2	Throughout the year
21.	Black smithy	2	3	2	1	Throughout the year
22.	Blanket weaving with sheep wool	-	1	-	-	Throughout the year for 2-3 months
23.	Collection of Butea leaf for leaf plate making	5-10	30	5-10	-	15-20 days in a year
24.	Collection and selling of uncultivated foods	2-5	6-8	2-3	-	10-20 days in a year.
25.	Rearing and selling of local fowls	50-60%	60-65%	50-60%	40-50%	5-10 days in a year
26.	Cobblers	1	2	1	-	Throughout the year
27.	Grocery	3	3	4	2	Throughout the year
28.	Tea shops	2	4	4	2	Throughout the year
29.	Selling of natural palm toddy	1	2	1	1	Throughout the year
30.	Laundry	4	6	3	3	Throughout the year
31.	Hair cutting	2	1	2	1	Throughout the year
32.	Auto driving	-	1	25	-	Throughout the year
33.	Rope making	2	5	1	-	20-30 days in a year
34.	Gold smithy	1	1	1	1	Throughout the year
35.	Basket weaving and pig rearing	1	2	1	-	Throughout the year
36.	Sheep rearing	2	1	1	2	Throughout the year

Annex 4 Ranking of SFM by farmers in Karnataka study villages

Practice	Bommenahally	Malligere	Laxmanapura	Koppalu	∅
Green leaf incorporation	2	1	--	1	1.33
Redges and furrow cultivation	--	3	1	--	2
Ploughing	--	--	--	3	3
Mixed cropping	1	7	2	6	4
Farm yard manure	5	5	5	2	4.25
Crop rotation	2	8	3	4	4.25
Tank silt application	4	2	4	8	4.5
Bunding	3	6	6	5	5
Donkeys & Sheep penning	4	4	--	9	5.67
Red soil application	5	9	7	7	7
Application of chemical fertiliser	7	10	8	10	8.75 8.75

Note: 1 means best; the higher the number, the lower the rank

The criteria used for ranking various soil fertility management methods include:

1. Easy availability
2. Cost
3. Effect on soil fertility
4. Effect on soil structure
5. Cost on transport
6. Effect on moisture holding capacity

Annex 5 Ranking of SFM by farmers in Andhra Pradesh study villages

Practice	Yedakulapally	Metlakunta	Gopanpally	Lingampally	∅
Niger cultivation	1	1	1	2	1.25
Farm yard manure application	1	4	1	1	1.75
Crop Diversity	2	2	*	*	2
Black gram cultivation	5	4	2	2	3.25
Sunhemp incorporation (green manure crop)	3	5	3	3	3.5
Pigeon pea cultivation	***	***	5	4	4.5
Soil and Moisture conservation works	5	7	-	4	5.33
Vermicompost	3	8	**	**	5.5
Chemical fertilisers	6	9	6	5	6.5

Notes:

- 1 means best; the higher the number, the lower the rank
- * The parameter was not studied
- ** No vermi-composting in non-intervention villages.
- *** Pigeonpea cultivation was taken as a part of total crop diversity in DDS intervention villages.

Annex 6 Resource flow summaries of case study households in Karnataka and Andhra Pradesh

Farmer	Location	Family size	Adults	Labour	Land-holding (ha)	Field layout	Livestock	Exported nutrients	Cycled nutrients	Imported nutrients	Comments
Hanuman-thaiah	Laxmanpura, Tiptur District, Karnataka	11	8	4 (others having non-agricultural income sources)	2.34	not clear (no map)	2 cows, 2 bullocks	810 kg grains, milk 500l, vegetables 910 kg, coconut 1000 kg	fodder 11000 kg (cut and carry), FYM 14000 kg	350 kg fertiliser (20:20, super, urea)	Map missing
NK Kumar	B. Koppalu, Hassan District, Karnataka	5	4	rely on wage labour too	1.65	4 small fields, one cocunut garden	2 buffaloes, 2 chickens	1100 kg grains, 500 Kg coconut, 1500 Kg coconut stalk/ fronds	5440 kg (fodder - straw and weeds), 10500 kg FYM to all crops	50 kg fertiliser (20:20:20, sulphur, urea) to field crops, 25000 kg tank silt to coconut	
Mr Shive-gowda	B. Koppalu, Hassan District, Karnataka	4	3	rely on wage labout too	0.15	1 small field	3 buffaloes, 2 bullocks, 1 sheep, 2 chickens	110 kgs grains, 36 kg butter, 2000 kg FYM (sold)	1000 kg (fodder), 300 kg FYM	45 kgs (20:20:20), 2000 kg straw from neighbours, 1000 kg tank silt added to compost	Good data, may be able to get accurate balance
Mr Nanje-gowda	B. Koppalu, Hassan District, Karnataka	4	2	hire in additional labour	2.025	2 small fields, one coconut garden	3 cows, 10 chickens	1950 kgs grain,1500 litres of milk, 250 kg coconut, fronds, husks and sheels used as fuel	millet straw, nizer stalks, green sorghum, and green gram residue used for fodder and composting; 1400 kg FYM on all fields	200 kg (20:20:20 & urea) on field crops, 150 kg animal feeds	
Mr Chidananda iah	Bommenahalli Village, Tumkur District, Karnataka	4	4	none	3.5 acres	?	3 cows	1000 kgs grain	3250 kg fodder and crop residues; 2500 kg FYM plus vermicompost; plus FYM to cocunut	100 kg fertiliser (DAP & Urea)	Area of land not given. Other data can be completed. But no map
Mr Basavalin-gaiah	Bommenahalli Village, Tumkur District, Karnataka	4	4	hire in additional labour	6.75	Land in 2 blocks, one irrigated (includes coconut, areca nut)	5 cows, 2 bullocks, 3 sheep	2800 kg grains (inc paddy), some veg, 5000 kg coconut, 60 litres milk	applies 36,600 kg FYM (mostly to paddy and cocunut) - some imported	400 kg fertiliser to field crops (esp paddy), 6000 kg sheep manure/ FYM purchased; 200 kg animal feed plus oil cake	Owns a tractor, is hired sometimes

