Integrating biodiversity conservation and livelihood improvement:

The role of markets for mango varieties and *Garcinia* species in India

Froukje Kruijssen and Sudha Mysore



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Executive summary

The study described in this report was conducted to increase understanding of the role of markets in the maintenance of tropical fruit diversity on farm. This is considered important firstly because there is a need to evaluate how economic development is affecting farmer maintenance of diversity and secondly because the decisions taken by farm households on the management of annual and perennial crop diversity are different and while much is known on annual crops, the knowledge of perennials is much less. The field study was conducted in southwest India and comprised three fruit species; mango, *Garcinia indica* (kokum) and *Garcinia cambogia* (uppage). For mango, both commercial and homegarden production was considered. A range of research methods was used in five study sites in Andhra Pradesh (commercial mango), Karnataka (homegarden and wild mango, kokum and uppage) and Maharashtra (more commercialized kokum) in order to identify the trends and status of target fruit diversity, assess the economic contribution of the fruits to the livelihoods of the households dependent on these species, to determine the status and contribution of markets (organised or unorganised) on fruit diversity and the influence of the existing policies on the collection, production, utilization and marketing of the species.

Varietal diversity of commercial mango maintained in farmers' fields is witnessing a declining trend. Mango production is characterized by a biennial and seasonal bearing behaviour, a high level of fixed costs and long-term investments, and high variable costs of production. Because mango needs space to be planted there is a threshold area size for varietal diversity. However with larger mango area size, diversity declines. Seasonal price fluctuations for mango are an important factor for farmers for their fruit production as well as the specific market demands of the outlets in the region. Market information is an important factor that can facilitate better decision making the market chain structure should be transparent to accommodate this. However, the mango market chain evaluated lacks this transparency. Commercial mango diversity shows a declining trend with an increasing level of household income, while the level of education of the head of households is positively correlated with varietal diversity.

While for commercialization, fruit traits related to production and marketing are essential, the important traits of fruits collected from homegardens and the wild are more related to their use for the household. In this report, four cases are presented and the collection, use and marketing of kokum and uppage are compared in different stages of commercialization.

Factors that can increase the contribution of these fruits to household income while securing agrobiodiversity are: increasing consumer awareness of the uses of kokum and uppage; the establishment and strengthening of farmer organizations to increase efficiency and improve access to markets; the introduction of processing technologies and the development of new products; and at the same time the implementation of a conducive institutional and policy environment that supports the maintenance of diversity.

The report recommends that more research is conducted on the production, market and use traits of tropical fruits, coupled with an increase in grower or collector (i.e. harvester from the wild) awareness about them. This may be achieved by the development, branding and promotion of products derived from locally-important agricultural biodiversity. The evaluation of the suitability for on-farm conservation for specific varieties and species is needed to assess which varieties and species are in general suitable to be conserved through on-farm measures and which would need to be conserved through *ex situ* methods in order to optimize genetic diversity conservation and minimize costs. In this context it is important to note that only that diversity that is beneficial to farmers can be conserved *in situ*. In general, more attention should be given to intra-specific diversity in perennial plant species on-farm. Any effort should include a suitable institutional framework to support and monitor agrobiodiversity. This latter aspect is of major importance as utilisation and commercialisation are dynamic processes that need constant monitoring, evaluation and adaptation to changed conditions.

1. Introduction

Problem statement

In the South, Southeast and East Asian regions, tropical fruits play an important role in people's livelihoods and food security. A rich diversity of approximately 500 species of tropical fruits, of which about 90% are perennial, is found in this region (Arora, 1997) and provides for a broad range of livelihood support including household income, employment, better nutrition, food supplements and other contributions such as medicinal use, timber and livestock fodder. These species also have an important role to play as components of stable ecosystems. The importance of non-timber forest products (NTFPs) for many rural livelihoods is significant (Poole, 2004) and in India, 50 million people rely on forest products (Hegde et al., 1996). However, unorganised and sometimes exploitative markets, limited or no access to market information, high transaction costs, and lack of a favourable institutional structure, often characterize the marketing of these products. This not only results in low prices realized by actors along the market chain but also threatens both the cultivated diversity due to shifts to other land uses and the biodiversity in the wild through unsustainable harvest practices for some forest species (IPGRI, 2003).

In India, the most important tropical fruit in commercial terms is mango, which is grown virtually all over the country and has an annual production of 10.2 million metric tonnes, approximately 22% of total fruit production in the country and 54% of total world mango production (Singh et al., 2004). A rich diversity of mango is available in the country, with over 1000 varieties under active cultivation; however, only about 30 of them are commercially grown (IPGRI, 1996). Of these, only three or four take the major share in production under commercial cultivation although most of them provide some income for those households that depend on them.

Two of the fruit species that have local importance in terms of livelihood support and food security in south India are *Garcinia indica*, also popularly known as the 'kokum' butter tree and to a lesser extent *Garcinia cambogia* (or *G. gummi-gutta*) commonly known as 'uppage'. These two species are considered to be the most well-known Garcinia species of India (Subash Chandran, 2005). Both 'kokum' and 'uppage' are evergreen trees that are native to the western parts of Kerala in India and Malaysia. In India, they grow mainly in the south of Maharashtra, Goa, the coastal areas of Karnataka and Kerala. However, owing to a lack of organization in the 'kokum' chain and limited processing options, farmers and collectors (i.e. harvesters from the wild) in other locations are unable to benefit from the potential of the production and collection of 'kokum'.

Recent years have witnessed a paradigm shift in conservation policies for agrobiodiversity from strictly *ex situ* conservation towards more holistic approaches to biodiversity management and utilization including both *in situ* and *ex situ* approaches. The main focus of *in situ* approaches is on creating economic incentives (although in some cases non-economic incentives play an important

role, too) for farmers that encourage them to continue to maintain agrobiodiversity on farm. The primary objective of such an approach would be the diversification of products based on agrobiodiversity, and regovernance of the market chains of these products. This requires the creation of market infrastructure and facilitating situations that compel regovernance of markets for diversified products such that it results in agrobiodiversity conservation. Increased attention is given to creating forward market linkages by locally initiating processing facilities to utilise important agrobiodiversity for a range of products of different cultivars for diversified uses, and empowering farmers to engage in market-oriented production. Although this approach is considered to have high potential for improving the well-being of the rural poor, a critical analysis is needed on the trade-off between agrobiodiversity and poverty reduction. Monitoring of sustainable use of diversity has been insufficient, especially among perennial crops (Hutton and Leader-Williams, 2004).

Research objectives

The goal of the study described in this report is to examine the roles of markets and livelihood strategies in conserving agricultural biodiversity and improving livelihoods. Better understanding of the factors that are important should lead to more effective projects on the management and use of on-farm agrobiodiversity. The immediate purpose is to gain understanding of the socio-economic characteristics of the farm households utilizing mango, kokum and uppage and the market forces that play a role in their decision making for on-farm conservation and the outcomes for their livelihoods. In this study we aim to (i) identify the field level/region level patterns and changing status of diversity in mango and kokum species in an important growing region; (ii) assess the economic contribution of the cultivated/wild types of the target species to livelihoods of the households dependent on these species; (iii) determine the contribution of markets (organised or unorganised) on the existing utilization and diversity of the target fruits; and (iv) assess the institutional and non-institutional factors that influence the maintenance of diversity in production, marketing, processing and consumption of the fruits and their products.

It is expected that fruit production, utilization and trade are largely unorganized and are hampered by missing market information, high transaction costs, inequitable distribution of margins, and other typical marketing obstacles that often prevail in developing countries. This also has an influence on agrobiodiversity maintenance as there is a lack of incentive to maintain it. Alternative market outlets such as the processing industry also have an impact on agrobiodiversity maintained. The effects can be shown much better for intra-specific (variety level) than for inter-specific (species level) diversity. However, markets do have a role to play in the utilization of inter-specific diversity as well.

Methodology

Data collection

Data were collected in two main locations in the south-western region of India where diversity of the target fruit species is abundant. Data on commercial mango growers were collected in Chittoor district of Andhra Pradesh. For the home garden and wild collectors of kokum, uppage and mango, three locations were included in Karnataka state; the areas around Kumta, Salkore and Sirsi in Uttara Kannada district. Producers of kokum were also visited in the region of Vengurla in Sindhudurg district in Maharashtra state. Figure 1 shows a map of south-western India with the location of the study sites.

The total sample consists of 175 fruit growers, collectors, traders, processors and other actors involved in the production, processing and trade of the target fruits, of which 69 participated in a household survey, 68 in focus group discussions, 12 in an informal group discussion and the remaining 26 were key informants with whom informal interviews were conducted. The survey sample can be subdivided in the sample for mango and that for kokum. A sample of 46 commercial mango growers was interviewed utilizing a semi-structured questionnaire. The questionnaire consisted of several components including a section on general information on the household such as the composition and socio-economic status, sources of household income including agricultural activities, collection from the wild, marketing and processing, and other sources of income. A section on the household's expenditure pattern, monetary vulnerability and participation in networks was also included. A stratified sample was taken in terms of total landholdings with three categories, 0-5 acres (16 respondents), 5-10 acres (16 respondents) and more than 10 acres (14 respondents), to ensure inclusion of resource-poor and rich farmers in the analysis. Semi-structured questionnaires were also used to interview 23 collectors from homegardens and the wild, and a number of processors and traders. The sample of kokum collectors is only divided into two strata because of the relative small size of the sample. These strata are smaller than 3 acres (11) and 3 acres or larger (12). A Rapid Rural Appraisal (RRA) was conducted in focus group discussions. Exercises that were used included (i) a Venn-diagram to identify key stakeholders, institutions, existing networks, and gender roles impacting on people's livelihoods and the utilization of tropical fruits; (ii) a resource map that was used to assess the use of resources in home gardens and from the wild and to get familiar with the socioeconomic set-up of the target communities; (iii) a timeline of the target and other forest species over the years to determine trends in diversity; and (iv) a diversity 4-square analysis to identify the farmer-named species and their use and present status.

Vengurla: Key informant interviews

Sirsi: Two focus group discussions on mango and kokum collected from homegardens

Kumta: Survey of 17 kokum homegarden collectors

Salkore: Informal group discussion with 12 collectors of uppage from the wild

Chittoor: Survey of 46 commercial mango growers and key informant interviews

Figure 1. Map of research areas, sample size and research methods

The choice of the target species was done in line with a Bioversity International project funded by UNEP/GEF entitled "Conservation and Sustainable Use of Cultivated and Wild Tropical Fruit Diversity: Promoting Sustainable Livelihoods, Food Security and Ecosystem Services". In this project carried out in India, Indonesia, Thailand and Malaysia, target fruits identified include *Mangifera indica* and *Garcinia mangostana*. The choice was therefore made to analyze some of the *Garcinia* species of importance in India, which is linked to regional efforts to conserve the total genetic diversity in mangosteen and its wild relatives, i.e. conservation of the gene pool rather than one cultivated species.

Data analysis

The market chains of the target fruits are described and important actors in the chains are mapped. For mango, a cost-benefit analysis is conducted. Analysis of the quantitative data took place through simple statistical analysis and tabulations.

Structure of the report

The remainder of this report is structured as follows. Chapter 2 gives an overview of the underlying concepts and theories of this study, including a more detailed description of complementary conservation strategies and the role of markets for the conservation for both commercial crops and underutilised species. Chapter 3 presents the results of the study on commercially-cultivated mango and mango collected from the wild and homegardens. Chapter 4 then continues with *Garcinia* species grown in homegardens and collected from the wild and includes four case studies of *Garcinia* species in different stages of market development. Finally, chapter 5 consists of a discussion of the comparison between mango and the *Garcinia* species, which brings out the lessons that can be learned from the comparison of a commercialized crop and an under-utilised species. This chapter also examines the policy implications of this study and gives some recommendations for further research.

2. Background

Complementary conservation strategies

In the problem statement we described that while the conservation of agrobiodiversity used to be focused on *ex situ* methods (such as field genebanks for tree and vegetatively propagated species), in more recent years *in situ* approach has gained more importance. Preferably these two strategies should be used as complements rather than substitutes (Boyce, 1996; Gollin and Smale, 1998) because of the disadvantages attached to the individual approaches. *Ex situ* conservation is mostly limited to a number of well-known plants and is static. *In situ* conservation on the other hand, can be used at agroecosystem level that includes large numbers of groups of species or populations of a species. It has the advantage of evolutionary forces acting on the species and genetic diversity to promote adaptation and to be able to respond to changes in environmental pressures (Sthapit and Jarvis, 2003; Gollin and Smale, 1998). In the context of agricultural biodiversity, *in situ* conservation strategies include conservation in protected areas (focusing on crop wild relatives and agriculturally-useful species) and on-farm conservation (focusing on crop and orchard species). The first is often viewed as a threat to development because these areas are restricted from future land use options, resulting in high opportunity costs for the rural poor who often do not benefit accordingly (Adams et al., 2004). In addition, with *in situ* conservation methods, it may be difficult to identify and access genetic resources; there is less control of germplasm by scientists; the dynamics may threaten the security of landraces (e.g. by war and natural disasters); and social and economic change may hinder on-farm management. The major challenge of *in situ* conservation still remains to evaluate how economic development is affecting farmer maintenance of diversity (Jarvis et al. 2000) and we will begin to address this issue in this study.

Economic incentives for on-farm agrobiodiversity

The immediate rationale for the conservation of agrobiodiversity is the biological, cultural and economic value attached to it. The economic value of agrobiodiversity can be divided into “use” and “non-use” values. Use values include the direct benefits to producers and consumers that come from having a choice between different varieties of the same crop (such as income and for crop improvement) and the indirect benefits arising from ecosystem services they provide. There is also what Gollin and Smale (1998) describe as the future 'option value' or 'quasi-option value', which is the value of “retaining for the future the possibility of using a resource or of acquiring information about that resource”. Non-use values are the values that people derive from the existence of genetic diversity, for example, the value of knowing that rain forest are being conserved, but these non-use values are not as important for agricultural biodiversity (Gollin and Smale, 1998). As we have mentioned earlier, the evaluation of the effect of economic development on farmer maintenance of diversity still remains a challenge and in this report we will examine how certain use values of agrobiodiversity are affecting its conservation.

What makes the issue more complex is that the economic value of agrobiodiversity is found in both the public and private domain and is therefore considered by Smale and Bellon (1999) to be an "impure public good". This classification stems from the extent of rivalry in use and the difficulty of excluding users. The optimum allocation is not equal for both domains and public interventions are therefore needed to ensure that the good is allocated at the required levels, because farmers will only maintain on farm those parts of agrobiodiversity that provide them with a private value. To ensure that public resources are spent in the most cost-effective manner, on-farm agrobiodiversity policies need to be targeted carefully. Public investment costs for on-farm agrobiodiversity management are considered to be lowest "…where both the public value of the resources is believed to be greatest … and where the private net benefits farmers earn (monetary and non-monetary) through maintaining diverse crop genetic resources is high" (Smale and Bellon, 1999). Increasing farmer utility for a certain variety or species with a high public value will also enhance the incentive for farmers to maintain agrobiodiversity (including crop genetic resources) on farm. A method to increase the private value (and thus farmer utility) for agrobiodiversity is to enhance the income generated from these resources. The establishment and improvement of access to markets with products derived from agrobiodiversity is considered to be a potentially successful tool to achieve this (Rietbergen et. al., 2002). Individual smallholders in developing countries however face numerous constraints in the marketing of their products resulting from high transaction costs in the chain and other marketing obstacles.

Production of perennial species

When we examine the decisions farmers take to maintain fruit tree diversity on their farm we are in fact considering a farmer' supply response to several exogenous and endogenous factors. French and Matthews (1971) distinguish three major characteristics of the production of perennial species that differentiate them from annual crops, i.e. "(1) long gestation period between initial input and first output; (2) an extended period of output flowing from the initial production or investment decision; and (3) eventually a gradual deterioration of the productive capacity of the plants". From these characteristics we can identify four phases in the lifespan of a perennial plant, i.e. the non-bearing, the young bearing with low yields, the middle-aged bearing with the peak in yield and the older bearing phase with declining yields (depending on the species). Perennial plants in commercial orchards have features that are common to other investment processes where capital is committed for several years although other factors such as labour availability will also play an important role. Planting and removal are considered to be the most important decisions made by producers of perennial crops. Plantings (or investments) are based on three main considerations, i.e. expected profitability of certain (combinations of) species or varieties which are dependent on expectations of prices; yields and costs; the 'capacity utilization' of each variety or species, which is the ratio of output to inputs (including capital) (Albisu and Blandford, 1983); and (especially for semi-subsistent farmers in developing countries) socio-cultural factors such as provision of food and nutrition, medicinal properties and cultural value. However, the latter factors are thought to become less important once farmers become increasingly involved in markets. This is due to increasing opportunity costs of

maintaining diversity, the availability of new consumer products and substitutes for previously self-grown or collected products, and social and cultural change (Bellon, 2004). Perennial fruit trees are often grown as a cash crop rather than a subsistence crop and these last considerations will thus play a less important role for these (small-scale) commercialized growers.

