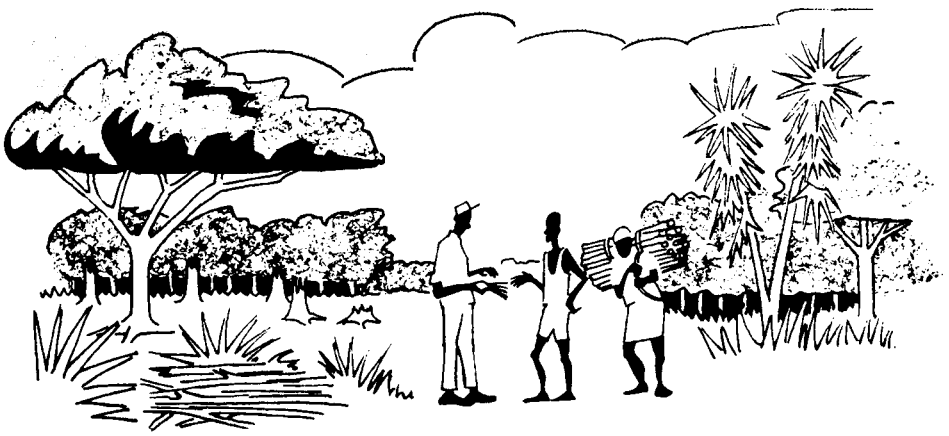
PART II

CHAPTER 1

INCENTIVES FOR AGROFORESTRY



"IF I HAD KNOWN THE DISCUSSION WAS TO BE ABOUT KUNI I WOULDN'T HAVE WASTED MY TIME IN COMING".

Phillip Bradley
Beijer Institute
Nairobi
Kenya

CONTENTS

Introduction

The title is a comment overheard during a group meeting which discussed the problems of kuni (firewood) supply on some farms in southern Kakamega in 1984. It sums up a widespread male reaction to the issue of firewood problems and what might be done to remedy the situation. The theme of this article is the "acceptability" to farmers of technical changes associated with development programmes. In this instance, the material is drawn from the agroforestry initiatives that form part of the Kenya Woodfuel Development Programme. I focus on four situations; three in Kakamega District, and one in Kisii District. Both districts are part of Kenya's high potential agricultural land, with altitudes ranging between 1500 and 2000m and annual precipitation between 1200 and 2000mm, spread over two seasons. Population densities vary from less than 100 per sq.km to as much as 1000. Two examples concern small areas (sublocations[1]): Ebusikhale and Murhanda in Kakamega district, and two look at individual farms: Thomas Nzaywa's in Kakamega, and Zacharia Moyancha's in Kisii. These four examples are employed to present a general thesis about aspects of social change which influence acceptability.

Situations

Ebusikhale is a small sublocation of approximately 7 sq.km, located in the far south of Kakamega District. With a near perfect climate for agriculture, Kakamega District itself forms part of Kenya's high potential zone: the most productive agricultural land in the whole of the state. According to the 1979 census[2], 6034 people lived in Ebusikhale. By now this will

---

1. A sublocation is the smallest administrative unit in Kenya, and varies in physical size according to population density. Usually, sublocations will have a total population of between 5 and 10 thousand.

2. Central Bureau of Statistics (1981)

have grown, and it is safe to assume that the rural population density of the sublocation exceeds 1000 per sq.km. Despite its bountiful sunshine and rainfall, the environmental base to Ebusikhale's agriculture is far from benign. The most serious limitation is due to the impoverished nature of its soils. Developed over ancient basement granites, they are exhausted, and prone to sheet wash. These infertile and erodible soils limit the productivity of the area, but by far the greater stress comes from the deep social crisis which inflicts the production system.

For many years Ebusikhale has exported its male labour, leaving behind a residuum of elderly dependents, children, and their mothers, all of whom try to scrape a living from small plots of land. The average farm size is less than 0.5 ha, and the average resident family consists of over 8 people, most of whom are largely unproductive dependents. In many villages, upwards of 75% of the adult male labour force is absent. In theory these men are working in the major urban centres of Kenya, most notably Nairobi (where most domestic staff are from southern Kakamega), and remit part of their wages to support the family at home. In reality, however, many are in very low paid casual employment, frequently laid off, and normally unemployed for considerable periods. Remittances are less than is commonly supposed and in a perverse logic, their absence from the farm is better construed as a shedding of extra consumption than as a loss of productive labour.

Back on the farm the women struggle to grow maize and beans for food, and perhaps a few vegetables and bananas for sale at the local market. Some will care for an undernourished cow, which may provide milk for the children or for sale. There is a busy level of petty commerce in anything that can supplement the family bduget: chickens, fruits as and when they come into season, temporary surpluses in maize and beans, and so on. Although there are small plots of coffee in the surrounding area, in Ebusikhale there are none, and neither is there any other "cash" crop. Effectively, all crop production is for food.

However this is not a subsistence economy. Notwithstanding the sale of labour power on the part of the men, other examples of the imprint of the market are everywhere evident. Small roadside kiosks sell sodas, sweets and other non-essential consumables,

women develop all many of small income-generating initiatives (basket and pot making for example) and travel with their meagre goods to the local markets, and the children attend school where possible (representing a considerable financial outlay). Harambee[1] contributions add to the financial strain.

Enmeshed within this social and economic crisis is another: that of firewood. On the one hand it pales into insignificance compared to the wider malaise, but on the other, it imposes a very real burden on the women of the sublocation. Whilst the social world is collapsing around them (and there are many examples of delinquent behaviour that bear testimony), they are nevertheless subjected to the intense social pressue that judges a wife or mother by her ability to fill the kitchen pot and ensure the provision of properly cooked food[2].

The Kenya Woodfuel Development Programme (KWDP) came to this area in early 1984, and spent the first six months enquiring into the nature and extent of the woodfuel problem throughout the district. At the same time the team conducted investigation of existing and potential agroforestry activities in the district, surveys of the social and cultural traditions governing the supply and use of wooduel, and the general resource base of the population. The results of this work led to the selection of Ebuskihale as a representative area in the densely populated southern third of the district, where development assistance for a better provision of woodfuel might be well received. Indeed, the portents were vary favourable. A number of factors led the team to believe that

---

1. Harambee literally means "pulling together", and was introduced as a form of self-help to communities all over Kenya. In reality it a form of "quasi-official" taxation, and can impose a real burden on poor people. There is much social pressure to be seen to donate to an harambee fund, and it is in practice extremely difficult for poor farmers to demur.

2. See Chavangi (1984), (1985)

Ebusikhale might be the one sublocation (there were six others scattered throughout the district) where most could be learned, where a rapid uptake of agroforestry initiatives might follow and where a general model for the rest of the district might be developed. These hopes were based on a number of factors.

1. Of all the areas visited in the district, and according to the results of surveys[1], the shortage of firewood was the most severe in this area.

2. As women are the prime movers in firewood collection and use, and as women had been left to manage the farms when their husbands were absent, a programme which would most affect women was thought likely to find a sympathetic response in Ebusikhale.

3. Existing agroforestry practices were well developed in the sublocation, and their implementation and management were very much the responsibility of women[2].

In developing its implementation strategy, the KWDP constantly kept Ebusikhale in mind, and one of its earliest interventions was concentrated in this sublocation. However, before examining

---

1. Agroforestry survey -van Gelder and Kerkhof (1984)
Cultural Survey - Chavangi (1984), (1985)
District Resource Analysis - Bradley (1984)
Woody Biomass Survey - Bradley and Kuyper (1985)

2. A common practice, not seen elsewhere, is the use of *Sesbania sesban* as a maize intercrop. The small, quick-growing and nitrogen-fixing tree is cultivated as a dispersed overstorey in maize fields. Its very rapid growth, coupled with a light shade, offers protection for the maize from hail storms. It is known to improve soil conditions, and, most importantly for the KWDP, it provides rapid supplies of firewood.

this action, and its fate, we should first turn to some other situations in Kakamega, and in Kisii District: the second of the districts in which the programme intervened.