Annex 6 - continued

Farmer	Location	Family size	Adults	Labour	Land-holding (ha)	Field layout	Livestock	Exported nutrients	Cycled nutrients	Imported nutrients	Comments
Mr Shanka-rappa	Lakshmanpura, Tumkur District. Karnataka	10	6	hire in additional labour	4.05	Land in 6 blocks (includes a coconut garden and some irrigation?)	5 cows	3000 kg grains (in paddy), some veg/ melons, 1000 kg coconut, 1500 litres milk, uses frond, husk and shell as fuel	8500 kg fodder, 7000 kg FYM	20000 kg tank silt (lifted by BAIF), 550 kg fertiliser (NPK, Urea), 250 kg animal feed	2 Maps with names Shankaraiah and Shamaiah
Mr Kariyppa s/o Kariyppa	Lakshmanpura, Tumkur District. Karnataka	10	6	hire in additional labour; but also engage in wage labour and tailoring/ leaf plate making	0.675	1 field (includes some irrigation?)	3 cows	400 kg grain, 400 litres milk,	5000 kg fodder, residues; 2000 kg FYM (mainly to ragi and paddy)	300 kg cattle feed	check land area and no of fields, no fertiliser?
Mr Mallaiah	Malligere, Tumkur District, Karnataka	4	3	shared labour practised	0.45	Includes coconut and paddy (grown together)	No cattle, 8 goats	1000 kg grains, 50 kg cocunut	Residues incorporated, 3000 kg FYM (most to coconut)	25 kg fertiliser (NPK/ Urea)	
Mr Malige Shivanna	Malligere, Tumkur District, Karnataka	5	4	hire in and share labour	2.7	Includes 2 acres coconut	2 cows; 10 chickens	1300 kg grains, 75 kg copra, one cow	2000 kg FYM; 2500 kg residues	10000 kg tank silt, 100 kg fertilser (urea and 20:20:20)	
Mr Siddaiah/ papanna											No report, only map
Nadipi Mogalaiah	Lingampally, Medak District, Andhra Pradesh	6	3	3 (hires in labour for weeding, harvesting and threshing)	5.85	7 acres black soil, 3 acres saline black, 3 acres shallow black, all rainfed	2 bullocks, 1 cow (all local breeds)	2500 kg and 4 bags of grain (sorghum and legumes), 50 kg coriander	10,000 to 14,000 kg FYM, crop residuces (quantity?) used as fodder	Livestock feed: some grazing on CPR land; green manuring with sesabania / sunhemp; 7 bags DAP	no map