Planting will also depend on the availability of planting material and for perennial trees, the time needed for production of this material may be considerable. As indicated, annual yields (and thus profitability) of perennial species will vary with the age of the trees, technologies used, and weather and biological factors. In some cases, such as for mango, current yields will also depend on past yields due to alternate bearing behaviour (French and Matthews, 1971) although this can largely be managed if the farmer has the required pruning skills.
Considerations for plant removals are the absolute level of returns, or their level in comparison to other varieties or species and expectations about future returns. These decisions are also influenced by the age of the plants and the expected productive lifespan. Finally, natural disasters such as diseases and cyclones are a further factor in the removal decision making (Albisu and Blandford, 1983). Based on the above we can summarize the major characteristics of perennial crops in Table 1.

Table 1. Characteristics of perennial species

Category	Characteristic
Investment	Time lag between initial investment and first output
Adaptation/suitability	Commercial orchard; semi-commercial orchard; mixed garden/home garden; wild/natural ecosystem/forest
Yield	Four phases with different yield-levels, sometimes alternate bearing behaviour.
Reproduction	Time needed for development of planting material, skills for reproduction techniques
Use	Predominantly cash crop

These specific characteristics of perennial species are important to consider because they will result in different decision-making processes for on-farm conservation than those for annual crops.

Commercial and underutilized fruit species and varieties

Although commercial fruits such as mango and citrus are of great importance to the livelihoods of many people and provide an important source of income in many countries in the region, there is also a large variety of fruits that is less well-known and has less economic value in commercial production, but that has a large value in terms of food security and cultural importance. These species are often referred to as neglected and underutilised plant species (NUS). Attention for these NUS and the role they play in the livelihoods of people, especially the rural poor, has increased because of concern about the limited number of species on which global food security and economic growth depend. Most of these species, often neglected by researchers and policy makers, are of major local importance for the subsistence of local communities, although this may

be declining as a result of a variety of agronomic, genetic, economic and cultural factors that have triggered changes in land use patterns (Padulosi et al., 2002; Eyzaguirre et al., 1999). The promotion of use and *in situ*/on-farm conservation of these plant species is one of the major components of Bioversity Internationals strategy to safeguard them. This includes the strengthening of market systems and the commercialization of NUS (Eyzaguirre et al., 1999). Underutilized species are considered to have an economic potential which is not reflected in the market because of a lack of knowledge by many of the actors in the chain about the use and properties of the plant. Improving this knowledge could not only increase their use, but also trigger the process of diversification into other products derived from these species, making them more valuable to more consumers (Gruère, Giuliani and Smale, 2006). The improvement of markets for value-added products of underutilized species can enhance agrobiodiversity conservation and the livelihoods of the resource poor (Giuliani and Padulosi, 2005).

Holistic approach to on-farm management of tropical fruits

Figure 2 presents a schematic model of a holistic approach to the conservation of tropical fruits using *in situ* and *ex situ* methods complementarily. The model concentrates on increasing the private value of agrobiodiversity and thus providing farmers with an economic incentive for the maintenance of agrobiodiversity on-farm and aims to accomplish this by establishing and improving access to markets with products derived from agrobiodiversity.

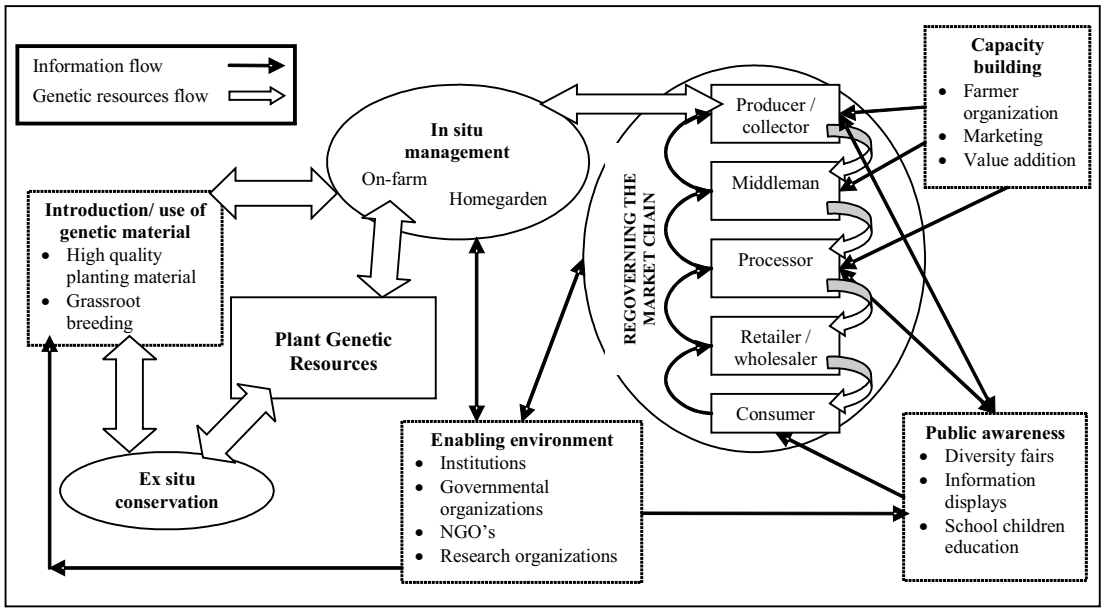


Figure 2. A holistic conservation model

To achieve the dual objective of benefiting the poorest stakeholders in the chain and to maintain agrobiodiversity on-farm, the re-governance of the market chain first of all requires a thorough understanding of the chain, the obstacles and the opportunities. As mentioned earlier, smallholders in developing countries face many obstacles when marketing their produce. Often these small-scale farmers and collectors have limited access to physical and financial resources, restricting their opportunities to increase their scale of production and to invest in technology to reduce labour

intensity or increase value addition. Because of this, smallholders face relatively high transport and handling costs. Furthermore, they often have limited technical skills and limited access to training to improve this. Also, individual producers can be hindered by a major lack of bargaining power with inequitable division of value addition along the chain as a result. The organization of producers and collectors is often mentioned as an effective means to solve many of these problems, such as through the formation of community-based organizations. Collectively, resources can be pooled and producers can market as a group thus overcoming high transaction costs. It can improve their access to resources such as inputs, credit, training, transport and information, increase bargaining power (Bosc et al. 2002), and facilitate certification and labelling. This will therefore not only require capacity building of smallholders in technical skills but also training for the formation and management of these community organizations together with technical innovations and the involvement of the enabling environment of the market chain. However, for a more holistic approach to biodiversity management, this should be complemented with research activities that aim at the development and availability of high quality planting material in order to bring those species that are collected from the wild under domestication to prevent additional pressure on resources in the wild. A constraining factor in this would be the availability of land. Public awareness is also needed to increase the awareness of general public and policy makers of the cultural, nutritional and economic values of the target fruits for such interventions. It is often observed that the knowledge of use of traditional ingredients for the preparation of local dishes is not maintained by the younger generation and public awareness campaigns should therefore be specifically directed at certain groups.

3. CULTIVATED AND COLLECTED MANGO

COMMERCIAL MANGO

In terms of commercialization, mango is the most important tropical fruit in India, with an annual production of 10.2 million metric tonnes. It is grown all over the country but the states with the largest production are Andhra Pradesh, (28.9%), Uttar Pradesh (22.5%), Bihar (16.5%), Karnataka (9.1%), and Tamil Nadu (6.7%) (Singh et al., 2004). The size of the geographical area and the climatic diversity in the country has brought about a rich diversity of mango in India; *M. indica*, the main cultivated species, is reported to have over 1000 varieties under active cultivation. However, only about 30 of these are grown on commercial scale, of which only three or four take the major share in production (IPGRI, 1996). India, although is the home for the cultivated mango, has only a few wild relatives; *M. zeylanica* and *M. sylvatica* are mostly found in the north-east, while *M. andamanica*, *M. camptosperma* and *M. griffitii* are found in the Andamans. In this report we will concentrate on intra-specific diversity of *M. indica*. India has three main mango belts, one around Rathnagiri in the coastal area of the south-west, which has a major focus on the variety alphanso, the major export variety, one in the north stretching the states of Uttar Pradesh and Bihar with dasheri as the main variety, and the third in the area around Chittoor towards the coast in the south-east, which is the main belt for totapuri (IPGRI, 1996). Annex 1 contains a map of the major production areas. In this report we will focus on the totapuri mango belt, specifically Chittoor district in the south Indian state of Andhra Pradesh, where the presence of a large number of processing units seems to induce the cultivation of totapuri. This state accounts for 21% of the country's mango area and for 25% of production with a productivity of around 8 t ha^{-1}. Chittoor district contributes about 15% of the region's mango production (Government of Andhra Pradesh, 2005).

Production system

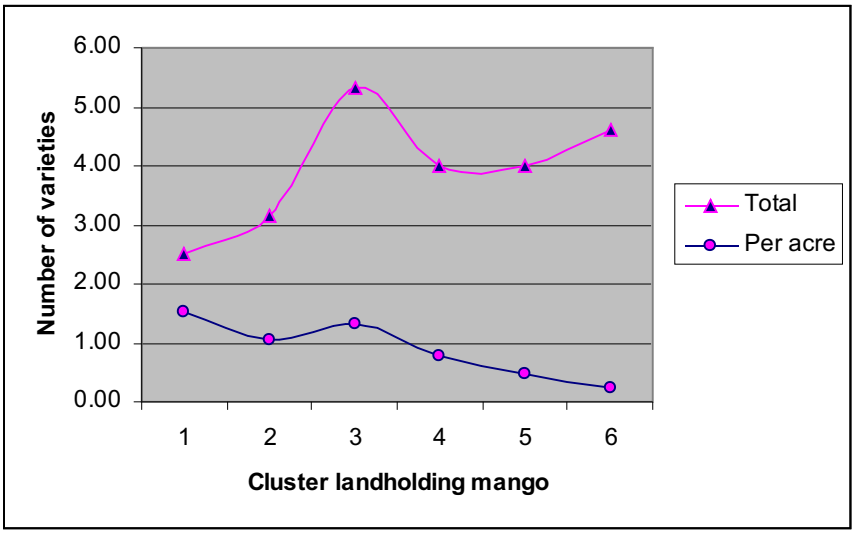
Mango in Chittoor is usually produced in a mixed commercial orchard maintaining a number of varieties and trees of different ages. The orchards in this region vary in size from less than one to over 20 hectares. Mango trees come to bearing from the fourth year after planting and continue to yield up to 60 years, however, economic benefits are highest in year 840 after planting. A fully grown mango tree in full bearing can yield up to 60 kg; however, a distinctive characteristic of mango trees is the fact that they are biennial bearers, which implies that low and high yields can be expected in alternate years. In Chittoor district, individual farmers cultivate from one to 13 varieties in their fields and a total of 23 different varieties were observed. Mango is thus mostly produced in mixed orchards (in our sample six farmers or 13% had only one variety).

Mango is a seasonal fruit, mainly available for three to four months in a year, in most of India from May till August. However, the harvesting season is not alike for all varieties. While benishan arrives in the market first in south India, around the beginning of May, totapuri is only harvested from the middle of the season onwards, around mid-June, while neelam ripens last, at the end of the season (mid-July). It is for this reason that neelam has gained popularity as farmers receive a higher price

for this variety. Alphanso is considered the "king of fruits" and is the main (fresh) export variety of India. This variety is most popularly grown in West India, while in the north the most common variety is dasheri. The soils of Chittoor are not as suitable for the cultivation of these varieties and hence the productivity is lower.

Present status of agrobiodiversity

The absolute number of varieties grown by an individual farmer shows an increasing trend with an increase in area size as is shown in Figure 3. The absolute number of varieties grown has an increasing trend for farmers that have a larger area of land planted with mango. For the relative number of varieties grown (i.e. the number of varieties per acre of land) a decreasing trend is observed. The trend for both absolute and relative number of varieties grown, however, has one exception. This the group of farmers with an area size of larger than 3 acres, up to 4.5 acres of land; larger farms tend to grow fewer varieties. This shows that the number of varieties maintained not only depends on farm size, but on other factors as well which we will examine further in this study.



Adapted clusters: I ≤ 2.5 ac < II ≤ 3 ac < III ≤ 4.5 ac < IV ≤ 5.5 ac ≤ V≤ 11 < VI

Figure 3. Number of varieties per area size group

One observation has been removed as the farm size of this farmer is disproportionately large.

The variety most commonly grown is totapuri, which is grown by 93% of the farmers, followed by neelam, planted by 85% of the growers and banganpalli produced by 67%. Table 2 shows the number of farmers in the sample that grow a certain variety and the number of trees of each variety they grow. Thus, although the number of varieties may be as high as six or seven for an individual farmer, most will maintain only a few trees of most of the varieties while the bigger area is planted with totapuri and neelam.

Table 2. Distribution of mango varieties

Varieties	Number of farmers	Percentage of farmers	Number of trees	Percentage of of total trees
Totapuri/ bangalora	43	93%	14 268	60%
Neelam	39	85%	4 642	20%
Banganpalli/ banisham	31	67%	2 356	10%
Alphanso/ badami	14	30%	1 016	4%
Pulera	14	30%	274	1%
Khadar	13	28%	224	1%
Kalapadi	7	15%	196	1%
Malgova	6	13%	194	1%
Other	27	59%	422	2%
Total	**46**		**23 592**	**100%**

Of all farmers, 59% has some other varieties than those explicitly mentioned (15 other varieties were observed. However, this comprises only 2% of the total number of trees. These varieties are local ones, or hybrids. The fact that the variety totapuri is the main variety in terms of the share of trees is reflected in the situation in Chittoor district. Over 50 processing units are located in the area and one of the major varieties used for mango pulp is totapuri. This variety is less preferred by Indians; however, European consumers prefer the less sweet taste and it thus mainly grown for processing purposes, especially for export as pulp, a semi-processed product, while less than 20% is consumed fresh domestically.

Trends in mango diversity

Because mango is a perennial crop with a lifespan of at least 40 years it is difficult to assess the trends in mango diversity. Although many varieties are present in farmer fields, the shares of some varieties are extremely small and it is possible that these shares have substantially reduced. In addition, as mango orchards are often mixed in age, it is difficult to compare the varietal diversity of older orchards. We therefore calculate a weighted (by area) mean age of each orchard and examine the trends in diversity.

We use two measures for the level of agrobiodiversity, the Simpson index and the Margalef index. The Simpson index measures both the richness and abundance of a crop population and expresses the relative concentration of dominance (Meng et al., 1998) and has a lower limit of zero when only one variety is grown. The Simpson index is constructed as follows:

$$MD=1-\Sigma p^2 \quad (1)$$

where; MD represents mango diversity maintained by a farmer ($MD \geq 0$); and p is the share of a variety in total number of mango trees maintained by a farmer.

The second measure for diversity takes the land area into account. This is important because the number of varieties grown will strongly depend on the land resources available. The Margalef index is the number of mango varieties normalized for area planted and also has a lower limit of zero when only one variety is grown (Nagarajan et al., 2007). The Margalef index is constructed as follows:

$$MD=S-1/\ln A \quad (2)$$

Where; MD denotes the mango diversity maintained by a farmer ($MD \geq 0$); A is the total area planted with all mango varieties by this farmer; LN = natural logarithm; and S represents the total number of mango varieties maintained by this farmer.

Figure 4 shows the trend in diversity as given by both indices (generated by using a fitted smoother line in SPSS) in mango diversity with the average age of the orchard.