Murhanda is another sublocation targeted by the KWDP. it is quite different from Ebusikhale, being larer at 12 sq.km, and with a slightly lower population of 5519 in 1979. It is located between Kakamega town, the district headquartes, and the Kakamega Forest. In fact its eastern boundary abuts the forest itself. Despite its proximity to the major urban centre of the district, it is a quiet and withdrawn area. Like Ebusikhale, its climatic base is good, and the soils are better than in the south. At the same time, farm sizes are larger (mean of 1.2 ha), the predicament of male emigration less severe, and the agricultural production base much healthier. Cash crops are commonly gown, with tea and French beans most prominent. Food resources are good, as the larger farm sizes enable both cash and food crops to be grown. With the greater presence of men, labour supply is adequate. At the same time, firewood supplies were much less precarious than in Ebusikhale. Women were allowed to enter the nearby forest to gather dead wood, and so developed is the practice that small crocodiles of women can be seen leaving the forest each day, all carrying large headloads of wood. Much of this is destined for the market where a small but important trade in firewood is pursued. Unlike Ebusikhale, *Sesbania sesban* is rarely found, and in fact is regarded as little more than a weed. Suggestions that it might become a useful agroforestry species were met with derision, particularly by the men whose vision of a tree was a standard tree of great commerical significance. To them *Sesbania sesban* was little more than a joke - scarcely the stuff of development programmes. The pattern of trees and shrubs on the farms of Murhanda was different from that of Ebusikhale in other ways. Although still present, hedges and formal woodlots of *Eucalyptus saligna* were less prominent than in Ebusikhale, while small ravines harboured remnant riparian forest stips. The fields themselves were relatively bare of trees, and the practice of growing trees on the farm (either through small on-farm

nurseries[1], or in small tin cans) was rather unusual. Additionally, the woodlots that did exist frequently contained an indigenous species *Croton macrostachys*.

At the outset, the prospects for introducing a wider balance of agroforestry actions in this sublocation seemed inherently less favourable to the KWDP team, particularly as the primary motive from the team's point of view: a firewood crisis, seemed not to exist. Furthermore, people from the surrounding areas regarded their compatriots from Murhanda as rather staid and traditional. So far social disruption associated with the sale and trading of land which has been experienced over so many parts of highland Kenya has been avoided, for little land seems to have passed out of family hands in the sublocation. Despite its proximity to the modernizing effects of an urban centre, its provident resource base, the continued presence of the men, and a religious affiliation which stressed the continuity of the past, have all led to an inward-looking society with a less than enthusiastic attitude towards external agencies of change[2]. Coupled to this conservative outlook is a strict social demarcation between the roles of men and women. The former guard and manage the trees, the latter collect and use the firewood. The evident functional link between the two does not seem to mitigate the structures of customary social practice. There is an interesting side issue here. Whereas the woodlots of exotic species such as *Eucalyptus saligna* and *Cupressus lusitanica* are regarded as perennial cash crops, with the wood and poles destined for the market, those of *Croton macrostachys* serve ritual purposes, for when the senior

---

1. The agroforestry survey found that throughout the district the practice of producing tree seedlings, particularly of the commercial species such as *Eucalyptus saligna* and *Cupressus lusitanica* was widespread, though concentrated and most actively pursued in the densely-populated southern third of the district.

2. Personal report from the extension officer assigned to the sublocation

male of the household dies his funeral pyre must be of *Croton* wood. The connection between planted and managed trees (as these *Croton* woodlots undoubtedly are) and firewood is therefore made, though only for a very particular situation and only under the authority of the men. All in all, Murhanda was regarded in the early period of the programme as a "difficult one", and expectations of early success were focussed elsewhere.

We turn from the general background of small areas to the specifics of individual farms. Two such farms serve as illustrations. The first is situated in southern Kakamega, in an area very similar to Ebusikhale, with poor soils, absentee husbands, small farms and high population densities.

Thomas Nzaywa owns a very small farm of o.3ha in southern Kakamega. His wife and three children, and a grandmother live on the farm, which is almost entirely devoted to the upkeep of four grade dairy cows. Such is the attention paid to these cows, that the normal pattern of land use in the area (maize and beans as a food crop, tea as a cash crop, and some small plots of cassava, sweet potatoes and bananas) has all but been abandoned. Some maize is grown, but most of the food consumed by the family is purchased. The money for this comes from a range of products founded on the zero-grazing unit for the cows, and the fodder grass and leguminous trees with which they are fed. It is an impressive technical solution to the pressures on traditional agriculture which come from insufficient land. Instead of attempting to intensify maize production (as many neighbours have done with hybrid maize and fertilizers) Thomas has switched production to milk and byproducts. The investment needed for such a change is considerable, particularly for the cattle and the stall in which they are housed. He has received support from development agencies for this.

The technical base to the farm is specialized. Fodder grass provides bulk food for the cows. This is supplemented by the protein-rich leaves of *Leucaena leucocephala* and *Calliandra calothyrsus*, two exotic agroforestry species introduced into the area. Thomas is extremely enthusiastic about his trees, and has managed to cross breed the two exotics to produce a hybrid which seems to have captured the best characteristics of both parents. The flowers of the trees provide nectar for the bees in his

improved bee hives, the cattle provide manure for the soil (in copious quantities - he even sells it), the trees provide further benefits to the soil as well as fodder for the cows and shade for sensitive plants (he grows various types of spinach and greens). His wife has more than enough firewood within easy distance. The pattern of rows of trees separated by rows of fodder grass, growing on a bed of soil and manure appears luxuriant and always fresh and green. The surplus milk is sold, and provides enough for food purchases and for reinvestment. He has recently bought a new type of shredder which breaks up the grass and tree leaves before they are fed to the cows. He mixes these to a strict formula so that the cows have a properly balanced diet. It is an extremely successful farm, even on such a small piece of land. From its production he has been able to finance his elder children through school, and has managed to accumulate a little and become "richer". The whole enterprise is founded on an easy complementarity between the zero-grazing system and intensive agroforestry.

The KWDP was naturally interested in this farm, for it pointed the way ahead for an agroforestry programme to relieve firewood stress on small farms, and provide many other benefits. We shall return to this later.

In **Kisii**, situated at over 2000m in the northern highlands is **Zacharia Moyancha's** farm[1]. It is long and linear, like many others in this area. In fact subdivision of the farm according to Gusii practice has left Zacharia with a 1.1 ha small holding which stretches 750m from ridge crest to valley bottom, yet is only 20m wide at its widest. His wife Piria, is responsible for 16 children, five from a former wife who has died, the others her own.

The farm is the main source of income, although some baskets made by the wife are occasionally sold to bring in a little extra

---

1. Full details of this and a number of other farms in Kisii district, which participated in the on-farm agroforestry trials work can be found in Kuyper, 1988

money. Tea is the only cash crop on the farm, though Zacharia undoubteldy receives cash when he sells any of his trees (principally *Eucalytus saligna* and *Acacia mearnsii*). The tea takes up 25 per cent of the farm, whilst another 50 per cent is devoted to the upkeep of 5 cows. The remainder is used for food crops such as maize, sorghum, beans, cassava and sweet potatoes, and for two small woodlots: *Acacia mearnsii* on the thin stony soils at the top of the farm, and *Eucalyptus saligna* in the valley bottom. A few scattered *Croton macrostachys* and *Cupressus lusitanica* are located along the edges of fields and around the house compound area.