Annex 6 - continued

Farmer	Location	Family size	Adults	Labour	Land-holding (ha)	Field layout	Livestock	Exported nutrients	Cycled nutrients	Imported nutrients	Comments
Peddagolla Tukkaiah	Lingampally, Medak District, Andhra Pradesh	6	5	5 (hires in for weeding, harvesting, threshing)	2.7	all rainfed black soil, 2 acres fallow	2 bullocks, 2 cows, 30 sheep	850 kg and 2 bags of grain, 4 bags of onions, some straw (quantity?) sold as fodder	15000 kg FYM, crop residues (quantity?) used as fodder	Sheep graze on village commons, 3 bags DAP	No map
Konejeti palli Narsaiah	Lingampally, Medak District, Andhra Pradesh	3	3	1 (2 sons employed)	0.9	1 plot black soil	none	250 kg grain, sells crop residues (quantity?)	none	Buys 1 lorry load FYM (1000 kg?)	
Peddagolla Laxmamma	Gopanpally, Medak District, Andhra Pradesh	4	2	3 (employ 50 labourers per year)	0.9	Only drylands	20 sheep (belong to others)	200 kg grain, 50 kg husks, 300 kg stalks, but not clear what is done with crop residues	none	1000 kg sheep manure	
Busenellie Tippamma	Gopanpally, Medak District, Andhra Pradesh	6	5	4 (employ 40-50 labourers per year)	1.8	?	2 cows, 1 calf	1100 kg grains	2000 kg FYM, residues of pigeon and chickpea ploughed back (quantity?)	5000 kg FYM, 3 l Endosulphon (for pigeonpea), 50 bags DAP	
Permanagri China Narsamma	Metlakunta, Medak District, Andhra Pradesh	7	2	2	2.7	own land: 3 acres, but only 1 cultivable	2 buffaloes, 2 bullocks, 2 calves, 4 goats	515 kg grain from 2 acres	30,000 kg FYM, 100 kg plus 2 1/2 bag vermicompost, 100 kg neem cake	1000 Rs worth of fodder, fodder headloaded from wage work field, cattle taken for grazing by herder	Not clear whether FYM figure is correct - she only produces 10,000 kg
Polgari Manemma	Metlakunta, Medak District, Andhra Pradesh	5	2	2 (hire 120 person-days)	2.25	?	1 buffaloe, two calves	377 kg grain, 3 l milk/day	2500 FYM,	2500 FYM, 300 stacks jowar for buffaloe, animals graze daily	

Annex 6 - continued

Farmer	Location	Family size	Adults	Labour	Land-holding (ha)	Field layout	Livestock	Exported nutrients	Cycled nutrients	Imported nutrients	Comments
Papi Reddy	Metlakunta, Medak District, Andhra Pradesh	4	3	2 (hire 150 person per year)	7.65	3 plots, some irrigated	2 cows	470 kg grain, 180 l milk, 500 stalks fodder	safflower and linseed residues incorporated	Seems to be using FYM, but no information available	Missing data on imported nutrients!
Shivappa	Yedakulapally, Medak District, Andhra Pradesh	7	?	3 (and hire labour when needed)	4.5	6 plots, black soil, all irrigated	1 calf (just sold 14 heads of cattle)	250 kg onion, 1075 kg grain, 46 tons sugarcane, 3.6 tons guava,	Animal feed: 1500 kg sorghum stalk, 2000 kg bengal gram residue, Burned on field: 2750 kg residues	360 kg urea, 600 kg DAP	Had to sell cattle due to labour and fodder problem. Used to apply FYM regularly.
Manik-yappa	Yedakulapally, Medak District, Andhra Pradesh	4	4	2	0.9	3 plots, one of them tank irrigated	1 bullock (?)	20 tons sugar cane, 210 kg grains	Fodder: 200 bundles dry jowar stalks, 40 bundles green fodder from sugarcane, 8000 kg FYM	7,500 kg FYM	
M Bagaiah	Yedakulapally, Medak District, Andhra Pradesh	5	5	4 (hires 200 person days of labour per year)	1.64	3 plots on 2 farms	2 bullocks	9.5 tons sugarcane, 425 kg and 4 bags grain, 40 kg vegetables (not all harvested yet)	20000 kg FYM (but not all own?), crop residues are used as fodder	1 bag urea, 1 bag DAP on sugar cane	

Notes:

- Excluded purchased food

Units:

- 100 gunta = 1 ha, 0.45 ha = 1 acre
- 1 cartload FYM = 500 kg (AP), 300 kg (Karnataka), 1 tractor load FYM = 1000 kg, 1 cartload of straw / fodder = 500 kg
- 1 coconut = 0.5. kg

Annex 7 Productivity changes of principal dryland crops over years

Year	Productivity (kg ha^{-1})							
	Sorghum	**Pearlmillet**	**Maize**	**Chickpea**	**Pigeonpea**	**Ground -nut**	**Rapeseed-mustard**	**Cotton**
1950-51	353	288	547	482	788	775	368	88
1955-56	387	302	704	554	814	752	336	88
1960-61	530	286	926	674	849	745	447	125
1965-66	429	314	1005	527	678	554	446	104
1970-71	466	622	1279	663	709	834	594	106
1975-76	591	496	1203	707	785	935	580	138
1980-81	660	458	1159	657	689	736	560	152
1985-86	633	344	1146	742	767	719	674	197
1988-89	708	646	1401	735	756	1132	907	202
1993-94	894	527	1583	761	--	926	--	248

Source: Singh et. al. (1998)