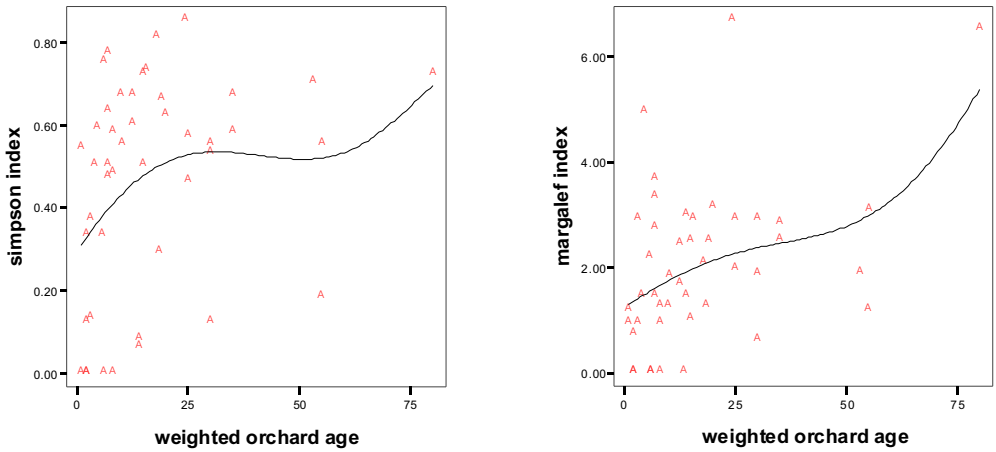


Figure 4. On-farm agrobiodiversity trends

The figure shows a trend of increasing agrobiodiversity with an increase in the weighted orchard age for both the Simpson and the Margalef index, although this trend is much stronger for the latter. This implies that the newer plantations have been established with less varietal diversity i.e. erosion of diversity. This is confirmed by a statistically-significant positive correlation coefficient for the correlation between the weighted age of the orchard and both the Simpson index and the Margalef index. Because genetic diversity basically means the total allelic diversity in a population, it is not certain if a reduction in number of varieties is an actual indication of genetic erosion. However, with fewer varieties being planted, it may be safe to assume that there is real genetic erosion in mango in the study area.

Producer costs, returns and profits

Because we are considering a perennial crop, long-term investments are expected to be substantial. To analyze the impact of this investment, we conducted an economic assessment of the costs, returns and profitability of mango production. First an assessment is made of the fixed costs incurred that represent the costs for the initial establishment of the orchard such as for planting material, land preparation, planting and fertiliser application and all other fixed items such as land development, irrigation system and other infrastructure, and annual depreciation of capital.

Secondly the operation or variable costs are examined, which are all costs required for daily maintenance of the orchard such as the expenses of fertilizers, pesticides, labour, transport and marketing. Estimation of yield obtained and marketed is another important aspect in assessing the profitability of horticultural crops. Total returns are estimated based on the prevailing wholesale market price for different varieties and the estimated yield.

The following pages present the costs and returns for a mango orchard with approximately 80 plants (mixed) and the average returns and profitability. Because the mango orchard starts yielding in the fourth year after planting, all the expenses incurred until such time starting from the moment of physical establishment are considered as establishment costs (fixed costs).

Table 3. Mango establishment and maintenance costs until first harvest (Rs / ha)

Sl no	Cost categories	Value in Rs/ha
Physical establishment		
1	Plants	4 363
2	Digging pits	2 257
3	Ploughing	865
4	FYM	1 763
5	FYM application	353
6	Planting	269
A	Sub-total	**9 870**
First year maintenance		
1	Fertilizers	300
2	Fertilizer application	37
3	Pesticides	195
4	Pesticide application	30
5	Weeding	948
6	Interculture	827
7	Others	173
B	**Sub-total**	**2 510**
	Total costs first year	**12 380**
Annual maintenance after first year until first harvest		
1	FYM	1 201
2	Fertilizers	1 950
3	Pesticides	2 250
4	Labour	2 201
C	Sub-total	**7 602**
Total establishment cost (A+B+3*C+10% interest)		**38 706**
Apportioned annual fixed costs (over 40 years)		**968**

As can be seen in the table, these expenses amount to 9870 Indian Rupees (Rs) per ha, while the maintenance costs for the first year amount to Rs 2510 / ha. For subsequent years, until the first

harvest, mango maintenance costs are on average Rs 7602 / ha annually. The total costs of establishment amount to Rs 38 706 / ha. Assuming that the economic life of an orchard is 40 years, the annual fixed costs of mango production are Rs 968 / ha.

The costs presented in Table 4 are calculated for a typical orchard with at least two applications of pesticide sprays and regular fertilization. Marketing costs are also included. In case farmers sell directly to pre-harvest contractors (PHCs) farmers will undertake more limited orchard maintenance reducing their costs to Rs 10 312 / ha. The gross returns from the sale through a PHC would range

Table 4. Average annual profitability of mango orchard (Rs / ha)

Sl. No	Particulars	Value Rs/ha	Percent to total
Cultivation costs			
Material Input costs			
(i)	FYM	1 325	5.9
(ii)	Fertilizers	2 972	13.3
(iii)	Pesticides	4 153	18.6
A	Sub-total material inputs	**8 449**	**37.9**
B	Labour	3 240	14.5
C	Miscellaneous	811	3.6
D	Total operating costs (A+B+C)	**12 500**	**56.0**
E	Interest on working capital	1 250	5.6
F	Total cultivation costs (D+E)	**13 750**	**61.6**
Marketing costs			
(i)	Transport	375	1.7
(ii)	Commission	3 098	13.9
G	Total marketing costs	**3 473**	**15.6**
Fixed costs			
H	Rent on land	4 000	17.9
I	Apportioned establishment costs	968	4.9
J	Total cost of production (F+G+H+I)	**22 191**	**100.0**
	Average yield (kg/ha)	11 665	
	Average price (Rs/kg)	6.64	
	Gross returns (Rs)	**77 456**	
	Net return (Rs)	**55 265**	
	Cost-Benefit Ratio	**3.49**	

The annual maintenance costs increase with the age of the orchard until it stabilizes at about Rs 13 750 / ha on average. A mango orchard between 10 to 20 years of age yields an average of 11 665 kg and gives growers a net return of up to Rs 55 265 / ha. The relationship between the benefits and costs, expressed as the Benefit Cost Ratio (BCR), is 3.49, which implies that on average,

commercial mango farmers have a 3.49 times return to their investment into the orchard in a year. Only 10 farmers in our sample are able to reach these yields as they maintain orchards that are mixed in age. On average, the yield for the year 2005 was 8350 kg ha^{-1}. Failure to secure the harvest owing to a disease or natural disaster could result in a loss of Rs 4968 18 718, depending on when the disease or disaster strikes during the production season. Costs will also further increase if trees die or are removed before the 40-year economic life that is used for the estimation of fixed costs.

Comparing the 2005 yield and gross return data with the contribution of the varieties in gross returns reveals that some varieties have low productivity but higher returns. This shows the significance of agrobiodiversity. Figure 5 shows the differences in contribution of varieties to farm yield and gross returns.

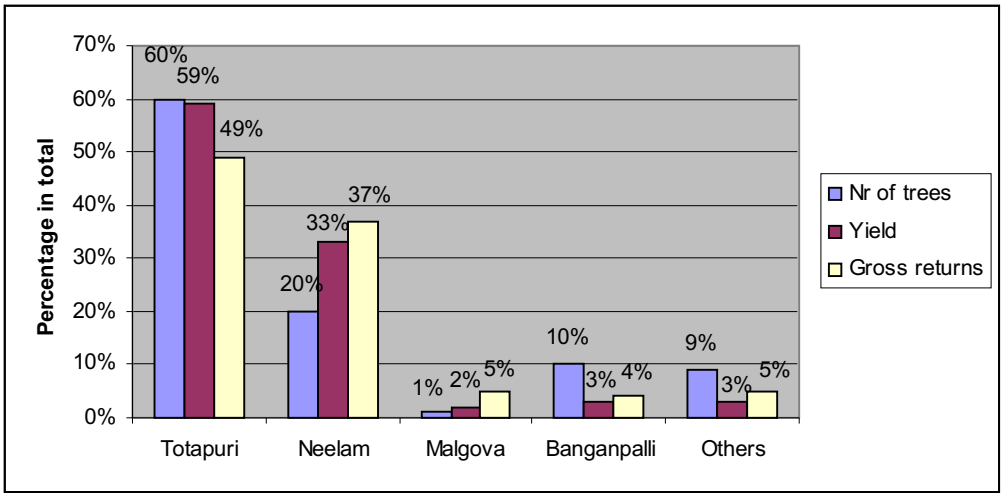


Figure 5. Contribution of varieties to farm yield and gross returns 2005

The figure shows that while totapuri has a share of 60% in the total number of trees, it contributes to 59% of the farm yield but only 49% of gross returns. Neelam, although only making up 20% of the number of trees, contributes to 33% of farm yield and 37% of gross returns. This is caused by neelam's premium price, arriving in the market late in the season when most other varieties have ceased to produce. Unfortunately we were only able to obtain reliable data for the yield of the year 2005 because of difficulties of recall by farmers and it is therefore not possible to establish whether the major difference in yield between totapori and neelam is caused by the biennial bearing pattern. Malgova, banganpali and all other varieties together contribute 2-3% in farm yield each although the share of malgova in total number of trees is much smaller than that of the other two. Their contribution to gross returns is also quite similar, around 4-5%. These varietal differences in value will only become visible to farmers if they participate in the market themselves (as opposed to bulk-sales to a PHC). Providing market information, building awareness and facilitating farmers to undertake self-marketing, are thus important issues for farmers' appreciation of varietal diversity. Another important issue is timing; once the fruits have ripened the farmer needs to sell them quickly at the prevailing price as mango does not have a very long shelf life. Farmers therefore do not have the flexibility to wait for a period with better price which reduces their bargaining power. The only

way to manipulate harvest time is by influencing the time of flowering. This is not commonly done by the farmers in Chittoor district. Shelf life slightly varies by variety, depending on the thickness of the skin and other traits of the fruit. This also indicates that more research is needed in enhancing shelf-life of mango, so that the farmers can wait for better market price.

The market chain

Commercial mango growers in Chittoor district have several outlets for their fresh mangoes, including pre-harvest contractors, wholesale and retail markets and processing units. We describe the mango chain as was observed in Karnataka state bordering the state of Andhra Pradesh and a destination for much of Andhra Pradesh mango as well. Karnataka state has one of the country's major mango wholesale markets, but also offers several alternative outlets. Figure 6 depicts the mango market chain as was observed in Karnataka state. The dark yellow boxes show the main channel. In the following sections we will explain the main actors in the mango chain depicted in the figure.

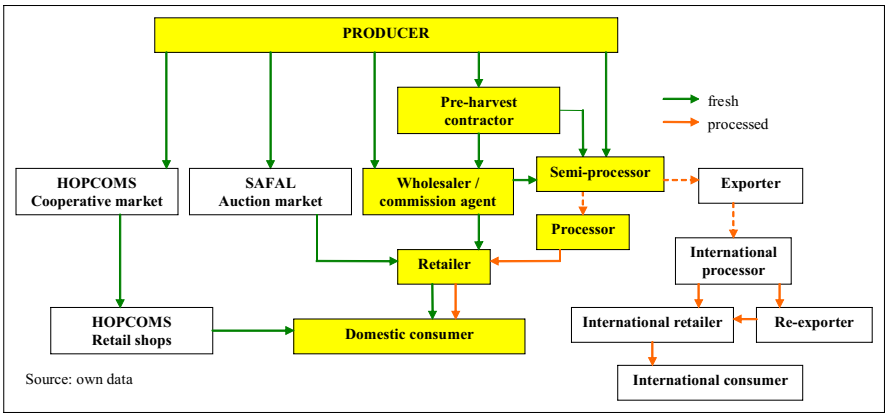


Figure 6. Mango market chain in south-west India

The main market channel

Pre-harvest contractors: The most common outlet for mango growers in India is the pre-harvest contractor (PHC). The PHC enters into a contract with a farmer three to four months prior to the harvest season, based on the flowering of the trees and sometimes undertakes some of the maintenance of the orchard. The PHC enters into contracts with several farmers and is therefore able to reach economies of scale by amassing the produce. By entering into a contract with PHCs, farmers transfer their production and marketing risks down the market chain, thereby foregoing the opportunity of selling their own produce directly, which could be more profitable. This is encouraged by the specific characteristics of mango production and sale, such as biennial bearing of mango trees and high transaction costs. The PHCs supply to wholesale and retail markets and processing units. In Chittoor district we found 23% sold though a PHC and marketing through the wholesale market was most dominant.

Wholesale market: The farmer or PHC transports the harvested mango to the wholesale market, a specialised market solely trading in mango with a large number of auction lots, where the produce is auctioned by a commission agent. These markets, usually referred to as *mandi*, are in a central location with more or less permanent selling facilities where up to 1500 tonnes is traded daily. The

commission agent rents the auction lot during the mango season or buys it and auctions to processors, retailers and petty vendors. The commission agent provides facilities for sorting and grading, and oversees the auctions. For this intermediary role, the agent charges a commission to both the selling and buying parties. Sellers entering the market place also pay a fee based on the weight or size of their vehicle. Prices in the wholesale market for the years 2004 - 2006 as recalled by farmers are shown in Table 5 which shows both the fluctuations in prices over the years and the differences between the varieties.

Table 5. Average mango wholesale price per variety (Rs / kg)

Variety		Year		average
	2004	2005	2006	
Totapuri/ bangalora	4.46	7.45	5.46	5.79
Neelam	8.25	5.93	7.25	7.14
Banganpalli/ banisham	10.50	10.06	9.29	9.95
Alphanso/ badami	20.00	20.00	20.75	20.25
Pulera	n/a	4.44	4.88	4.66
Khadar	n/a	16.50	n/a	16.50
Kalapadi	n/a	5.56	n/a	5.56
Malgova	n/a	12.50	13.75	13.13
Other	n/a	4.44	6.00	5.22

Source: own data

What can not be observed from this table is that apart from price fluctuations between the seasons, major fluctuations also take place within the season. By maintaining a combination of varieties, farmers can take advantage of the price differences between varieties and seasonal fluctuations.

Retailers: The retailers that sell the fresh fruits to the consumers come in different shapes and sizes ranging from mobile road side vendors to modern supermarkets. Although small vendors and outdoor markets are still the main outlet for fruits and vegetables, the share of supermarkets is increasing fast. Retailers purchase the produce from wholesale markets. Generally the fruits are then directly sold to the consumer although in limited cases some packaging will be done.

Processors: The Government of India has played an active role in promoting the establishment of processing and value adding units near the production areas. As a result the number of semi-processing units in Chittoor district has doubled in the last decade and the district now houses over 50 small- to medium-scale mango semi-processing units located within a radius of about 50 km from the mango orchards. These units operate during three months in the year, converting fresh mango (mostly of the variety totapuri and to a lesser extent alphanso) into pulp. Together they processed pulp of a value of Rs 1166.3 million, which is US$ 26.5 million, in 2003 (Mahendradev and Rao, 2004). Mango is usually sourced from the wholesale market, although large farmers have the

option to supply directly, given that the processing units are located close to the production centre. While the majority of processors are small scale canning units with investments up to Rs 2 million with a capacity of 10 tonnes of fresh mango per hour (Ministry of Agriculture, 2005), there are a few units with the state-of-the-art technology for undertaking aseptic packaging involving an investment of over Rs 5 million (5 tonnes per hour capacity). The processing units undertake custom processing based on the orders from exporters. Raw material and packing material (tin cans) are supplied by the exporter, while the semi-processing units simply convert fruit into pulp using the available infrastructure and labour. The amount paid to the processor to conduct this activity is about Rs 2250 per tonne of pulp. Processing units also undertake their own processing, procuring the raw fruit from the market. Then a working capital of over Rs 200 000 per container (of 6000 cans or 18.6 tonnes of pulp) is involved. The final product of this processing stage is a semi-processed product, mango pulp. The exporter bears the costs of transporting the pulp to the port and exports to its export destinations by sea. Further processing to final products takes place in the destination countries.

Margins in the chain: It is of interest to understand the role played by different market intermediaries and their share of margin so as to assess the level of equity in distribution of value across the market chain. In Table 6 an overview is presented of the costs and margins of fresh and semi-processed totapuri sold through a PHC. The highest margin in the fresh chain is earned by the retailer (28%), followed by the wholesaler (16%), farmer (10%) and lastly the PHC (9%), whereas in the processed chain the exporter receives the highest share (17%). The PHC is in this chain better off than in the fresh one (11%) and is only then followed by the processor (7%) and finally the farmer (6%). In real (rupee) terms there is no price difference for the farmer. The PHC, however, is able to increase the margin in real terms due to the elimination of the commission agent from the chain.