Because there are few trees on the farm, and only very small hedges, firewood supply can be problematic. Piria collects from the hedges virtually every day, but this is often not enough. Zacharia helps by buying small bundles and allowing his wife to cut some of the smaller trees. As a member of a local women's group Piria states that the subject of conversation at meetings frequently turns to firewood. When the KWDP first contacted the farm, both husband and wife expressed keen interest in doing something about the firewood supply.

This farm was selected by the KWDP Kisii team as a site for on-farm agroforestry trials, in which, at the farmers' request, and with his active involvement, large numbers of a variety of tree species were planted on the farm. The choice of species and numbers was the farmer's own, and he arrived at this after visiting the KWDP headquarters in Kisii and following further discussions with KWDP extension officer and agroforestry specialist. The choice of planting sites was also left entirely to the farmer, and on the part of the KWDP no instructions were given. To the eyes of the agroforester the planting density was too high, the selection of sites less than ideal, and the choice of species unadventurous. However Zacharia was given everything he asked for in the way of seedlings. There were no other inputs from the KWDP except for frequent visits to discuss progress and monitor results. As and when he wished for more seedlings these were provided, along with suggestions about seed collection and

improved on-farm nurseries to grow his own stock[1].

From the point of view of the KWDP, the whole process was designed to establish a number of things: (1) were the trees acceptable "en masse" as a substantial component of the farm management system, (2) would they find favour in the eyes of both the men and the women, and (3) was it realistic on small farms to suggest that this type of agroforestry initiative could solve the firewood supply shortage?

What Happened

Before elaborating on what happened in these four situations, the early thinking of the KWDP in terms of extension approaches, the content of the extension "package", and technical advice should be reviewed.

From the technical perspective of agroforestry, a unanimous choice for technical advice stemming from local practice was made. The distribution of seedlings grown in centralized nurseries was eschewed in favour of encouraging home production. Efforts were made to test a range of methods for seed collection, storage, and nursery design. Seed for new exotic species was imported at the start, with a view to local production in the near future. Exotic species were favoured, not so much because of their biological properties, but because no prior and hidden values and perceptions would be associated with them.

---

1. From the Kakamega experience, the KWDP had produced a number of leaflets describing technical aspects of tree nurseries, seed collection and storage, transplanting and so on. It had built upon the normal practice of on-farm nurseries and designed an improved version which become a major compoment of the extension effort. See Mungala, Kuyper and Kimwe, 1988 for further details.

On the extension and message front, particularly following the results of a cultural survey[1], the team opted for addressing the family rather than women alone, for a strong focus on agroforestry for woodfuel[2] rather than for multiple benefit an finally for providing assistance in the form of animation with only minor physical inputs, free of cost.

First, let us go back to Ebusikhale, upon which so many early hopes rested. Initial contact had already been made through the various surveys that were conducted in early 1984. The middle of the year saw a limited general awareness of the presence of a "tree-planting" programme in the sublocation. A few families were given small quantities of seedlings to gauge opinion. Later in the year, an extension officer gathered small groups of people together to discuss fuelwood issues. The men, as expected, were disinterested, but the women showed every sign of engaged interest. An initial attempt (later abandoned) was made to distribute considerable quantities of seedlings to group members, with guidelines on planting and after care. Subsequent visits to the groups as a whole, and to individuals, followed the progress of the intervention. At a later stage in early 1985, a full-blown local drama programme came to the sublocation, after which a high demand for seed[3] was experienced. These were distributed, along with a "comic strip" version of the drama and technical leaflets on nurseries and tree management. Throughout all this there was an intensive campaign by the extension officer to reenthuse sagging interest where it was noted, to lead the group discussions further, to offer individual support, to take requests for assistance or technical problems back to the offices

---

1. Chavangi (1984)

2. A motto "MOTO MWAKA" was adopted as the trade mark of the programme. It is swahili for fire all the year round.

3. The programme had by this stage switched from seedling provision to seed supply and technical advice on tree nurseries.

in Kakamega for consideration and so on. At a still later stage, attempts were made to monitor the impact of the programme. This monitoring exercise covered all the sublocation selected for attention, and not just Ebusikhale.

To the surprise and disappointment of the team, it appeared that all this intensive effort had been to little avail. Interest had waned, the new trees were performing badly, and many had been abandoned or not cared for. The whole effort seemed to be grinding to a halt. One should not be overly harsh in assessing the programme in this way so soon. We are speaking of a time span of only three years, and although there is little sign of a community-wide uptake, there are nevertheless many individual families who have benefited and who are continuing on their own. There is insufficient space here to present a full explanation of the reasons for this disappointing result, but one or two points need to be stressed.

Firstly there is the issue of male and female roles in Luhya[1] society. Although the majority of men are absent from the area, this does not necessarily mean that the women have expanded decision-making powers. It is true that the men traditionally take all decisions regarding trees, but in their absence, it was thought that some of these powers might be transferred to the women. If not openly, the team had thought that the women might discretely get on with the task of planting their own trees. Such it seems, was not the case. Sons, related males such as cousins or brothers, or grandfathers usually interceded and effectively hampered the efforts of women. Even though the majority of men did not consider the small, quick growing species the team favoured as real trees (again the 30m tall *Eucalyptus saligna* is the standard by which they judge other trees), somehow, the old constraints overflowed into a "non-tree" situation, and this despite the fact that *Sesbania sesban*, the locally favoured "agroforestry" tree had provided a precedent for the type of species that was introduced.

---

1. The Abaluhya constitute the vast majority of the people of Kakamega.

Secondly, and perhaps much more importantly, was the consequence of deciding to donate, rather than charge for, the seed that was offered. It later transpired that anything given for free was by definition worthless, and therefore could be of no material benefit. This proved to be damning assessment. At the same time, free gifts represented Trojan horses, following an earlier and disastrous flirtation with an agricultural credit scheme.

The result of all this was that far from becoming the pioneering model that had been anticipated, so far Ebusikhale represents one of the KWDP's less successful forays into the district.

As we have seen, the position of Murhanda was different, and a very cautious approach was adopted. The same elements were employed (initial group meetings followed by the drama and then technical advice), and the response though outwardly enthusiastic, was underneath guarded. This was anticipated, and the team was aware of the need for patience, and continuity in their efforts and commitment. Slowly the response has picked up, and although there is still a long way to go before the momentum is self-sustaining, steady progress has been made. What is of great interest in the Murhanda setting, is the change in attitudes that began to emerge in 1988. We have noted that the presence of a source of firewood in the nearby Kakamega forest meant that initial reactions to the programme were less than excited. In 1988 a national drive to encircle all highland forests with a ring of Nyayo[1] tea got underway. The aim of this strategy was to protect the forests from indiscriminate felling and clearance, and to provide a source of income for those in the neighbourhood who had previously relied on the forest for resources. The implication for Murhanda was that the women's access to an unlimited firewood supply would be severely curtailed. Interest in the programme increased, and the extension worker confirms that a much more positive attitude now

---

1. Nyayo is the philosophy of President Moi, meaning progress, unity and peace. The tea belts which encircle and protect the highland forests are known as the Nyayo tea zone.

prevails. Her sentiment is that a new "awareness" drive associated with the drama programme would elicit a more enthusiastic response than it did on the first occasion.

The situation with Thomas Mzaywa's farm is quite different. Here is a farmer who by any standards, is progressive. The technical and economic success of his enterprise is clear, although he has only been able to accomplish this with considerable outside support. Nevertheless his example illustrates the possibilities for small farms whose traditional base is in decline. It must be said though that his enterprise sits like a small atoll in a tropical sea. None of his neighbours has copied his approach, few if any of the trees he grows have spread beyond his plot boundaries, and the zero-grazing initiative has only been followed in a few "rich" farms of the area. For the majority, the patterns of land use and farm management remain essentially unchanged. It has all the hallmarks of yet another disappointing "paysant pilot" scheme.

Although the achievements of Zacharia Moyancha are less dramatic in their technical sophistication, unlike Thomas Nzaywa's they have created considerable interest in the neighbouring farms. The team has been inundated with requests for assistance. Zacharia Moyancha himself has given seed and seedlings to neighbours, and many of the local farmers visit his farm to view and discuss the trees. At the moment there are over 550 young trees of mixed species on his farm: mostly of *Leucaena leucocephala, Calliandra calothyrsus, Grevillea robusta,* and *Mimosa scabrella*, but with lesser numbers of many others. They are located all over the farm, alongside hedges, scattered in the maize fields, as lines along terrace edges, around the house compound area, and he is rapidly increasing their number with seedlings produced on his own nurseries with seed he has collected from his own trees. Zacharia is not yet sure whether his small farm can ever become self-sufficient in firewood, but he is keen to utilize what he has as intensively as possible. his wife is able to cut the trees for firewood whenever she wishes, with the exception of his cattle *(Acacia mearnsii)* and gum *Eucalyptus saligna* woodlots. He also uses the new trees for cattle fodder, and is aware of the possible benefits they may bring to the soil.

Generalities

Individuals' case histories such as these provide useful detail of the workings of development initiatives as they touch the farmer, and therefore provide checks and balances in the continued modification and execution of programmes. But because of their very individuality and variability, they can make the design of broad-based, mass intervention programmes fraught with indecision and doubt. The requirement is to perceive and draw out general criteria from such apparently unconnected diversity, and to use these criteria to guide the formative design stages of mass extension programmes. It is assumed that the technical basis of an agroforestry programme is either already known, or can be determined by appropriate trials and experiments. The difficulty is one of making the technical options acceptable to the majority of the people they are directed towards. Extensionists have much to say on this of course, particularly on the mechanics and technicalities of the problem, but I am more concerned to take one step back and to consider what aspects of the nature of smallholder production in Kenya can give guidelines to the design of intervention programmes, even before the technical and extension parameters are drawn up.

In the present example we should first attempt to establish what, if any, are the common threads which run through the differing "success" rates of the four cases described. In searching for commonalitites, I am not assuming that somehow there are some previously missed "hidden" secrets that will finally provide the magic keys. Nor should we anticipate the construction of a "menu" for success.

In the case of Ebusikhale, the consensus of those working in the sublocation is that three issues predominate: the social dislocation associated with prolonged male labour emigration, the continuing tension between men and women in the management of the family enterprise, and the extent to which all things seemed to be assessed in monetary terms. Put together these social and economic circumstances inhibit the diffusion of a technical change which is neither new nor exciting, and offers no immediate prospect of monetary gain. Instead it is modestly attuned to existing technical practices; following on from, and enlarging upon, existing agroforestry activities. It is neither labour

demanding in its execution, nor expensive in its inputs, and it responds to the anxieties of the local people - firewood shortage and impoverished and erodible soils. These people do experience directly the impact of these deficiencies, particularly the women who gather the firewood and till the soil. But standing above them is a chronic shortage of money. Far from being a subsistence economy that is painfully adjusting to the penetration of the market, it is in fact little more than a residuum. The men have joined the lumpenproletariate of the cities, the women remain to raise the family, guard the dwindling assets, and scrape what they can from the soil. Their subsistence base is increasingly dependent on external injections of cash, and their farms have been reduced to little more than supplementary gardens. Precisely because of the prolonged and very deep penetration of modernizing forces, the mainstay of peasant production (the ability to withdraw from the market when economic conditions turn against it), is no longer viable. In that picture, tinkering with the residue of a peasant economy is a little like blowing into the wind. In coming to this assessment, the key phrase was the comment that because the assistance was free, it could not be worth anything. Effectively it was too late to attempt to reinvigorate the peasant economy in this modest way. Subsequently, the extension worker in the area has noticed a number of men and women selling seedlings in the nearby market. They seem to have had no difficulty in disposing of their stock. On the basis of this observation, the district team is considering returning to the sublocation with a modified approach that involves the purchase (albeit at a nominal price) of all inputs. In other words, in order to break through, the programme has had to come to terms with the existence of the market, and to tailor the programme to the specific conditions of the particular area.

In Murhanda, market forces are less corrosive in their impact. There is a cash crop base, which gives the farming enterprise a value in the modern world. There is a greater availability of land, and the disruption of the social reproduction system seems less severe. As I have observed, the response to the programme was less than enthusiastic from the start, but because the traditional base (collecting firewood from the forest, producing most of the necesary food on the farm) is still more or less intact, when it was faced with the Nyayo tea belt, the response

was an attempt to meaning. In a sense it was in the right place at the right time, and came with a message that articulated well with the changing circumstances of the area.

In the case of the two farms, we are observing two different episodes. For Thomas Nzaywa in Kakamega, adoption of new techniques has effectively meant the complete transformation of his farm. It is no longer representative of its neighbours, and has instead metamorphosed into a completely different economic enterprise. The extension worker has discussed this farm with the neighbours, and they express a view which in effect sees no parallel between Thomas's farm and their own situation. It represents too great a leap, and their response is one of jealousy rather than emulation (Thomas has experienced troubles with his neighbours over land, strange illnesses of his cattle and destruction of his bee hives). Important too is the impact of such a change on social as well as technical matters. By freeing his wife from the arduous job of tilling the soil (little or no food crops are cultivated), by providing sufficient firewood on the farm so that she doesn't have to search far in collecting, by having piped water on the farm so that she no longer has to carry heavy water cans from the local well, Thomas has inadvertantly changed her social world. She now has fewer opportunities to gossip with neighbours and establish her social credentials because many of the more communal activities associated with women's work have been made redundant (group work parties in the fields, group firewood collection, gatherings at the well, etc). Moreover, in bearing all the hallmarks of success, the family is becoming isolated from the community. There are many other and more subtle issues involved here, beyond my competence to assess, but there seems little doubt that a technical change of this nature carries with it profound social consequences.

In the Kisii example, the changes that Zacharia Moyancha has brought to his farm are less dramatic. They are building on an existing model rather than replacing it. His neighbours see a more adventurous version of their own farms, and respond accordingly. The dynamic within the tea zone of north central Kisii is one of reasonably successful absorption of a cash crop, with a real improvement in the economy of the farms. There is enough money for the children to attend school and enough for

improvements around the house. In some respects the adoption of new ways (tea came to Kisii in the late 1950's) has been successful, and with this success has come the material base and the inclination to experiment with new ideas., In all of Kissii, it is here that the zero-grazing system shows most signs of being adopted, that investments in farm productivity have kept pace (fertilizers, animal traction, etc); and it is here where a modified smallholder economy is viable and worthy of sustained support and investment. Within this context the agroforestry initiative is well received, particularly when it is promoted in a non-threatening manner (the risk-prone) change. The new system is non-competitive, enforces no radical technical re-orientation, and therefore falls into line with the normal process of experimentation on farms. Above all it comes in to a changing smallholder production system, with a dynamic which so far favours rather than disarms the farmer.