Table 6. Marketing margins and price spread of totapuri mango through PHC

Fresh			**Processed**		
	Value (Rs/kg)	% of total		Value (Rs/kg)	% of total
Farmer			**Farmer**		
Net price	1.63	**10.19**	Net price	1.63	**6.14**
PHC			**PHC**		
Buying price	3.00	18.75	Buying price	3.00	11.30
Costs			Costs		
Transport	0.12	0.75	*Transport*	0.01	0.04
Handling	0.30	1.88	*Handling*	0.01	0.04
Commission	0.42	2.63	*Commission*	0.01	0.04
Margin	1.41	**8.81**	Margin	2.97	**11.19**
Wholesaler			**Processor**		
Buying price	5.25	32.81	Buying price	6.00	22.61
Costs	0.65	4.06	Costs	0.06	0.23
Margin	2.60	**16.25**	Margin	1.91	**7.20**
Retailer			**Exporter**		
Buying price	8.50	53.13	Buying price	7.97	30.03
Costs			Costs		
Transport	2.50	15.63	*Cans*	3.33	12.56
Handling	0.50	3.13	*Reforming & filling*	1.67	6.29
Margin	4.50	**28.13**	*Packing*	0.02	0.09
			Transport to port	0.25	0.94
			Sea freight	2.53	9.52
			Commission	0.64	2.41
			License	5.56	20.95
			Margin	4.57	**17.22**
Consumer price	16.00	100.00	**Export price**	26.54	100.00
Price spread	14.37		**Price spread**	24.91	

Some large scale producers that are located in the vicinity of the processing units are able to make direct deliveries to the processing units, thereby substantially increasing the margin they receive, possibly up to about 16%. The processor's margin reflects the level of risk undertaken by this chain actor, the work is contracted and own investments are therefore limited, resulting in a relatively low level of risk. Along the market chain the material is increasingly bulked, due to a concentration of the produce with a decreasing number of players at each stage in the chain, which implies that income in real terms will also increase substantially along the chain. The difference between the price paid

by the ultimate consumer and the price realized by the producer is the price spread, in the case of fresh and processed totapuri Rs 14.37 and Rs 24.91 / kg respectively. Although the price spread is significantly different in the two chains because the costs involved in processing are much higher, this is not reflected in the margins earned in real terms.

Alternative channels

Horticultural Producers Cooperative Marketing Society (HOPCOMS) is a cooperative society set up in Karnataka to provide the producers an alternative marketing channel for powerful market intermediaries such as the PHC and commission agent. HOPCOMS, set up in the 1970s has 230 outlets in the state of Karnataka and employs around 1800 people. Fruits and vegetables are only procured from the approximately 16,000 members of the cooperative. Facilities are provided for farmers to stay overnight and have their produce graded and sold early the next day. The daily price of HOPCOMS is established based on the daily retail market price. The farmer receives a 75% share of the final HOPCOMS retail price, but has slightly higher costs than those trading in the traditional markets as the cooperative members have higher transport costs and pay a (small) membership fee. One of the major constraints of this marketing system is a lack of appropriate infrastructure to handle large quantities. Figure 7 provides an overview of quantities of different varieties of mango transacted at the HOPCOMS market and their total value for the production season 2003 - 2004 and 2004 - 2005. The figure shows that while the quantity traded in 2003 - 2004 is much higher for all varieties, the total value is relatively stable for some varieties. Prices for 2004 - 2005 were thus much higher due to low supply. Total quantity traded for production season 2003 - 2004 was 805 tonnes, which is a marginal proportion of the total quantity that is traded at the mango wholesale market. HOPCOMS will thus only be able to provide an alternative to a relatively small proportion of farmers.

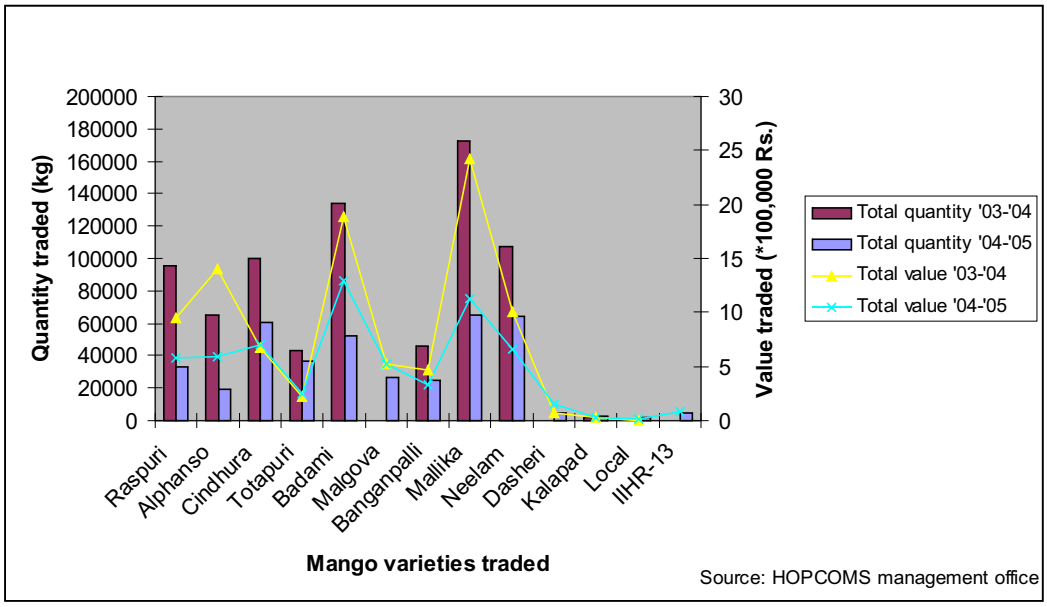


Figure 7. Quantity and value of mango varieties traded at HOPCOMS

SAFAL. About ten years ago a, for India new type of market based on international auction systems, was established in Bangalore (Karnataka). This market, called Safal uses the Dutch auction system (with an auction clock on which prices are reduced) for fruit and vegetables and the English system (with the auction clock counting upwards) is used for onion, potato and garlic. With two auctions per day, the reference price for the morning auction is the wholesale price of the day before, while the afternoon auction uses the morning wholesale price of that day.

The produce is procured from 200 farmer associations through local collection centres. The produce is transported to the auction hall, graded, shown in lots and sold the day after the farmers deliver it to the collection centre. Farmers receive payment based on a weighted average of the auction price the next day. Any produce that is not sold through the auction is sold in small outlets at the Safal premises. Because of the novelty and unfamiliarity of the auction system, Safal faces the challenge of gaining buyer interest and trust. Quantities of mango sold through this outlet are therefore relatively low.

The Mysore Foods aseptic processing unit annually processes about 14,000 tonnes of mango of the varieties totapuri, raspuri, alphanso and neelam into 6500 tonnes of blended mango pulp for secondary processing abroad. Final products (produced by the secondary processors) include baby food, fruit juice, ice cream, drinking yoghurt and mango bars.

The factory specifically supplies factories in the Middle-East and Europe that are equipped with machinery following the Hazard Analysis and Critical Control Point (HACCP) standards, which require a fully mechanized processing line. The factory operates 210 days annually, of which 90 days are for mango pulp production, 60 days for guava and 60 days for tomato. The capacity of the unit is 4 tonnes of pulp per hour, with an output of approximately 48% of pulp for the total weight of raw material (for alphanso, the output for totapuri is slightly lower). During the mango season the factory will be in operation 24 hours per day with 5-hour interruptions for the required cleaning processes.

Mango is procured directly from Bangalore, Kolar, and Chittoor mango mandis. Although contract farming is conducted for tomato, this has so far not succeeded for mango because farmers have a tendency to sell their produce at the wholesale market when prices are higher there.

Aseptic processing: With increasing attention for food safety standards, the demand for aseptic packaging of pulp for export markets is increasing. This type of process requires substantial investments in sterile processing and packing technology and lab testing facilities. In south India only two of these kinds of units are present; one in Chittoor and one in Bangalore. The latter unit is further described in the textbox. The units have a capital intensive process with high levels of fixed investment and sourcing of raw material in the appropriate quantity, with the required maturity, for the requisite price is a crucial constraint. It is essential for processors to utilize the unit at full capacity at all times during the mango season. The unit near Bangalore indicated that about 40 - 50% of the factory's sales are based on pre-fixed contracts with a fixed price. Profit therefore largely depends on the seasonal price of fresh mango. Contract farming schemes, which would ensure a stable supply at a fixed price, have not been successful as yet.

Chain improvements

As described, the mango market chain is dominated by a few powerful actors that dominate the mango trade. Entering the wholesale market is a major obstacle for many (small-scale) farmers. Apart from organizing transport and paying entry fees the farmers have to bargain with large buyers. Not only is there inequitable division of bargaining power, sometimes there are also practical problems such as a language barrier. It is for this reason that the commission agent has such an important role and position in the chain, taking a substantial share in the margins. Pre-harvest contractors relieve farmers all together from participating in the wholesale market, but will usually also result in lower farmer profits. Alternative outlets such as HOPCOMS and Safal seem to be beneficial to farmers but currently do not have a significant share in trade. Increasing farmer bargaining power and reducing transaction costs seem to be crucial factors which would require collective action, bulking farmer produce at community level through strengthening of community-based organizations and identifying buyers at district level who procure fresh material directly from these groups. Although potential benefits of this approach are substantial, collective action also has major drawbacks that would have to be overcome such as free riding by group members and reduced flexibility to respond to market changes. Furthermore there is often a need for investments, first, at the individual farmer level to acquire and maintain membership or as initial capital, and second, at the group level to build the capacity of smallholders to collaborate. Some level of investment for infrastructure may also be required. Collective action may, therefore, not always be accessible to the most resource-poor smallholders, who lack investment capital, although it has the potential to be more inclusive of the poor than contract farming.

The farm household

Farm household characteristics

The characteristics of the households of the mango growers in Chittoor district have an important role in the decisions that the household takes about the allocation of labour to economic activities and the maintenance of agrobiodiversity. We examine three important factors, the number of household members (on average 5.5) the age of the head of household (average 53) and the number of years of education of the head of household (with a mean of 9.5). Households with more members have a higher level of total income and also have higher income from mango. Their level of income diversification is lower than that for smaller households which is surprising as they would have more labour to allocate to other activities. Households in which the head is older also have a tendency for more specialization in income. Education is another important factor; households in which the head has a higher number of years of education tend to have higher total and mango income as well as a higher share of mango in total income. These households also have higher Margalef and Simpson indices for agrobiodiversity, implying that the agrobiodiversity maintained by these farmers is both richer and more evenly distributed.

Farm household income of mango growers

The composition of the income of the farm households is shown in Table 7. Between brackets is the number of farmers in the cluster that have this type of income. Averages are shown only for those that have this source of income and not as average of the whole group. The rows and columns therefore represent the averages of the particular group and thus do not add up to the total averages given in the last row.

Table 7. Composition of average income per farm size cluster (Rs)

Income category	≤ 4 acres	4-8 acres	>8 acres	Total sample
Mango	(12) 24 335	(10) 81 410	(8) 638 580	(30) 207 159
Other crops	(10) 49 635	(6) 65 875	(7) 167 557	(23) 89 760
Livestock	(5) 31 170	(4) 30 938	(3) 104 925	(12) 49 531
Agric. wage labour		(1) 12 000		(1) 12 000
Non-farm employment	(6) 113 642	(2) 70 500		(8) 102 856
Business	(1) 42 000	(2) 85 000	(3) 170 000	(6) 120 333
Pension, remittances	(3) 46 000	(1) 30 000		(4) 42 000
Total average income	**(12) 146 506**	**(10) 168 610**	**(8) 894 290**	**(30) 353 283**

The table shows that the differences in income between the two smaller farm size clusters do not differ that much, while there is a large gap between these two groups and the largest area cluster. There are, however, substantial differences in the composition of income of the group with equal to or less than four acres of land and that of the group with four to eight acres of land and the share of mango income in total household income as presented in Figure 8. The figure shows that the share of income of the smallest farm size group is below 20%, while that of the second largest group is almost 50%. For the largest farm size group the share of mango income in total income is more than 70%. The income productivity, i.e. mango income generated per acre, is substantially higher for those farmers that have a higher share of mango in total income.

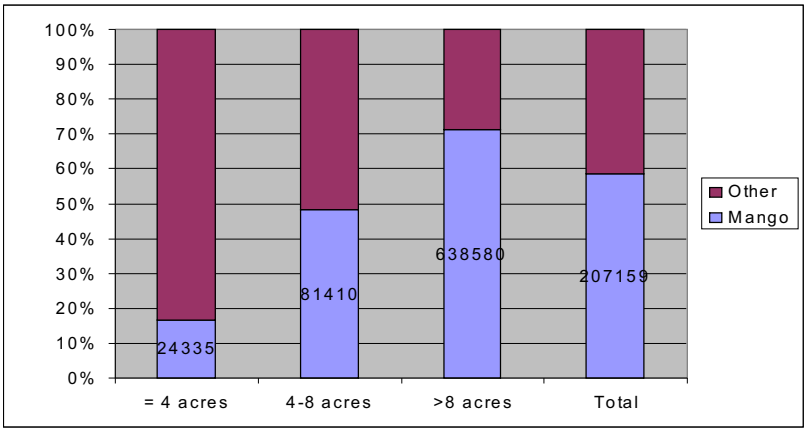
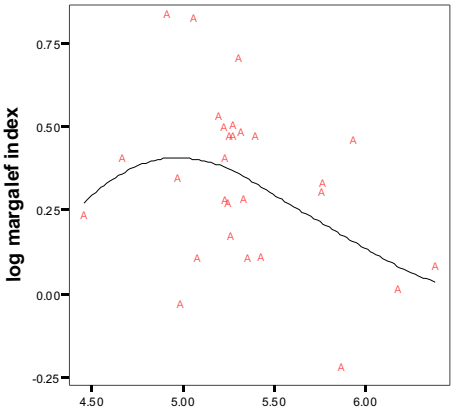


Figure 8. Share of mango income in total household income

A significantly positive correlation exists between the level of income specialization, as given by the Herfindahl index, and the mango area size. The Herfindahl takes a value of one if full specialization is taking place and is calculated by taking the sum of squared shares in total income of different income generation categories (Barrett and Reardon, 2000). That means that farmers that have a larger mango area size are more specialized in their income generation. There is, however, no significant correlation between total income and the Herfindahl index and that means that the level of income specialization is not related to the level of income which would have been expected as a mechanism to cope with shocks. Maintaining more agrobiodiversity on farm could be another strategy of resource-poor farmers to cope with risk. Then the level of agrobiodiversity maintained should be correlated with the level of income diversification. We therefore examined the relationship between the Herfindahl index and the Simpson and Margalef indices for on-farm diversity, already described in the beginning of this chapter (equation 1). However, no significant correlation was observed between either of the variables, which means that two possible risk coping mechanisms are not used by farmers. This is probably due to a high level of access to credit, with 78% reporting that they have a loan and of those that do not have a loan, 73% indicate that they have no need for one at the moment. Besides, 63% have a savings account to fall back on, which is mostly used for agricultural activities. Of farmers, 24% also have an insurance policy and 13% have a pension, which are two other forms of safety nets. The Margalef index shows a positive correlation with the availability of a safety net, indicating that those households that have a safety net are also more likely to have a richer distribution of mango diversity. The Simpson index is not correlated with the availability of a safety net.

Examining the relationship between income generation and agrobiodiversity maintained for the commercial mango growers, we find a significantly negative correlation between the Margalef index and total household income. The correlation between the Margalef index and income derived from mango, however, is not statistically significant although there is a significantly negative correlation if we take the number of varieties per acre instead of the index. We further examine these relationships graphically in Figures 9 and 10 and discover that a similar pattern exists for the relationship between income derived from mango and agrobiodiversity as we have already seen in Figure 3 in the beginning of this chapter, which depicted the relative number of varieties and mango area size. A lack of resources thus seems to restrict farmers from having diversity of perennial species. As we have already discussed, mango requires substantial long-term investment but also needs substantially more space to be grown than most annual crops and is thus less diverse with resource-poor farmers.