Conclusions

In Kenya, as elsewhere in Africa, development agencies interact with an ongoing process of rapid change. Put crudely this is a transition from a system whose primary goal was subsistence and perpetuation, to one which is fully integrated into a modern and dynamic, external market economy. In the case of Kenyan rural society this still incomplete transformation has taken place in the space of three generations or less. It is an astonishingly rapid process. The intrusion of this market economy affects the technical rationality of the production system, through a host of new demands (new crops, new technologies of cultivation, new patterns of labour use, and so on). It also has impacts on the physical reproduction of the household (demographic changes, different health care systems, altered food production and exchange). Finally, and perhaps most importantly in the present context, it forces realignment of social goals and strategies.

Each individual has not only to secure his or her own physical well being, but has also to establish a social identity and a position within the community. In situations of transition such as exist in modern Kenya, social roles tend to be redefined, and status adjusted. The relationship between men and women within the household is an obvious illustration, in which traditional

roles are still recognized, even when the practical reality might suggest their demise. The struggle of maintaining extended family structures is another, in which we see one half of the family attempting to pursue individualistic urban life styles in Nairobi, while the other half expects continuity in the maintenance of former support systems. The emergence of bureaucratic power structures (the local political party, the administration machinery), are also new elements. Many others could be mentioned.

Rural people have to exist and find a role in this new social arena. It is arguable that in making decisions about the adoption of new technologies, this social and non-material essential is weighed with equal importance as the more obvious material necessities of food, shelter, energy and other basic needs.

The situation for women in Ebusikhale is difficult. Should they adopt a new technology which has the potential to offer dramatic help in securing firewood, or should they forego this benefit because it will jeopardize their social standing in the community[1]? Better to find some extra money and out of it (a socially acceptable strategy) than by risking rejection by their peers. In other words, the content of the programme itself was not particularly pertinent. Of much greater significance was the possibility or not of making money, of gaining something to sell. Without that added incentive, interest in the programme waned.

Each community and person enters these changes from different starting points, and adapts to them in different ways. Thus we find some families with enough land, but a shortage of labour. The men migrate to the citities, followed by educated sons and

---

1. A frequent response by women when confronted with the opportunity offered by the programme, was that by planting trees, they would undermine their relationship with their absentee husbands, and therby lose standing in the community.

daughters. Younger children and elderly dependents remain on the farm, and labour is hired to pick the tea or coffee. With too little land, reduced opportunities for the education of the children and an escape to the city, the small farm is overburdened with consumers with nothing to do. A myriad other situations can be seen on the ground[1]. For agencies who design and execute large development programmes, it is perhaps more sensible to focus on communiites, or administrative units such as a sublocation, than on individual farms. The same questions apply, however. How does the household (or the community) find itself as market forces intervene? Are people keeping abreast of changes and able to take advantage of the, as in the Kisii highlands, or even possibly in Murhanda, or are they effectively overwhelmed by them as seems to be the case in Ebusikhale?

I have already indicated that the interpretation of events presented here cannot lead to a prescription, or a menu for success. Nevertheless I would argue that much can be gained by embracing some of these concerns, and by adjusting approaches to the design of development programmes accordingly. A little history helps. What has happened over the recent past in the area selected? Has modernization progressed steadily, or has it brought sudden traumatic changes (as is the case in the sugar belt of Kakamega for example). What particular set of circumstances characterize the intrusion of these market forces (new crops demanding radical readjustments in land use, obligatory labour migration, HYV's and the need for each based inputs, land tenurial changes, and so on)? In what ways has the community adopted or resisted this process, and what opportunities exist for individual farmers to respond to the incentives and constraints of the market?

One particular issue of interest is the possibility of community based development in a situation of rapid land privatization. This is especially relevant in the Kenyan case, but has obvious

---

1. See Bradley and Ngugi, 1986

implications elsewhere[1]. The privatization of land in most of highland Kenya is now complete, but registration in other areas, particularly those where agricultural environments are marginal, and where new settlement is currently concentrated, are still underway. Because of their marginality, these environments are especially fragile, and risk widespread erosion if cultivation practices come to replace extensive pastoralism. it is in these areas that agroforestry programmes for catchment conservation are frequently identified. Some would suggest that agroforestry based soil conservation programmes are best approached as community programmes, particularly where a resource of the commons, such as a watershed, is concerned. However, if land privatization is anticipated, the impact of this process on community action is difficult to foresee. The experience in Kenya suggests that the readjustment of social processes which follow on from privatization makes communal action extremely difficult. Who would benefit? What advantage is to be gained by giving in to the pressure of being seen to participate in community action, when the very social system that places value on the public display of communalism is being undermined? Public enthusiasm for community-based action may in fact be no more than a reactionary stance in the face of the uncertainties of an individualist future.

An alternative approach might be to downplay the issue of watershed conservation, and instead to promote agroforestry as a private good, conducted under private means, with the broader catchment benefits as a hidden and indirect goal. This latter alternative is only viable however, if the land tenure system is appropriate. Again, the experience in Kenya suggests that the ownership of land and the ownership of trees go hand in hand[2], at

---

1. Shutch's (1983) examination of the poor success rate of a community afforestation programme in Tanzania draws explicit attention to the problem of the ownership and use of resources.

2. Chavangi (1985)

least within the smallholder production system[1]. Without the former, interest in the latter is subdued.

Any discussion of the "acceptability" of technical changes is fraught with difficulty, not least because the word itself involves judgement, subjectivity, and context-sensitive perception. Eventually, of course, the farmers decide, but in the meantime, and in the design and planning of development programmes, I would like to suggest that some insights can be gained by taking on board some of the issues that have been raised here. As a frame of reference, it is possible to conceive of an agricultural production system in which market forces impress upon a triad of technical, physical and social reproductive subsystems. Within this dynamic the development programme intercedes. In contemplating the likely success rates of different technical options, the careful examination of the conditions of each of these subsystems, and of how they interact under different circumstances, can provide useful guides for making choices.

References

Barrow E (1988) Trees and pastoralists: the case of the Pokot and the Turkana. Social Forestry Network Paper 6b, ODI, London

Bradley P N (1984) The District Resource Analysis as Applied to Kakamega District. KWDP Working Paper No2, Beijer Institute/KWDP, Nairobi.

Bradley P N and Kuyper J (1985) Woody Biomass Survey of Kakamega District. KWDP Working Paper No 9, Beijer Institute/KWDP, Nairobi.

---

1. Barrow's work with the Turkana and Pokot suggests that in some pastoralist systems at least, individual ownership of trees can coexist with control of grazing resources, see Barrow, 1988.

Bradley P N and Ngugi A (1986) Agroforestry, Soil Conservation and Woodfuel in Murang's District. Part II: Farm Typologies and Farm Profiles from Five Subregions of Murang's District. Beijer Institute/KWDP, Nairobi.

Central Bureau of Statistics (1981) Kenya Population Census, 1979, Vol I Kenya: Ministry of Economic Planning and Development.

Chavangi N (1984) Agroforestry potentials and land tenure issues. Paper presented to the International Conference on Land Tenure and Agroforestry, May 1985. Beijer Institute/KWDP, Nairobi.

Kuyper J B H (1988) On-farm agroforestry trails in Kisii District KWDP Working Paper No 12, Beijer Institute/KWDP, Nairobi

Mung'ala P M, Kuyper J B H and Kimwe S (1988) On-farm Tree Nurseries Beijer Institute/KWDP, Nairobi

Skutsch M M (1983) Why People Don't Plant Trees. The socioeconomic impacts of existing woodfuel programmes: village case studies, Tanzania. Centre for Energy Policy Research, Resources for the Future, Washington D C.

van Gelder B and Kerkhof P (1984) The Agroforestry Survey in Kakamega District: Final Report. KWDP Working Paper No 6, Beijer Institute/KWDP, Nairobi.

RAPID RURAL APPRAISAL FOR ECONOMICS: EXPLORING INCENTIVES TO TREE MANAGEMENT IN SUDAN

Ian Scoones and Jules Pretty,
International Institute for Environment and Development
3, Endsleigh Street, London. UK

CONTENTS

Abstract

Understanding the incentives to tree management requires a disaggregated analysis that incorporates regional, village, group and individual perspectives. Rapid Rural Appraisal techniques offer an approach to understanding farming system complexity and local specificity. Examples are given for two villages in the proximity of Khartoum, Sudan that provide illustrations of different determinants of local incentives. Regional level influences on tree management relate to changing patterns of wood product supply and demand and the interaction of urban and rural markets. Uncertainty over economic, tenurial and environmental influences on the village farming system can be seen to affect tree management incentives; land use, tenure patterns and institutional control over communal forest land are also found to be significant. Preferences for different tree species by different sectors of a village influence assessments of the costs and benefits of alternative tree management options. Similarly, different socio-economic groups have varying interests in the local resource base and are affected to different degrees by changes in the wider economy. We argue that a disaggregated analysis, investigating economic incentives at different levels, provides a more complete view of greater use for rural development.

Introduction

The effects of macro policies at the village and household level are complex and variable. However most agricultural or forestry policy research tends to treat rural situations with aggregate data. In this way farmers and rural people are treated as groups en masse, assuming an average behaviour in the face of policy changes. A disaggregated view often provides a different perspective. Local differences in environmental or socio-economic conditions will have significant consequences for rural economic development policy and planning.

Trade-offs in costs and benefits of development options differ according to perspective, whether national, regional, village, group, household or gender. To develop policy and development strategies that are suited to local conditions and acceptable to

local people, investigations from the national to the local level need to be integrated.

There is a need for information gathering and analytical techniques that can understand local complexity as part of the development planning process. These can complement aggregate or long-term studies and contribute to strategies that are sufficiently fine-tuned to suit variable and diverse conditions.

In this study to determine the incentives perceived by rural people to the cultivation, maintenance and use of trees, processes acting at various levels will be considered. These incentives take several forms - institutional, economic, cultural, and act at different levels, from national to regional, to village, to cohesive groups within a village, and to individuals.

Rapid Rural Appraisal has been developed over the last ten years in response to concerns over the commonly encountered pitfalls to conventional approaches for rural research and development. The term RRA has now come to refer to a wide range of techniques and methods: indeed not all RRAs are rapid, not all are restricted to rural situations, and not all are appraisals. It can be defined as a structured and systematic activity designed to generate new insights about the range of opportunities open to rural people and the factors and incentives which influence decisions over these opportunities (Pretty and Scoones, 1989).

Procedure for the RRA Exercise in Sudan

The RRA was conducted over a period of 11 days, and included a number of short intensive phases in order to foster progressive and sequential learning. The focus of activities was regularly shifted between workshop and fieldwork. Within the workshops activities were switched between plenary presentations and group work. The team consisted of 17 people from a range of institutions (see Acknowledgements) and split into two groups for the field work and analysis. INSERT OA

The principal objective was to ascertain the key incentives arising from national to individual level incentives to tree

management in two villages - Faki Hashim and Sheikh el Siddiq -both within 100km of Khartoum. The fieldwork methods used were based upon various interviewing, diagrammatic and ranking techniques. These included the following: semi-structured interviewing, maps, transects, seasonal calendars, historical profiles, preference rankings, direct matrix rankings, wealth rankings, venn diagrams, matrices, and key informant interviews. Details of all the methodologies employed in this Rapid Rural Appraisal are contained in the workshop report produced by the participants (IIED/IES, 1989).

Regional Profile - Greater Khartoum and Its Surrounds

Greater Khartoum is a significant magnet for both people and goods in the Sudan. The city population doubled between 1973-1983 to about 1.5 million, with some 70% of the increase due to net in-migration. Many rural people were displaced following the severe droughts of the early 1970s and mid-1980s. In 1984 it is estimated that some 120,000 people moved to Greater Khartoum as "environmental refugees" from Kordofan and Darfur (El Sammani et al., 1989). Many more refugees are thought to have immigrated from the eastern provinces. The influx of rural populations is likely to continue, through a combination of deterioration in rural economies together with perceived better options in Greater Khartoum.

The city is not entirely urban: there are large populations of livestock residing in the city. Cattle have been brought by their owners from at least 100 km distant, because the city is the only place where they can purchase fodder; sheep are also fed on fodder, but the population of some one million city goats feed largely on urban wastes and refuse. There is therefore a significant demand from within the city from both humans and livestock for agricultural and forestry products.

The climate in and around Greater Khartoum is largely unfavourable to rainfed agricultural activity. The average annual rainfall is of the order of 150-200mm. Since the early 1970s rainfall has become less predictable, and rainfed agriculture has become increasingly insecure. In Faki Hashim there has been no grain harvest from rainfed sorghum since 1981. The most

successful food producing areas are therefore the irrigated lands close to the Nile, and flood retreat agriculture. Nonetheless the drylands remain critical to the livelihoods of many people.

Incentives to Tree Management

We now report on the incentives to tree management, with five examples from the two villages of Faki Hashim, some 30 km to the north, and Sheikh El Siddiq, which is located 100 km to the south of Khartoum. Each example is focussed on a different level of the hierarchy from regional to individual household level. Each example illustrates different uses of RRA techniques.

The examples are divided into five sections:

1. Regional level: patterns of wood and charcoal supply and demand

2. Village level: economic, tenurial and environmental uncertainty as disincentives to tree management (Faki Hashim)

3. Land-use: the impact of tenure and ownership on incentives (Sheikh el Siddiq)

4. Group incentives to tree management (Faki Hashim)

5. Individual incentives to tree management - the consequences of socio-economic differentiation (Sheikh el Siddiq).

1. Regional Level: Patterns of Wood and Charcoal Supply and Demand

A series of key informant interviews were carried out to investigate the changing patterns of wood supply from outside the villages. These aimed to explore the impacts of changes in the regional economy on the local wood resources, and were conducted with brick-makers, a builder, carpenter, cheesemaker, baker, wood merchant, eucalypt pole and charcoal merchant, and farmers and displaced migrants; all of whom are involved in the import of wood products into their respective villages.

Charcoal and wood are widely marketed and the demand is met by three main sources:

- Clearance of savanna woodland for mechanised agricultural schemes to the south and south-east of Khartoum, particularly in Blue Nile and Kassala Provinces.

- Cultivated trees, mainly Eucalyptus and *Sunut* (see Appendix A for Arabic Glossary), on irrigated plots.

- Casual clearance and harvesting of local trees, including from *goz* lands.

The rate of land clearing for mechanised agriculture is expected to decelerate over the coming years. This will constrain access to both wood and charcoal. Taking Blue Nile Province as an example-it currently supplies much of the charcoal for the urban markets, yet most of it is already under cultivation. In 1985 it was estimated that some 900,000 feddans (380,000 ha) remained to be cleared of trees, which could produce 50 million sacks of charcoal. As Dewees (1987) put it "if only a third of the demand from Blue Nile Province, the Gezira and Khartoum were met by these supplies, they would be completely cleared by 1999". However the Mechanised Farming Corporation intends to move extensively into South Kordofan, Upper Nile, White Nile and Southern Darfur Provinces, which all have the potential of becoming significant suppliers of wood and charcoal. The extent of supply from irrigated plots and from peasant farmer clearance of *goz* land is not expected to increase significantly.