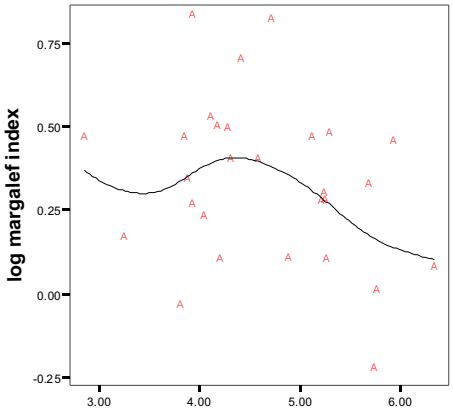


Figure 9. Household income and biodiversityFigure 10.Mango income and biodiversity

There may be some confounding factors in this analysis. The level of total mango income is related to the size of the area planted with mango and we already established that mango area size and the number of varieties per acre are negatively correlated. We therefore also analyze the correlation between mango income generated per acre and varietal diversity as expressed by the Margalef index, and find that there is no statistically-significant correlation between these two variables either.

There is no statistically-significant correlation present between the Simpson index and both total household and mango income.

Secondary employment

Besides the prominent actors in the chain such as the PHC, wholesaler/commission agent, retailer, processor and exporter, others also earn an important part of their livelihoods by participating in the mango trade. Employment is provided to a large number of people that are involved in odd jobs such as loading, unloading, sorting and grading at the market yard and sorting, cleaning, cutting and packing at the processing units. Also transport at all stages in the chain provides employment for many. During the mango season, people temporarily migrate to the market yard in the urban area or the processing units from as far as 200 km away to earn a living. During the years when quantity is high it is not uncommon that some of them also act as small (on the spot) retailers**.** However, the jobs performed at the processing level are under threat by the increase of automated machinery that is required for the aseptic packing, leaving many jobless.

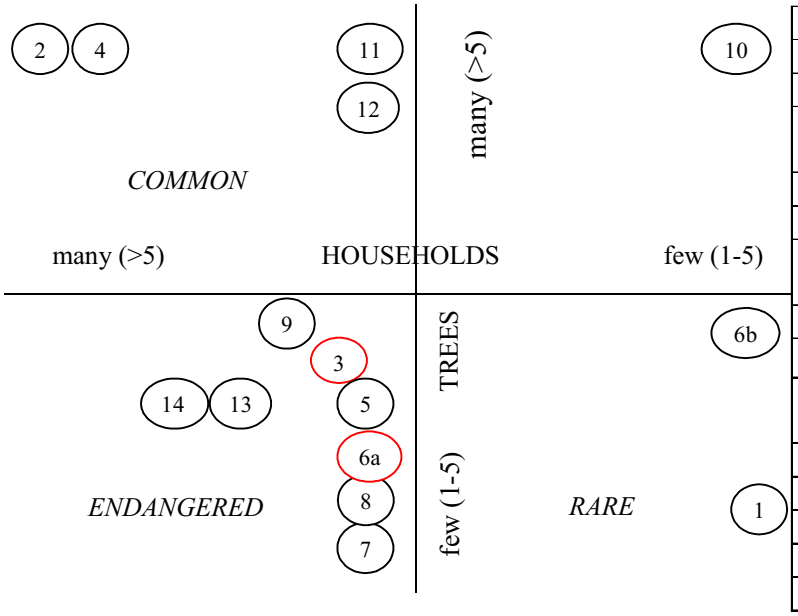
Mango collected from homegardens and the wild (Sirsi)

Apart from mango varieties cultivated by commercial growers there is also a vast number of varieties that is collected from homegardens and the wild. These and other wild fruits cater to the consumption needs of dependent farm families dwelling on the edge of forests and form an important component in their livelihoods. In an attempt to capture the status and contribution of mango collected from the wild, we undertook two focus group discussions in Sirsi, Uttara Kannada district, Karnataka state. In the discussion, several participatory techniques were used to assess the trends, status and use of mango diversity occurring in the vicinity. The two groups are separated by gender. The first group consists of 46 women from Kauler Koppa village, Siddhapur taluk (sub-

district). The women belong to two different groups of “Shri Shakti” ('women power'), a local organization supporting women. These two groups are subsidized by the government. The second group is composed of 22 men from Vaaje Gadde village, Siddhapur taluk.

Present status of mango diversity

A diversity assessment aims to identify key biological assets for local livelihoods and to identify common, unique and rare plant genetic resources in order to develop diversified livelihood options and conservation plans, making use of a participatory four-cell analysis (FCA) (Sthapit et al., 2006). During an FCA, the participants are asked to list all the varieties of a certain species and place them in one of four quadrants based on their household use, i.e. whether they are used by few or many households, and the size of the area or in the case of tree species the number of trees, i.e. a small or large area is cultivated or few or many trees are available in homegardens, farmer fields and the wild. The location of a certain variety in a quadrant can assist researchers to understand the amount and distribution of a variety. The mango varieties identified by both the women and men can be classified into three categories, i.e. those used as fruits (*mavu*), those used as vegetable (*kadigai*) and those used for pickling (*appe*). The *mavu* varieties can be further divided into sweet and sour. Within the sweet fruits we can identify fibrous and non-fibrous ones. Figure 11 shows the outcome of the FCA for the women group.



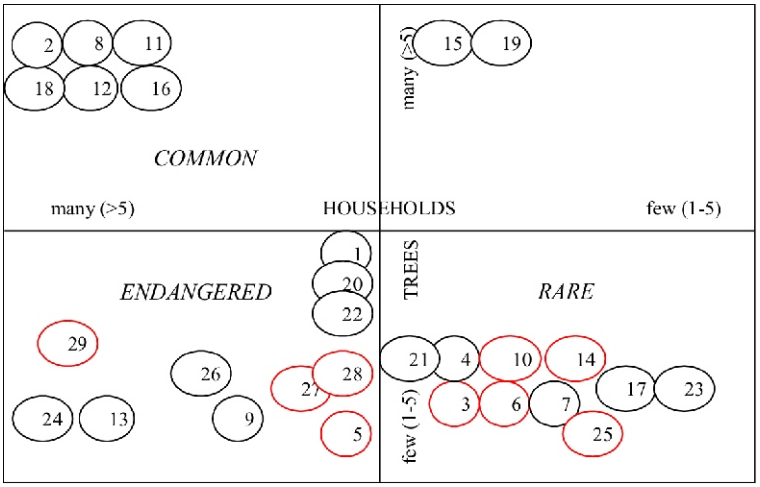
Nr	Name
1	Kutumb appe
2	Midi mavu
3	Jeerige appe (8 varieties)
4	Appe mavu
5	Sundarasi mavu
6	Esadi a. white, b. black
7	Raspuri
8	Magey mavu
9	Kadigai mavu (5-6 varieties)
10	Huli mavu
11	Kochagaye mavu
12	Sasme mavu
13	Mallika
14	Neelam

Figure 11. Four-cell analysis women group, Sirsi

Those varieties in the upper left hand corner are used by many households and many trees are available. These varieties can be considered “common”. According to the women group these varieties are midi mavu and appe mavu, both pickle varieties that are considered to have either market potential (midi mavu) or medicinal properties used for cracks on legs, regulation of the menstrual cycle and amoebic dysentery (appe mavu). To a lesser extent, sasme mavu and kochagaya mavu, used as vegetable, are also part of this category. Those varieties placed in the right-hand, lower quadrant are those that are used by few households and of which only few trees

are available. These varieties are considered to be “rare”. The women only consider two mango varieties as rare, i.e. kuturp appe which is a pickle variety and black esadi, a sweet, introduced variety that is very infection prone. The lower, left-hand quadrant is of most concern for conservation, as it shows those varieties that are used by many households but of which there are only few trees available. According to the women, eight of the named mango varieties fall in this category and some of these are considered 'endangered'. These include magey mavu, a sweet local variety, white esadi and sundarasi mavu, both sweet, introduced, and infection-prone varieties, of which the first is considered to be endangered; and jeerige appe and kadigai appe which are both pickle varieties that are considered to have market potential. Jeerige appe is considered to be endangered. In addition, raspuri, malika and neelam that are introduced sweet hybrids fall in this quadrant, but they would not be considered endangered. From this analysis, it is not possible to conclude whether these introduced varieties are a threat to the presence of the sweet local varieties.

The same analysis was carried out with the group of men. Traditionally the management and collection of fruits is an area where men are more dominant. This is immediately reflected in the number of mango varieties identified by the men group, 30 versus 14 identified by the women. Figure 12 shows the diversity assessment carried out by the men. The varieties identified by the group as endangered do not seem to have any relation with the number of households that are using it, but after discussion it does seem to be related to whether these varieties are deemed to have medicinal purposes. Out of nine varieties that are considered to be endangered, eight are also considered to have medicinal properties. The varieties that are considered to have market potential are all classified in the upper left quadrant that represents the 'common' varieties. Most introduced varieties are now in the upper half of the FCA, indicating that there are many of these varieties present.



Nr	Name	Nr	Name	Nr	Name
1	Anantha Bhatta appe	11	Giduganamaney mavu (1 hybrid, 1 local)	21	Parnula mavu
2	Jeerige appe (8 var)	12	Esadi (white and black)	22	Neelam
3	Kanadhagaddhe appe	13	Gilisundi mavu	23	Kampegundey appe
4	Adakmavu	14	Magey mavu	24	Shridhar mavu
5	Kanch appe	15	Sundarasi mavu	25	Ambekombina appe
6	Gadiholey appe	16	Aapoos mavu	26	Maalangi appe
7	Gund appe	17	Aamrapali	27	Amb appe
8	Kochagaye mavu (8 var)	18	Mallika	28	Cheepae mavu
9	Kadigai mavu (5-6 var)	19	Raspuri	29	Holeypaalu
10	Hasikai mavu	20	Sasme mavu	30	Totapuri

Figure 12. Four-cell analysis men group, Sirsi

While the women mostly identify those varieties that can be used for pickling and as vegetable, the men identify six varieties that are considered to have medicinal properties, compared with only one identified by the women. The variety identified as medicinal by women has not been classified as such by men. The use of this medicinal variety is for cosmetic purposes and menstrual problems and is thus more of interest to the women. The men further identify four varieties as having market potential, compared with two identified by the women. Only one of these two is also identified as such by the men. The variety that is identified by both groups as having market potential is jeerige appe. This variety is preferred and has many uses. While the women classify this variety as endangered, the men still consider the variety to be common.

Trends in fruit diversity

A timeline analysis was carried out in order to establish the way the status of diversity has changed over time. In the exercise both groups were asked to assess the shares of important fruit trees in the area at three moments in time, the 1950s, the 1980s and present times. The results of these timeline analyses are presented in Figure 13.

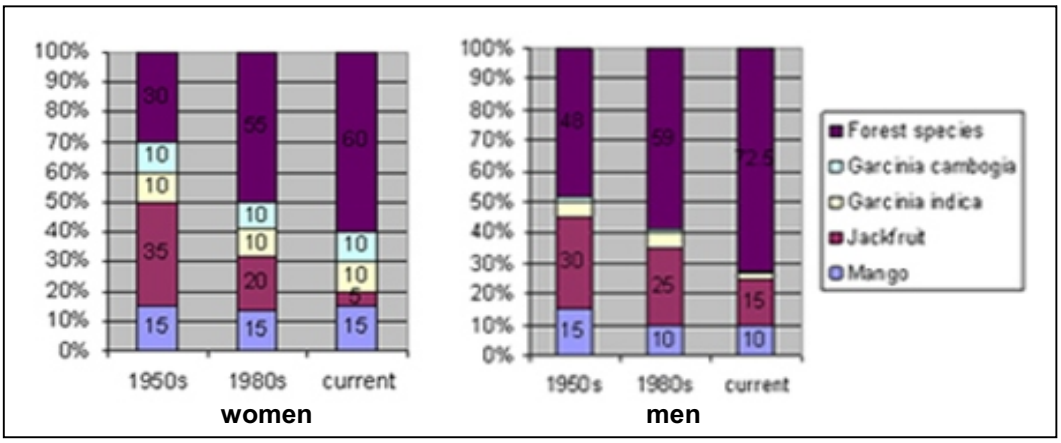


Figure 13. Timelines women and men groups, Sirsi

The women perceive that both mango and the two *Garcinia* species that are collected in this region have remained stable over the years, whereas a clear reduction was seen in the share of jackfruit trees in the forest. According to the men, however, there has been a clear reduction in the *Garcinia* species and a slight reduction in mango. Jackfruit is also considered to have been reduced in proportion, but the reduction is not as clear as that perceived by the women. The difference in perception most probably results from the fact that men are more involved in collection in the wild while women mainly use the fruits that grow in their homegardens. Their scale of measurement is therefore smaller than that of the men. This is reflected by the resource maps that were drawn by both the groups. In the map drawn by the women's group, the focus was on the resources in and around the villages, while the men also indicate many species and varieties outside of the villages. The resource maps can be found in Annex 2. Another possible explanation could be that there are some local differences. The locations of the two villages are approximately 15 km apart and the resources collected are thus also from different locations. This would imply that overexploitation of certain species is concentrated in very small areas.

The respondents are unaware of any conservation measures undertaken for these species. Most of the fruits that are harvested are used for home consumption as pickles, vegetables, fresh fruits or medicine and there is almost a complete absence of marketing efforts. The contribution to family income from the sale of fresh or processed products is negligible, although it does provide value through home consumption.

The link between agrobiodiversity and livelihoods

The analysis has shown that there is a declining trend in mango diversity maintained in farmer fields in Chittoor district. In the analysis above we found that in terms of farmer characteristics the total level of income has a negative correlation with agrobiodiversity maintained, while the level of education is positively correlated with the Margalef index. There is no impact of the level of income diversification on the diversity maintained. In making decisions, production characteristics that farmers take into consideration when maintaining varietal diversity include the biennial and seasonal bearing of mango, the high level of fixed costs and long-term investments, the high variable costs for production, the area size planted with mango and the occurrence of pests and diseases. However, mango productivity and the level of mango income have no significant correlation with agrobiodiversity as expressed by the Margalef index. Finally, in terms of marketing, the seasonal price fluctuation of mango is an important consideration as well as the specific market demands of the region (e.g. processors). Market information is an important factor that can facilitate better decision making and the market chain structure should be transparent to accommodate this. Finally, consumer taste differences are important to consider.

From the perspective of the commercial farmer there are thus three main aspects that determine the desire of farmers to maintain several varieties on farm, which will be further discussed in Chapter 5:

1. **Risk spreading.** Different fruit species and varieties are vulnerable to different types of pests and diseases and other stresses. Because of the seasonal bearing behaviour, other threats such as heavy rainfall during a certain period (for example, rain fall at flowering stage, rainfall accompanied by heavy winds) at early fruit set stage), may only affect one variety while it may have less or no effect on another variety depending on the growth stage at which rain occurs. Maintaining diversity thus will ensure household income even if the harvest of one variety or species fails.
2. **Income enhancement.** Planting of several mango varieties allows mango farmers to take advantage of a prolonged harvest season. Information on consumer preference for certain varieties coupled with variation in the time of harvest of different varieties is expressed in the price differences between the varieties. Income enhancement is also an important factor in maintaining those underutilized species that provide a substantial share in household income. The varieties that are considered to be endangered, especially those that are also considered to have market potential will clearly need attention and, if these varieties prove suitable for commercialization, the species would have to be brought under active cultivation. This would require the creation of a forest nursery in order to ensure access to sufficient and high quality planting material.

3. **Income / consumption smoothing.** Mango is a biennial bearer and the output of each variety will thus fluctuate over the years. To smooth out these output differences, farmers need to maintain several varieties of mango in their fields. Furthermore, prices of mango not only differ between varieties but also fluctuate during the season as varieties start harvesting at different times. As a strategy to ensure a better distribution of income over the harvest season, a mix of varieties (i.e. early, mid and late maturing types) is maintained. For forest species, the fluctuation will be present within the year and a range of fruits (not just mangos) available during different times of the year can then ensure food and income supply during the whole year.

4. *Garcinia indica* and *G. Gummigutta*

Two underutilized fruit species of importance in India are *Garcinia indicia* (kokum) and *Garcinia gummigutta* or *G. cambogia* (uppage). Both are considered to have great potential as a spice and medicinal plant (Korikanthimath and Desai, 2005). The *Garcinia* genus is one of the five genera belonging to the Clusiaceae (Guttiferae) family that are occur in South and Southeast Asia. In India, over 30 species occur, six of which are on the IUCN Red List of threatened species and thus under threat of extinction. Both species are found in evergreen and semi-evergreen forests, although uppage is more abundant in the evergreen and kokum in the semi-evergreen forests. Because of a lack of fire resistance, uppage is seldom found in farmland or open landscape, while kokum more commonly occurs under these conditions (Subash Chandran, 2005). Figure 14 shows the maps of the distribution of *Garcinia indica* and *Garcinia gummigutta* diversity in south India.