The flow of wood and wood products was investigated by a series of interviews in both of the case study villages and Khartoum, and a map was produced to summarise the information (Figure 1). The majority of wood and charcoal is transported long distances. Most travels first to Greater Khartoum, before being transported to outlying villages, such as Faki Hashim and Sheikh el Siddiq. Some does travel directly to villages though: charcoal has long been imported from Kordofan to Sheikh el Siddiq, where clearing of land in the *goz* areas has provided a steady supply. Charcoal

is transported by camel to the village and sold to merchants there. Despite the long distances it appears that the costs of the large scale production of both charcoal and wood, together with low transport costs, even over distances of 4-500 km, still produces a product at a competitive price. A recent survey indicates that transport costs account for only 20-25% of total retail costs for charcoal (Dewees, 1987).

Charcoal and wood are uncontrolled commodities, and prices fluctuate freely according to relative abundance or scarcity. Within years charcoal prices are highest during the wet season, when transport becomes difficult and labour costs are high, and lowest at the end of the dry season. In the long run, though, real prices have shown very little change for the Khartoum market (Figure 2). Price fluctuations appear to result from a combination of factors: changes in oil prices that affect transport costs; good agricultural harvests, which cause migrant labour not to seek work in the charcoal industry; high agricultural prices, leading to more rapid clearance of land; pressures on capital markets, which finance charcoal entrepreneurs; formation of temporary cartels between merchants, which drive up prices; and competing export markets to the Middle East (Dewees, 1987). Wood prices trends have not been recorded, but are thought not to have changed significantly in real terms over recent years.

The demand from wood products comes largely from household fuel requirements, brickburning and building. Fuelwood and charcoal demands are high in Greater Khartoum and the heavily populated peri-urban fringe. Demand is likely to increase as the population of the urban and surrounding areas grows, since there is no evidence of widespread switching to non-wood based fuels.

An additional significant demand for wood comes from the many brickworks situated to the north of Greater Khartoum. Firing the bricks requires large amounts of wood, which is purchased from the large traders, not locally. One brickworks in El Faki Hashim fired 7 kilns of 115,000 bricks each in the January-May season of 1988. This used a total of 875 kantars of wood (40 tonnes). There are sufficient brickworks in this region to consume more than 400,000 cubic metres of fuelwood annually (Ahmed and El Magzoub, 1985). This alone is estimated to require the harvesting of 11000

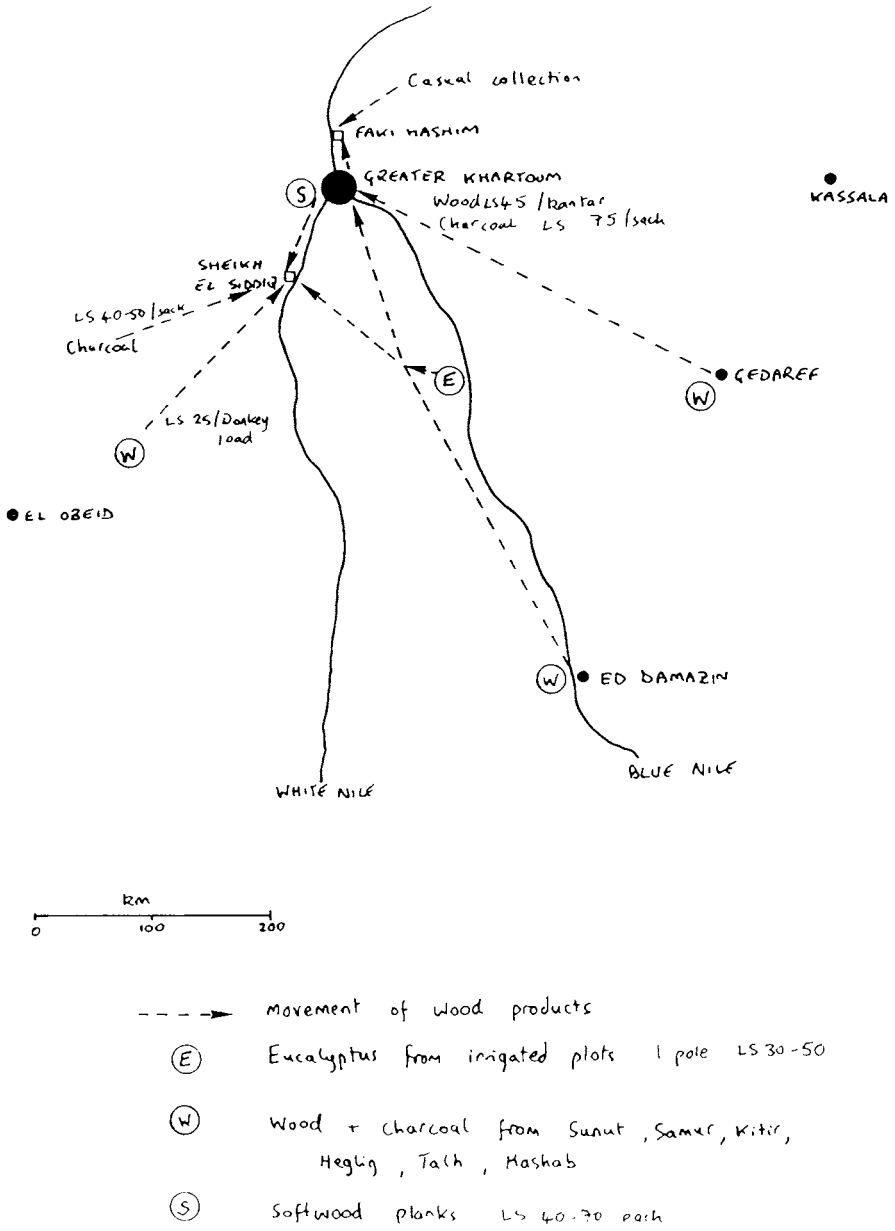


Figure 1 Movements of Wood Products

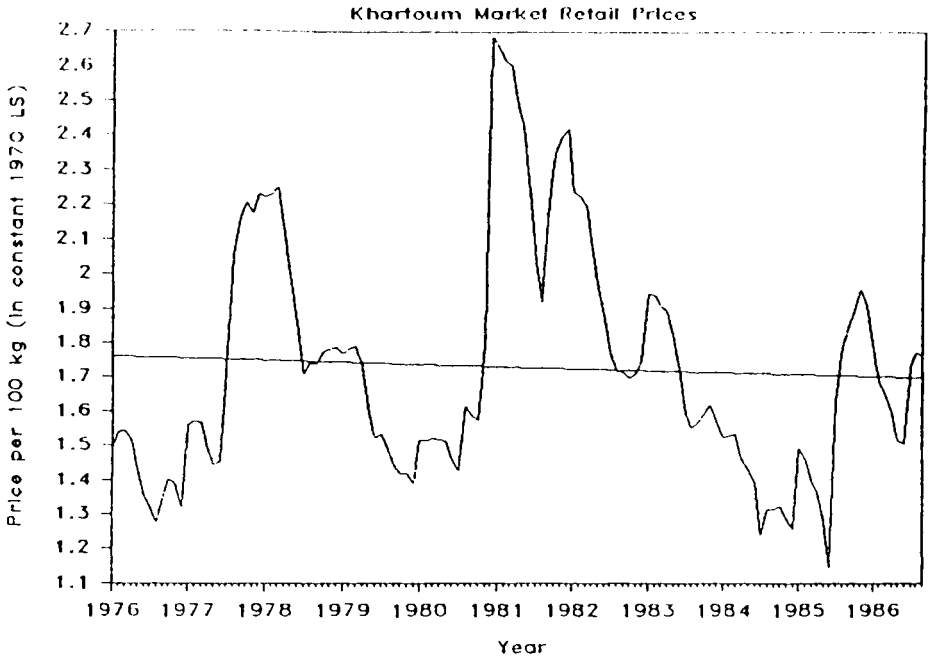


Figure 2 Charcoal Price Trends, Khartoum 1976–1986 (DeWees 1987)

feddans of *Sunut* forest each year, assuming a 20 year rotation with an increment of about $2m^3$ per year. The price of wood is now LS 40–45, though last year it was only LS 16/kantar.