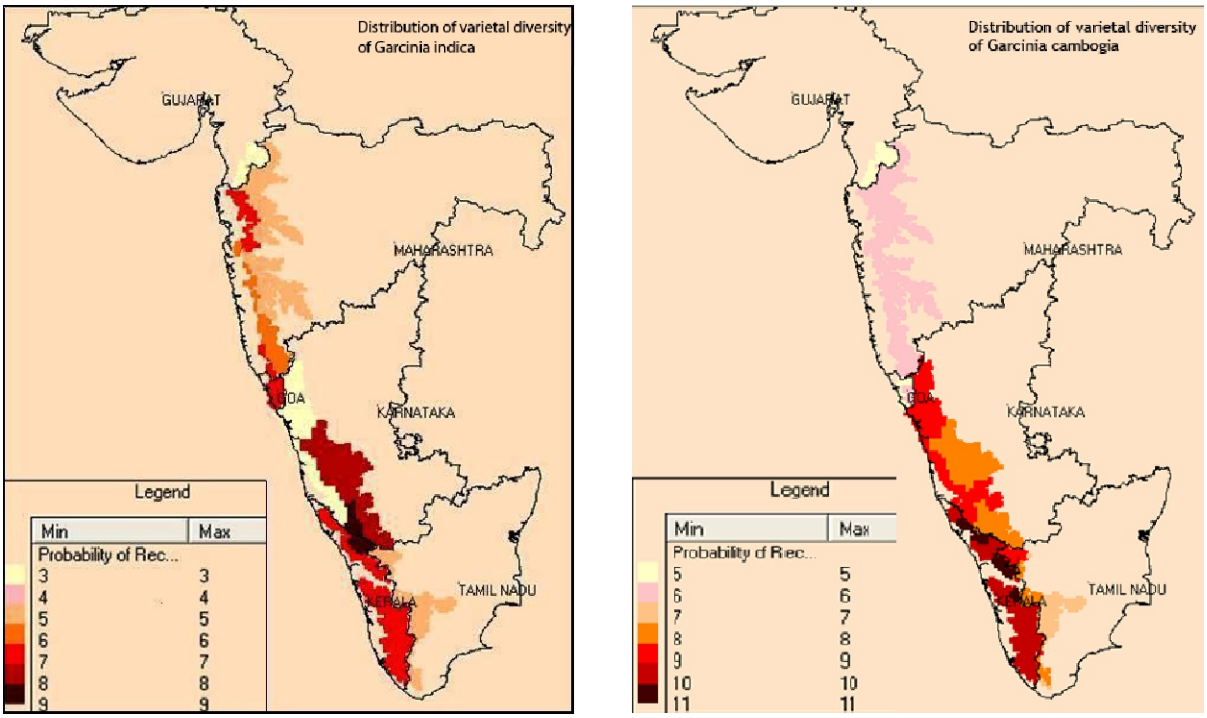


Figure 14. Maps of *Garcinia indica* and *Garcinia gummigutta* varietal diversity distribution

The four study sites are located in areas with a relatively high level of kokum and uppage diversity. Although there clearly is a high level of diversity in the area, this is not observed by collectors and they only differentiate red and white kokum and small and large uppage. As this study does not include any genetic identification of varieties, we were unable to establish which of the varieties were indicated in the categories of the fruits distinguished by the collectors.

Kokum is collected from the wild, grown in homegardens, and cultivated on a limited scale as a rain-fed crop, usually mixed with other fruit trees. In the Western Ghats region, covering Maharashtra, Goa and Karnataka, it is estimated to be grown on a total area of 1200 ha, with an annual estimated

production of over 10 400 tonnes (Patil et al., 2005a). Kokum trees also grow near the homesteads in homegardens. Even when cultivated, kokum is mostly grown without any application of inorganic fertilizers and pesticides. Its main harvest season in south India is between April and early June. A fully grown kokum tree can yield up to 80 kg of fruit, although average yield is around 20 kg. The trees start yielding from the sixth year onwards and continue to yield up to 60 years or even more.

Uppage is mainly collected from the wild and homegardens and is not cultivated. The main difference between the fruits is their appearance as shown in Figure 15 and 16.

Figure 15. ***Garcinia indica***

Figure 16. ***Garcinia gummigutta***

Whereas most kokum is bright red, uppage will become yellowish-red when ripe. Its fruits ripen later, from May to July. A specific characteristic of uppage is that it is a biannual bearer with yields varying significantly from year to year.

Different parts of the kokum fruit, which has a sweetish acid taste, are used for a range of purposes. The fruit pulp and seed are separated and the rind is dried (the result of which is called 'sole') and used as a souring agent in traditional dishes and for the preparation of syrup and juice. The process of juice production entails the soaking or boiling of the dried rind and subsequently squeezing it. Oil is extracted from the seed through an elaborate process and used for cooking purposes and as an ingredient in cosmetic products. The rind is considered to have medicinal purposes, for the treatment of piles, dysentery, tumours, and heart complaints (Patil, 2005). The main active component in kokum is hydroxycitric acid (HCA) which is regarded as a fat reducer (Kamat, 2005), although clinical research has failed to show any significant losses in weight with the tested subjects (Patil, 2005). The main product of uppage is the dried rind which is used in curries, vinegar preparation and for polishing silver and gold. The medicinal uses are for rheumatic and bowel ailments and for treatment of mouth disease in cattle; uppage also contains HCA (Campbell, 1991). The drying process of both kokum and uppage to obtain the dried rind is a highly fuel consuming activity. Some collectors indicate that up to 15 kg of firewood is needed to obtain 1 kg of dried rind (community members, pers. comm.). However, in some villages sun-drying is also practised which does not require any firewood.

Because these trees are part of the natural forest vegetation and thus available in the wild, they are used by collectors of forest resources and form an important source of livelihood support for the families dwelling close to these natural habitats. Most of these products are used domestically by the collectors and homestead farmers. Their commercial preparation is undertaken by small- to medium-scale processors. The extraction of oil from the seed is a labour-intensive task and is therefore mostly done by processors that have the appropriate equipment. Owing to their underutilized status, reliable data on demand and supply of the fruits is difficult to obtain. Some estimates indicate that during 1999-2005, domestic demand for kokum rind increased almost fourfold (Korikanthimath and Desai, 2005). Although the economic benefits derived from kokum are of significant importance for these rural economies, absence of an organized market chain leads to an inequitable division of power, information and benefits along the chain, to the disadvantage of the collectors.

Case studies of Garcinia species

In the remainder of this chapter we present four case studies on *Garcinia* species cultivated and collected in four locations in south-western India. These are uppage and kokum collectors from homegarden and the wild in Sirsi, uppage collectors from the wild in Salkore, kokum collected from homegardens in Kumta, and kokum produced in Vengurla. The first three cases are located in the coastal district Uttara Kannada, located in the north-west of Karnataka state. The latter case is located in Sindhudurg district in the south of Maharashtra state. Both states have a rich diversity of forest species, because of their location in the centre of the Western Ghats, one of the major biodiversity hotspots in the world. The cases are analysed and compared in terms of their market chain, institutional framework, and the outcomes for livelihoods and agrobiodiversity.

Garcinia collected from homegardens and the wild (Sirsi)

Status, trends and use of kokum and uppage diversity

The focus group discussions, presented in Chapter 3, carried out in Sirsi, in Uttara Kannada district of Karnataka on collected mango also contained information on *Garcinia* species. Although both *Garcinia indica* and *G. gummigutta* are found in abundance in the natural habitat and in homegardens, cultivation of kokum in this region is limited (Subash Chandran, 2005). The four-cell analysis reveals that the women differentiate between red and white *G. indica*, and only distinguish one *G. gummigutta* variety. Both the red kokum and uppage are assessed to be common. The part of the quadrant that is of most concern for conservation shows those species and varieties that are used by many households but of which there are only few trees available (the lower, left-hand quadrant). According to the women, white *Garcinia indica* is placed in this quadrant and is considered endangered. It is believed to have medicinal purposes and is used for stomach ache, head ache, cracks on feet, acidity and high blood pressure (kokum juice). The men's group distinguished two varieties of uppage one that is big with thick rind and the other small with thin rind; both are considered to have medicinal properties. Like the women's group, this group identified white and red varieties of kokum, of which the white is considered to have medicinal

properties and is almost extinct. Both *Garcinia* species are used by many households; however, only a few trees of uppage and white kokum are found, while there are many trees of red kokum. This implies that red kokum is considered common, while uppage and white kokum are endangered. In the timeline analysis in Chapter 3 we have already shown that the women perceive that the two *Garcinia* species that are collected in this region have remained stable over the years, whereas the men have seen a clear reduction in the species. This can be explained by the fact that the women mostly consider the fruits in their homegardens while the men also examine those in the wild.

Marketing

The kokum and uppage collected is mostly used for home consumption. The women consider kokum to have high market potential; however, at present they are unable to reach the market. In their own villages, community members have direct access to these fruits and will therefore be unwilling to purchase these resources. According to the men, the demand for uppage is higher; it is sold on a very limited scale for Rs 15 per kg. There are no processing units in the vicinity of these villages and there is thus very limited outlet for the collectors to sell the fruits.

Uppage collected from the wild (Salkore)

In Salkore village, an informal group discussion was held with a group of 15 foragers that collect uppage and other resources from the wild. The community members are tree climbing experts and also collect leaf manure to sell and, in most cases, have some poultry.

Forest species collected

Collectors will usually collect forest products daily, in groups of three or four, and gather the fruits by shaking the trees or breaking the branches. Daily a collector can cover an area of 3 - 5 km radius and collect over 20 kg of fresh fruit. The following species are commonly collected in the community's collection radius of approximately 10 20 km, which is where their unofficial territory ends and the area of another community starts:

1. Uppage or *G. gummigutta* fruits that are sold to local traders that have the appropriate forest collection license, which will be further explained in the policy framework section. The price paid by these traders is Rs 15 / kg of dried rind. Collection takes place from May until July. The community members can collect up to 10 kg per day, and do this twice or three times per week collecting 50 100 kg per month. Ten kg of fresh fruits can be processed into one to two kg of dried rind.
2. Lavanga or wild cinnamon leaves and fruits that are mainly collected for domestic use. Collection takes place in April and May and approximately 25 30 kg per month is collected by each collector.
3. Rampatri or wild nutmeg is collected in October and November. Up to 50 kg is collected per season and sold to local merchants for Rs 150 / kg, although the collectors indicate that the market price is Rs 300 / kg.
4. Appe midi or pickling mango fruits are collected in January mainly for domestic use.
5. Medicinal leaves and herbs for home use are collected during most months of the year.

An additional source of income for the collectors is wage labour for coconut and areca nut (beetle nut) production. The estimated annual income for a household of seven to eight members in the village is Rs 25 000 - 30 000 (US$ 565 - 679) annually (or less than US$ 0.25 per person per day) of which, depending on the number of family members that are able to participate in collection of forest resources, about 25% is contributed by uppage.

Policy framework

The community used to be involved in shifting cultivation; however, the British abolished this system and the state started auctioning collection rights for forest resources to contractors. Only those that are able to obtain a forest department license for collection of the resources are officially allowed to collect resources from the forest. There is no tender for licenses in this area and the community members currently do not have the financial resources or the ability to organize themselves to obtain the license. The community has an informal agreement with lower level administrative staff of the forest department (pers. comm., community members) and therefore continues to collect these resources that are highly important for their livelihoods. In other (tribal) areas, cooperatives have been set up that take the place of these middlemen. In this area, this is not the case and thus, owing to their high dependence on the forest resources for their livelihoods, the community members are forced to collect illegally and sell the products through middlemen that have been able to obtain the license.

Marketing

Because of these legal obstacles, collectors clearly face severe limitation in their bargaining power. Prices they receive for the dried fruits are extremely low and have been decreasing in recent years from as high as Rs 30 40 per kg of dried rind to Rs 3 10 per kg, resulting in the abandonment of the collection of kokum. For these collectors, who are living below the poverty line and depend on forest products and occasional wage labour, this has had a major impact on their livelihoods.

Kokum collected from homegardens (Kumta)

In this section the results are presented of the household survey with 17 households in Muttige village, Siddapur taluk, located approximately 25 km from Kumta.

Farm households and kokum collection

The village is a rural community where the members mostly depend on farming and the resources from their homegardens. The staple crop rice is mostly produced for home consumption while others such as areca nut, coconut, banana and sugarcane are mostly cash crops. The size of landholdings ranges from 0.4 to 13 ha with a mean of 2 ha. Apart from agricultural land the households have homegardens which have many types of fruit trees such as kokum, cashew, jackfruit and mango. All are used for home consumption but kokum and cashew are also important income generators. The composition of household income is given in Table 8. The figures in brackets indicate the number of farmers that obtain this type of income in each cluster. Averages are shown only for the number indicated. The rows and columns therefore represent the averages of the particular group and do not add up to total average income given in the last row.

Table 8. Household income composition (Rs)

Income category	< 3 acres	≥ 3 acres	Total sample
Kokum	(8) 12 656	(6) 4 106	(14) 8 995
Other crops	(7) 15 546	(9) 65 382	(16) 43 579
Agricultural wage labour	(3) 4 833	(1) 1 200	(4) 3 925
Non-farm employment	(1) 96 000	(2) 66 000	(3) 76 000
Business		(2) 32 500	(2) 32 500
Total average income	**(8) 40 072**	**(9) 90 142**	**(17) 66 580**

A few households use kokum for home consumption only and do not sell it. Practically all households collect kokum from their homegarden, while only about 30% also collects from the wild, usually within a radius of about two km from the community. Both the absolute income and share in total income of the income derived from kokum is much higher for the smaller land size group and clearly kokum is very important for the resource poor as it forms an average of 30% of total household income as is shown in Figure 17.

Figure 17. Share of kokum in total income

In recent years, when the market price for kokum started declining many collectors have reduced or stopped collection or have only maintained collection for home consumption and the share of kokum in household income has dropped (and thus used to be higher than indicated in the figure). This suggests an inverse relationship between market development and kokum conservation in the wild, i.e. if market demand and price is high, collection will increase and vice versa. The impact on conservation is, however, not that straight forward as the majority of the collectors only collects from their homegardens. The possible impact of a reduction in price could actually be reversed from that in the wild, i.e. households may eventually replace trees with other species when they become less profitable. This was not observed in Kumta, but could take place in the near future if the price for kokum remains low. We were unable to establish the pressure on the species in the wild, although the wild collectors mostly indicate that they have not expanded their collection area, which seems to imply that sufficient kokum is still available in the same area. Clearly, high market prices induce

farmers to collect and market more than when they are low, thus increasing the pressure on wild forest species. But, as in this community only 30% collects from the wild, this still seems to be sustainable.

Marketing

Figure 18 presents a graphical overview of the kokum market chain in Uttara Kannada.

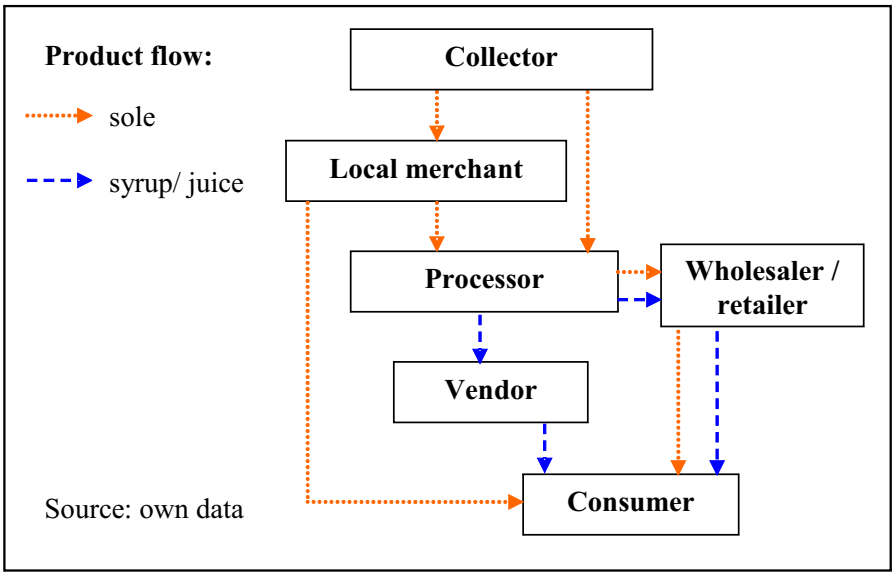


Figure 18. Market chain of kokum in Kumta

Kokum is mainly marketed through village level traders who come from within and outside the state and purchase at Rs 3 10 / kg of sole or dried rind (depending on whether the fruit was collected ripe or unripe). Extraction of kokum butter or oil from the seeds is only undertaken for home consumption and marketing of oil was not observed. Collectors in the region indicate that the price for dried rind has fallen sharply from as high as Rs 30 40 / kg. Only a few processors are present in the region, producing syrup and juice from kokum rind. In Uttara Kannada only a limited number of processing units were found. Mostly kokum is sold in dried form, either to a retailer or a processor.

Kokum produced in Maharashtra (Vengurla)

In this section we present the findings of key informant interviews with producers, traders and processors of kokum in Vengurla in the district Sindhudurg in the south of the state of Maharashtra. The district has a very strong agricultural orientation, but also has a considerable fruit processing and agro-based industry.

Status of kokum

In the district, kokum is mainly grown as a rain-fed crop and usually a few plants are found in farmer plots together with other fruit trees (such as cashew and mango). There are no organized commercial kokum plantations in the district (UNIDO, 2003). However, the state forest department of Goa has established a kokum plantation for research and utilization purposes at the boarder of the two states. In Sindhudurg, kokum is a more pronounced source of income.

Marketing

Vengurla has a reasonably well functioning cooperative marketing society based at the border of the states of Goa and Maharashtra. The society was established in 1964 and has approximately 9000 members all over the state, of which about one third has some kokum trees. The society collects produce through its branches all over Maharashtra. Of the total turnover of the society of about Rs 700 million, Rs 750 000 can be attributed to kokum (0.1%). The society procures kokum from the area and from both members and non-members. The 'sole' (dried rind) is packed by the society and sold through its nine bazaars. The buying price fluctuates depending on the season and the arrival of the rainy season. The price starts at Rs 35 / kg of dried rind in the beginning of the season and falls to Rs 25 / kg at the end. The total retail consumption is 7500 kg of rind. Alternatively farmers can market their kokum rind individually and even obtain a slightly higher price for their products by doing so. However, growers indicate that they prefer to deliver to the society as this is less time consuming and more secure.

The seeds are sold separately to processing units in Maharashtra and Andhra Pradesh at a price of Rs 13 / kg and the margin that the society receives is about Rs 3 5 / kg. A total of 40 000 kg of seed is sold. The seed can be sold to distant processors owing to the intervention of the society that guarantees sufficient quantities for economies of scale. Individually, farmers are unable to do likewise, owing to high transaction costs. The kokum market chain in Vengurla is shown in Figure 19.

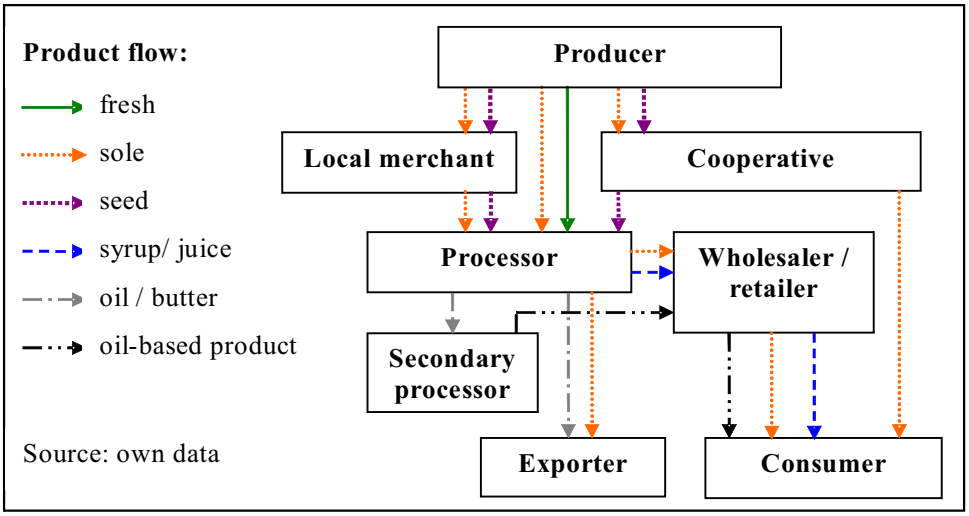


Figure 19. Market chain of kokum in Vengurla

Maharashtra has a number of private processors operating at different scales. Several products, including kokum amrit (sole), agal (syrup) and juice are popularly produced and sold. In addition, processing units for kokum butter are found that are producing for both the domestic and export market. Currently, there are only limitations for the quantity of rind that can be marketed; marketing of the seeds is less restricted. We interacted with three small scale kokum-processing units, a juice producer, a kokum butter producer and a pharmaceutical producer. While the pharmaceutical unit has a pharmaceutical license, the other two have a food processing license, which is much easier to

obtain. They are all marketing their products under their own brand name. All three processing units have witnessed increases in sales over the years, mostly caused by an increase in demand for kokum products from distant markets, while local demand remained stable. The text boxes give a brief description of the three cases and in annex 3 an overview of the economic viability of two of the units.

Institutional framework

In the Vengurla region three important initiatives have emerged that support the production and marketing of kokum.

Kokan Pharmaceuticals was established in 1976 in collaboration with a medical doctor. Approximately 1000 tonnes of raw material is procured in the months of May and June, and processed into approximately 200-300 tonnes of juice. Both fruits and juice are collected from farmers who have been taught juice production techniques by the processor. A quantity of 1 kg of kokum fruit yields approximately 250 grams of seed and 550 grams of sole which in turn can be processed into 200 ml of juice. A bottle (500 ml) of this pharmaceutical juice is sold at Rs 70 (or US$ 1.71). Compared with a bottle of juice (sarbat) sold by a regular processor without a pharmaceutical license at Rs 65 per litre, the value added of the pharmaceutical production is thus Rs 75 (or US$ 1.84) per litre. Kokum juice under the pharmaceutical label is sold to Shiruda, Goa, the Karnataka border, Gujarat, Delhi, Andra Pradesh and Rajasthan. The processor sells the seeds to a local merchant as he is not involved in seed processing due to lack of technical know-how and time. The product is said to cure piles, induce weight loss and promote blood purification.

The Dattatrigi oil mill has an hourly capacity of processing approximately 400 kg of kokum seed into 160 kg. The factory runs during two to three hours per day during nine months of the year (June to February), processing a total of 800 to 1200 kg of seed or 320 to 480 kg of oil per day. In the period June 2005 to February 2006 the unit processed 250 tonnes of seed into 100 tonnes of oil at a profit of Rs 23 per kg of oil. The final product is sold to a company in Gujarat which collects the products from the factory and transport costs are therefore not incurred by the processor.

A training institute in the region provides training courses on cashew and fruit processing (including kokum) to about 400-500 participants annually, mainly young men from the area. Students that successfully conclude the course obtain a certificate which allows them access to credit with a low interest rate at the local bank for the establishment of their own processing unit. Of those that have completed the course 50 60% is now successfully operating a processing unit, also because former students are assisted in the first phase of their business start-up. The centre also supports a local women self-help group by permitting them to process fruits at their facilities without costs.

Furthermore, research on kokum breeding is taking place in this region, conducted by the Regional Fruit Research Station in Vengurla that has been working on the screening of high yielding types of kokum. The research station has been characterizing and evaluating 14 types of *Garcinia indica* and has released two varieties of *G. indica*. Factors that are specifically evaluated in kokum include i) the possibility of a third harvest in rainy season; ii) early harvesting (April to May); iii) short flowering phase; iv) juice content of the fruit; v) kernel size, number of seeds; and vi) other physical characteristics. One of the main findings of the evaluation was that vegetative propagation through grafting caused the stunting of trees in the first years seedling trees grew taller than the grafted ones. Yield also seemed to be lower at 25 30 kg per tree per season for ten year old trees, whereas

seedling trees bear yields of over 40 kg per tree per season and a fully grown seedling tree yields up to 120 kg per tree per season. Application of fertilizers did not result in any significant difference in yield.

With the aim of promoting kokum and establishing it as the commercial medicinal fruit plant of the Western Ghats region, a group of growers established the Western Ghats Kokum Foundation. One of their activities was the organization of two seminars on the topic of kokum (in the years 2001 and 2005) in collaboration with Goa University.

Vijaya fruit products produces syrups and ready-to-serve drinks (RTS) of fruits such as kokum, mango, pineapple, jackfruit, amla,and lime but approximately 50% of total revenue is contributed by kokum. The company produces four types of kokum products: sarbat (juice), agal (more diluted type of juice), RTS (in special pack), and sole. During the month of May the unit processes 30 tonnes of kokum into 15 - 16 tonnes of syrup which is diluted in 30 tonnes of sarbat. Sales have been increasing from 1000 litres of sarbat in 2000 to 30 000 litres in 2005. For 2006 expected sales were 45,000 litres. Besides, about 2.5 tonnes of sole and 8000 litres of agal was expected to be sold. Profit on a one litre bottle of sarbat is estimated at about Rs 1.35 and on a pouch of RTS of 150 ml Rs 2.59. The unprocessed seed is also sold to Hindustanlever at a price of about Rs 12 per kg. Fixed investments are estimated at approximately Rs. 200 000 (in 1996), of which 25% was subsidized by a governmental organization.

Comparison of the cases

Table 9 presents an overview of the four cases of collectors and cultivators of two *Garcinia* species and apart from general information, highlights the components of the holistic model presented in chapter 2 that included aspects such as market chain governance, capacity building, public awareness and institutional framework.

The four study sites show clear differences in the market chain. Whereas in Salkore and Sirsi, there is very limited market outlet for both kokum and uppage, in Kumta kokum is a more commonly traded fruit (at least it used to be before the fall of prices). Market infrastructure is much more developed in Vengurla and it is in this case that we observe that kokum can make a larger contribution to producer income.

Although the activities in Vengurla have been undertaken with a limited level of coordination, many of the aspects that are included in the holistic model are more or less present. Public awareness is highlighted by producers and traders as required, especially among the young that have abandoned the earlier cultural practices and the preparation of traditional local dishes. Obstacles still remain in the Vengurla marketing of kokum, possibly caused by the large size and the low level of flexibility of the marketing cooperative. Producers still have a limited outlet for their products and a lack of bargaining power within the cooperative. The collectors in Uttara Kannada are however clearly much more limited in the marketing of kokum, resulting in the abandonment of its collection. Owing to declining prices, a source of income for these collectors has disappeared.

Table 9. Comparison of the four cases

			Cases	
	Sirsi	Salkore	Kumta	Vengurla
General				
State	Karnataka	Karnataka	Karnataka	Maharashtra
Research methods	Rapid Rural Appraisal	Focus group discussion	Household survey, key informant interviews	Key informant interviews
Species	Kokum, uppage	Kokum, uppage	Kokum	Kokum
Collection	Wild, homegarden	Wild	Wild, homegarden	Wild, homegarden
Production	No	No	1 plantation (private)	1 plantation (public), some production
Marketing				
Market chain	Local market, merchants (fresh, dried)	Local merchants (fresh, dried)	Local merchants (fresh, dried, seed), outside the state	Cooperative, local market, local merchants, processors, exports
Processing	Only at home	Only at home	Limited number of local processing units	Many units, for rind, juice and butter Local, long distance
Market organization	Very limited	Very limited	Very limited, lack of processing	Cooperative, processing industry present
Farmer price (Rs)	15/kg (dried rind)	15/kg (dried rind)	3-10/kg (dried rind)	25- 35/kg (dried rind) 8-10/kg (seed)
Institutional and policy framework				
Research	No	No	No	Development of high value material at research station, university workshops
Policy	-	-	-	-
Capacity building	Not present	Not present	Not present	Training centre for small-scale processing
Public awareness	Lacking	Lacking	Lacking	Lacking

Source: Authors' assessment

The Link Between Agrobiodiversity and Livelihoods

For commercial mango we observed that well developed markets can stimulate the maintenance of agrobiodiversity. While the share of mango income in total income was lowest for the most resource poor, we see that in the case of forest species this situation is reversed. For the resource poor these fruits form a major share in their total household income and these collectors are thus the most vulnerable to market forces and fluctuating prices. To reduce pressure on forest species, developing an organized market for kokum will require policy support that ensures availability of quality planting material, access to community/ common land and other resources to bring kokum under cultivation. Owing to its lack of fire resistance, this is much more difficult to accomplish for uppage and will require more demanding management.

Diversity of underutilized species is mostly considered at inter-specific (species) level as opposed to the intra-specific (variety) level considered for mango. This study was based on the perception of collectors and farmers with regard to the collection, production, utilization, processing and marketing of two species of underutilized fruits. Collectors were unable to distinguish more than two varieties although biological data indicate that many more varieties are present in the wild in the study sites. If collectors and processors do not distinguish between other varieties it is impossible for consumers to differentiate between them and market demand will thus not promote diversity at variety level.

The market chains of kokum and uppage are clearly hampered by several obstacles, such as a non-beneficial policy framework, lack of bargaining power, high transaction costs and lack of market outlets. Some possible interventions to improve these market chains can be identified at different levels:

1. Increasing consumer awareness of the medicinal purposes of kokum and uppage and the utilization in traditional recipes, especially among the young, in order to increase demand for kokum products. This approach has as the added benefit that these traditional practices are maintained. Coupled to this there is a need for some further research on the uses of kokum and uppage.
2. Linked to this is the aspect of the fat-reducing properties or any other feature, and the development of other products from dried rind and seed. Identification of high-value products derived from underutilized species and the promotion of their specific properties increases their marketability.
3. The establishment and strengthening of farmer organizations to increase efficiency and improve access. In the presentation of the holistic model in chapter 2, we have already introduced the concept of collective action, which requires some further discussion in the context of the four cases presented. In these cases we have seen several marketing constraints such as an inhibiting policy framework for the collectors in Salkore, high transaction costs, a lack of processing initiatives and limited availability of information. The formation of community-based organizations, in which smallholders can pool resources and market their products collectively, could overcome some of these obstacles. It can improve their access to resources (such as inputs, credit, training, transport and information), increase bargaining power (Bosc et al., 2002), and facilitate certification and labelling. In the context of long-term investments such as those required for perennial crops and capital-intensive processing technologies, a collective can also reduce individual farmer risk (Di Gregorio et al., 2004). That collective action can actually induce these improvements in the marketing of kokum is highlighted by the case of Sindhudurg. The establishment of a large horticultural cooperative in this region has reduced transaction costs and has given access to other outlets though the bulking of produce of many growers.
4. The introduction of processing technologies will reduce labour constraints and facilitate value addition. This should be coupled with the development of new products and promotional

campaigns. Access to financial resources to invest in these technologies could also be increased through collective action.

5. In the case where the institutional and policy framework inhibits the sustainable commercialization of fruit tree products, there is a need for careful examination of impacts and, in addition, adjustments should be made to provide opportunities to those dependent on them.

5. Discussion and Recommendations

DISCUSSION

In this report we have examined the relationship between the livelihoods of growers and collectors of target tropical fruits and the agrobiodiversity maintained in farmers' fields, homegardens and in the wild, with specific attention to the impact that markets have on the status of both. A trade-off takes place between the two. However, this report has also shown that target agrobiodiversity has the potential of playing an important role in enhancing incomes.

Fruit species were selected that were of important commercial value with a high level of inter-specific diversity (mango) or that were underutilized species that have some intra-specific diversity (*G, inidica* and *G. gummi-gutta*). Although genetic diversity that is determined through scientific research can be high for a certain species or genus, it is clear that farmers and homegarden users will only identify that diversity that is demonstrated by differences in observed traits. This was shown by the lack of varietal differentiation in the *Garcinia* species. Depending on the users of the crop and their trait preferences, this may result in a different classification (both in terms of use and conservation status) and prioritization. In this report we were able to identify three categories of traits, i.e. production, consumption and processing traits, which we will discuss separately.

1. **Production traits:** the production traits of fruits are most important to the commercial producers of the crop. In the discussion of the mango section we have already highlighted examples such as off-setting biennial bearing, and fruits that allow the farmer to lengthen the harvest season by taking advantage of differences in harvest periods of different varieties. What has received less attention so far in this report, but is also of major importance, is a higher resistance against pests and diseases both at variety and species levels as a result of mixed cropping. Another important aspect is climatic and agronomic suitability, which is underlined by the dominance of totapuri in the Chittoor belt and Alphanso in the Rathnagiri belt. As a result of the differences in traits, farmers can choose a mix of varieties and species, thereby reducing costs, enhancing income, and spreading risks.

   The production traits are, however, also important for homegarden and wild users as this influences the harvest calendar of a fruit. For these users the seasonal fruit species will be considered in a package of several species that are available at different times to allow for year-round fruit consumption.

2. **Consumption traits:** the consumption traits play a key role in the demand side of the commercial market. We have already highlighted aspects such as taste, appearance and structure as the most important factors determining the demand for certain fruit species and varieties. This however does not mean that only consumption traits will influence consumer/buyer behaviour as production traits will determine the availability and supply-side of the price determination of a variety or species.

   Also for homegarden use the consumption traits are very important, as was illustrated by the differentiation between medicinal and food uses. For mango the food use was further

subdivided into fresh, vegetable, and pickle, while the kokum fruit has several components that can be used for different purposes such as juice, spice and butter. The properties of the fruits will thus determine which are maintained in homegardens and which ones are removed.

3. **Processing traits:** some species and varieties will be more suitable for processing than others. In the section on commercial mango we have shown that the presence of many processing units with fixed investments will ensure a market outlet for the Chittoor mango producers. Kokum and uppage are not very suitable for fresh consumption and their processing traits are those that give them their market value.

It is thus important that the varieties exhibit diverse traits that allow for production, consumption, and processing or product differentiation. When farmers are involved in marketing it is crucial that they consider the demand side of the market. Varieties of fruits usually differ in appearance, texture and flavour that cater to different consumer tastes. In many cases, however, the information flow from consumer to producer (usually reflected in price) is inhibited or completely absent (e.g. when involvement of middlemen results in a loss of incentive to farmers to maintain diversity).

While commercial mango cultivators are influenced by the production traits of mango varieties, collectors from homegardens and the wild are more interested in the properties than can be utilized in daily life as was indicated by the differences between the women and men in the identification of uses. Marketing of the fruits can be done at existing marketplaces. Commercialisation of these varieties and their products would thus require promotional practices that build consumer awareness of these varieties that are already so highly regarded by the communities. Creating or supporting local farmer groups and a brand name that highlights the geographic origin of these rare tree products would ensure conservation in this location. Secondary facilities such as adequate processing and ecotourism facilities would further enhance the use value that can be captured by the communities. For example, the efforts made by NGOs towards this goal through school projects in which students are encouraged to participate in tree planting and tree identification need to be recognized and supported.

RECOMMENDATIONS

Conduct research into traits (enhancing the private use value). The fact that the observable variance in traits plays a key role in on-farm conservation implies that when these traits are not directly observable they need to made evident and growers and collectors need to be made aware of them (there may for example be traits that only become apparent after a certain processing treatment). There is thus a need for further research to establish the beneficial impact of specific species or varieties on human health and wellbeing, in order to identify marketable traits. The outcomes of this type of research will allow for direct promotion of the species or varieties both for home-consumption and marketing. Kokum is perceived to have medicinal properties and research would be able to establish whether this is the case. Sindudurg has one processing unit that has a pharmaceutical license for processing, which ensures a higher value of the products for the

processor. Further exploration should be made of the possibilities and legitimacy of pharmaceutical licenses for kokum and other species with perceived medicinal properties.

Evaluate the suitability for on-farm conservation for specific varieties and species (complementary approach). Careful evaluation of specific situations is needed to assess which varieties and species are in general suitable to be conserved on-farm and which others would require *ex situ* methods in order to optimize conservation and minimize costs. Methods to assess this could include the Four Cell Analysis that was conducted in the focus group discussion in Sirsi and brought out the popular and endangered mango varieties. Timeline exercises will further assist in establishing the trends in the distribution of agrobiodiversity, which should allow for appropriate targeting of on-farm conservation efforts. Secondary effects of improved marketing of underutilized species and varieties should be considered carefully as unwanted impacts could for example include a raise in food prices for the poor.

Give more attention to perennial intra-specific diversity on-farm (enhancing the private varietal use value). Although changes in varietal and species distribution patterns of these perennial fruit trees on farm are slow, scientists and policy makers need to detect trends as early as possible in order to respond with appropriate counteracting measures if specialisation in certain varieties is observed. Attention to the contribution of on-farm varietal diversity in fruit crops to livelihoods has however been limited, as is shown by a lack of market data at variety level. This study shows the importance of attention to this intra-specific diversity on farm and the need for similar studies on market-based approaches for varietal diversification in other economically important perennial species as the agrobiodiversity and income outcomes for perennials are substantially different from those of annual crops. Irrespective of the level of commercialisation, underutilisation of varieties occurs. We could therefore consider those less-commercialized varieties similar to these so-called underutilized fruits such as kokum and develop strategies to commercialize them.

Create a suitable institutional framework (holistic approach). For kokum, marked differences in the status of on-farm agrobiodiversity management were observed between Karnataka and Maharashtra. These differences could be attributed primarily to the difference in institutional interventions brought forth by both private and public efforts. It seems crucial to create a beneficial environment in which value-added products can be created and marketed while agrobiodiversity is monitored and supported. This latter aspect is of major importance as utilisation and commercialisation are dynamic processes that need constant monitoring and evaluation. For the specific case of kokum in Kumta it is important that efforts are undertaken to bridge the gaps in efforts across the region. Other types of arrangements originating from the private sector to promote commercialization and secure farmer outlets could be contract farming or preferred-supplier agreements, both of which have their own advantages and disadvantages as well.

Promote sustainable products (enhancing the private use value). The promotion of products derived from locally important agrobiodiversity is necessary. This can be done through such means as branding, certification and demonstrations. Suitable outlets could for example be tourist centres and specialty restaurants. both of which could be coupled with some form of ecotourism. Selling would also be possible through public outlets, as was seen in the case of a kokum processor who was marketing his products to a railway caterer, thereby reaching a very substantial public.

Develop alternative conservation strategies (complementary strategies). If observable differentiation is not present and it is determined that on-farm conservation strategies are not suitable, alternative conservation strategies need to be developed to ensure the conservation of this genetic diversity.

LIMITATIONS AND FURTHER RESEARCH

Due to the differences in characteristics between commercial mango and the fruits collected from homegardens and the wild, we were only able to collect structured quantitative data for mango. There is therefore a difference in the possibility for analysis. The sample selected for commercial mango included a substantial share of newly planted orchards, for which marketing and income data was thus not available. Due to the informal and unstructured interviews in the four locations where kokum was collected, it is difficult to come to a generalized picture of the kokum market. One study site was included in Maharashtra state, where advances in processing and marketing were said to have been made. For reasons of comparison, it would have been preferred to include another study site in Karnataka state. However, we became aware of another possible advanced site in Karnataka (Puttur) only after data collection was finalized.

Further research is necessary to investigate the trade-offs between agrobiodiversity of tropical fruits and livelihoods and to establish which types of market outlets are most suitable for policy interventions. A larger sample from a different country is needed to confirm the findings with a more rigorous analysis. Export markets may for example not be the most suitable for on-farm agrobiodiversity, but they may very well be the ones that generate the most income. The development of guidelines for the process of targeting the most appropriate fruits and markets could be an important output to assist policy makers. Ideally this approach should be multidimensional, including a large number of stakeholders and making use of participatory methods. Key species and varieties should be identified that have the specific observable traits desired by producers and consumers and those that do not need to be flagged for other conservation methods. Subsequently, the a market chain analysis is necessary to determine opportunities and obstacles. Given this assessment, strategies can be identified for capacity development, strengthening of collective action, identification of high-value products and development of public awareness campaigns.

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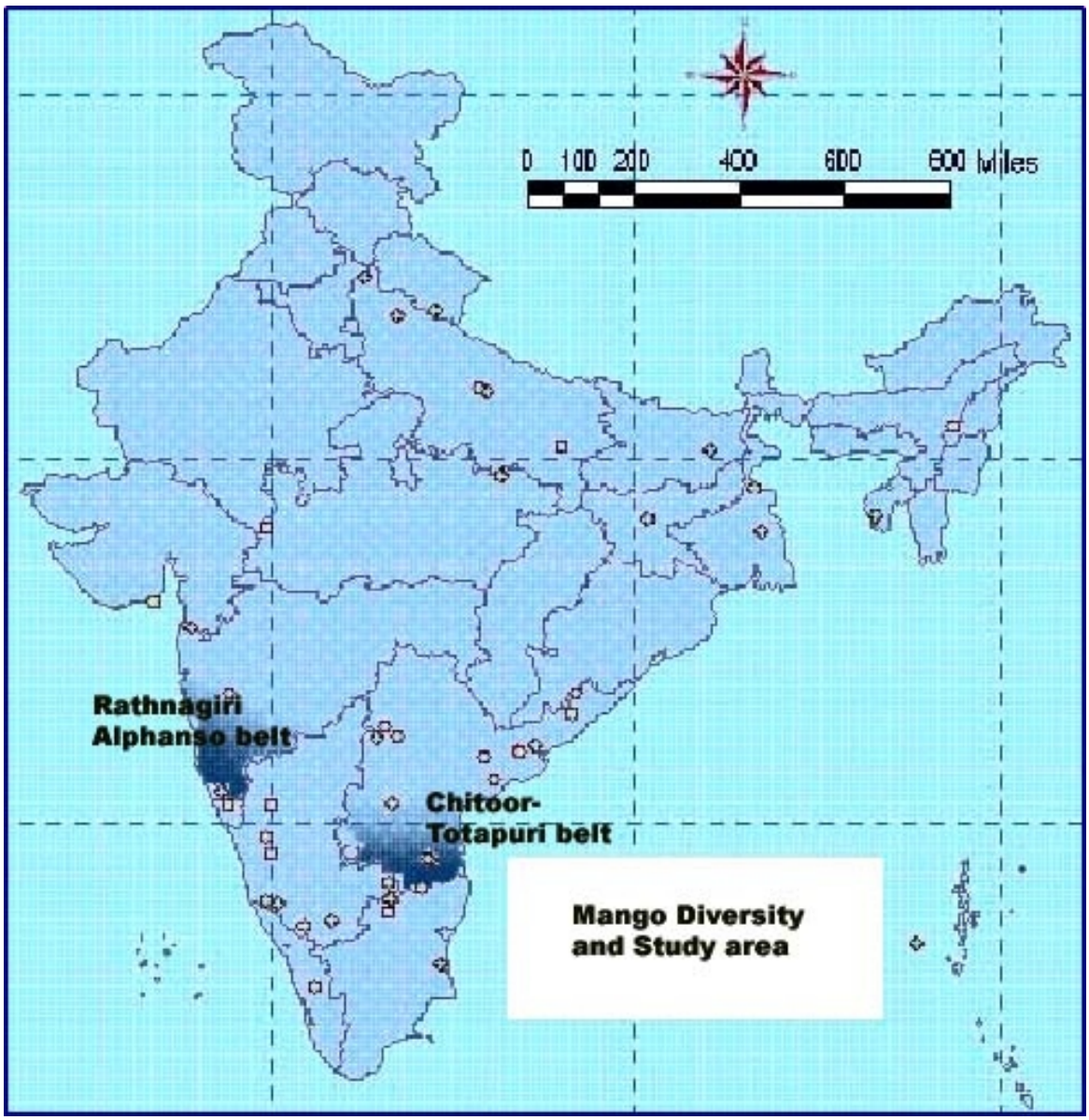
ANNEXES

ANNEX 1. MANGIFERA DIVERSITY MAP

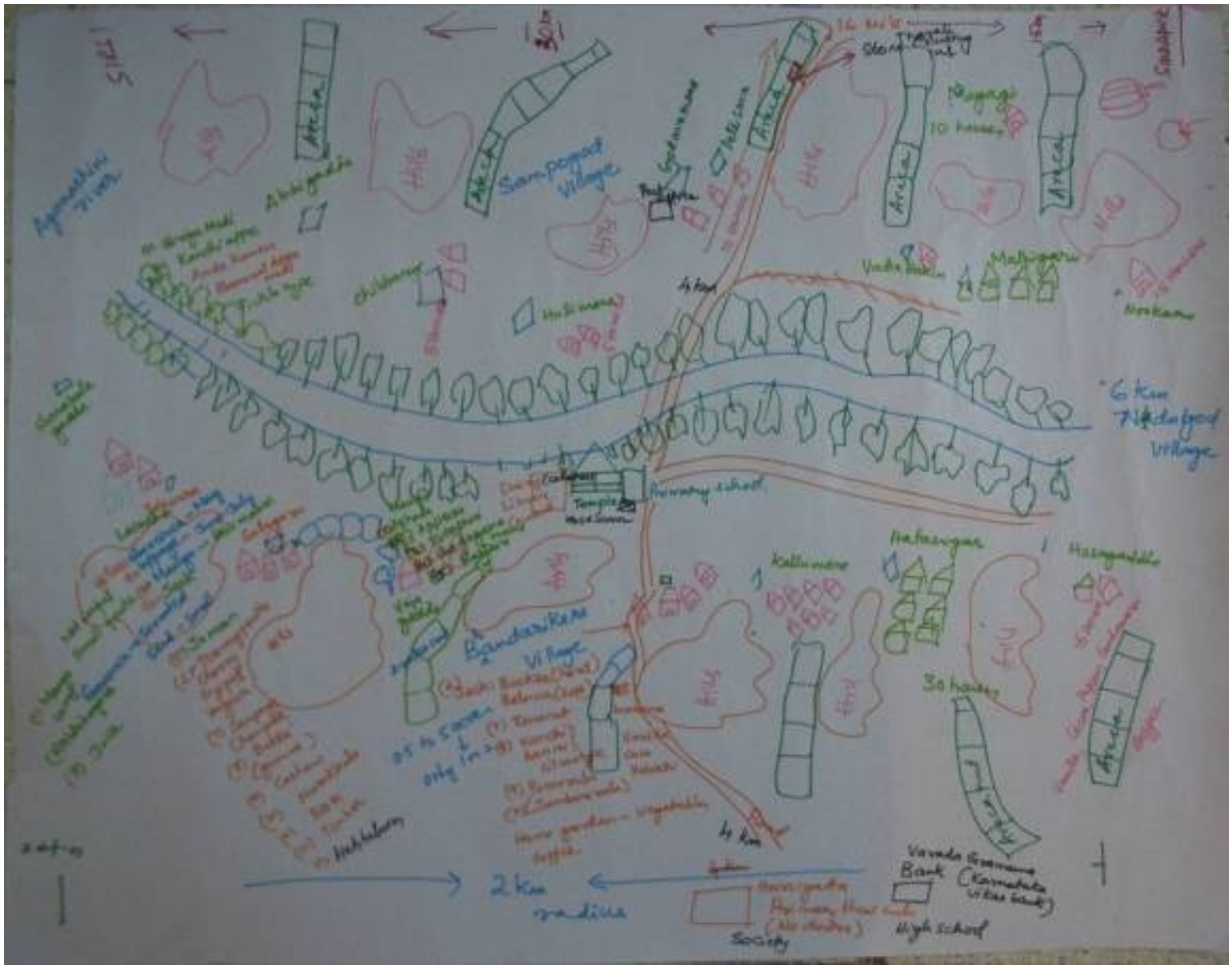


Source: IPGRI, 1996

ANNEX 2a. RESOURCE MAPS WOMEN IN SIRSI

Women's group

ANNEX 2b. RESOURCE MAPS OF MEN IN SIRSI



Men's group

ANNEX 3. COSTS AND RETURNS OF KOKUM PROCESSING UNITS (VENGURLA)

Category	Dattatrigi oil mill	Vijaya products (juice)
Fixed costs and overhead	200 000	150 000
Machinery maintenance	25 000	
Seed / fruits	(250 tonnes of seed) 7 500 000	(30 tonnes fruit) 150 000
Other ingredients	0	70 000
Labour	90 000	
	67 500	12 000
Packaging	200 000	250 000
Total costs	**8 182 500**	**632 000**
Revenue main product	(100 tonnes of oil) 10 000 000	(30 000 lit sarbat)1 950 000
Total revenue	**10 481 250**	**2 274 000**
BCR	**1.28**	**3.60**

Annex 4. Other outputs of the study

Kruijssen, F. and Sudha M. 2007. Developing the Potential of Underutilized Fruits through the Linkage of Farmers to the Market a Case of Kokum Marketing in the Western Ghats of India. Third International Conference on Linking Markets and Farmers: Exploring Leading Practices to Foster Economic Growth in Rural India. 11-15 March 2007, New Delhi, India.

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