The demand for wood, though, is not just for a fuel. There is also a significant demand for building materials. Since the coming to maturity of the irrigated eucalypt plantations in the

Gezira and in the Khartoum 'green belt', there has been a greater demand for marketed building materials.

The availability and price of alternative wood products at the regional level affects the patterns of local wood use and future substitution possibilities. The regional pattern of demand and supply is therefore important to understand to provide context for investigations at other levels. The relative prices of different wood products was investigated in a series of interviews. The Sheikh el Siddiq changes in prices since the mid 1960s of eucalypt poles, lengths of sawn timber and bags of charcoal relative to a donkey load of firewood are shown in Figure 3. Clearly imported products have become cheaper relative to local firewood since the 1970s. For instance, in 1970 a donkey load of firewood was equivalent to 0.02 eucalypt poles; now it is equivalent to 0.6 poles. Reduced availability of wood from local clearance has pushed up prices. With these prices of local wood resources rising in real terms there is clearly an increased incentive for those with money, to cut local wood for cash sale. Conversely, if protection regulations are respected there will be greater incentives to substitute for imported products with lower real price changes over time (cf Figure 2).

During the 1960's there was an almost complete switch from local wood for building and furniture making to eucalypt poles in Sheikh el Siddiq. As soon as eucalypt poles became available from the irrigated areas around Khartoum, first the builders and later bed makers switched to the imported product. The straight and long eucalypt pole was soon regarded as superior to the wide, uneven trunks of local trees. In Sheikh el Siddiq the heightened protection of the local forest area during the period of the Native Administration (from 1951) provided an additional incentive to import wood from outside.

Substitution of local wood for charcoal is difficult to predict because of the seasonal and interannual unpredictability in charcoal prices. Similarly the factors that would result in substitution of local fuel wood by eucalyptus are also unclear, since individual preferences and specialist qualities are important in guiding substitution decisions. As the cheese maker of Sheikh el Siddiq commented: it would be impossible to change from local wood to eucalyptus since the quality of the burn is so

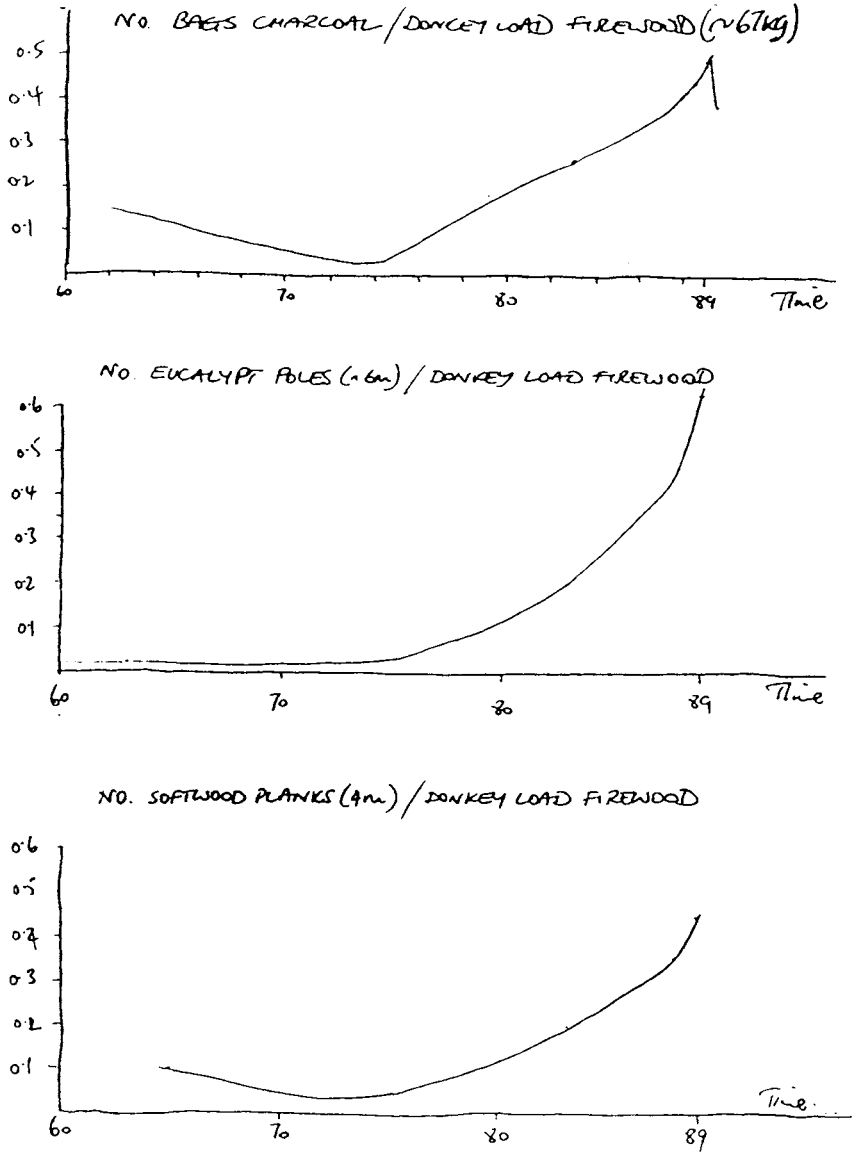


Figure 3 Relative prices of charcoal, eucalypt poles and softwood plants measured against donkey loads of firewood in Sheikh el Siddiq

different and it would affect the final product. Domestic fuel supplies may be different, and like other areas in Sudan, a substitution to other sources than local wood for fuel may appear economic in the future - as in the case of building materials in the 1960s.

2. Village Level: Economic, tenurial and environmental uncertainty as disincentives to tree production

Villages in close proximity to Greater Khartoum, such as Faki Hashim, are in the special position of being near to a very substantial centre of demand for agricultural produce. Like many large cities two important components of this demand are vegetables and fruits; unlike most cities fodder crops are also in high demand. In Faki Hashim almost all privately farmed land is used either for the cultivation of berseem (a type of alfalfa) and Abu Sab'in (a short duration fodder sorghum), or for a widevariety of vegetables (Figure 4). No staple cereal crops are grown on irrigated land. There are two large government owned mango gardens in the village, but very few trees are cultivated on privately owned land, save for a few mango close to the river and citrus trees in courtyards. Tree production and management is not a current feature of the Faki Hashim production system. This is in contrast to villages further away from Greater Khartoum, where land use is much more extensive and where many more trees are grown.

There are three important factors determining this pattern of land use which currently excludes trees. These relate to economic, tenurial and environmental issues. Each factor encourages farmers to adopt a risk averse strategy with low time preference rates and to invest for short term returns because of uncertainty about the future.

The national economic climate is unstable and inflationary pressures are strong. The returns to cultivating fodder and vegetable crops outweigh the advantages of planting mango trees today and waiting several years before the first harvest (Figure 5). This latter option is perceived as too risky. This is despite the fact that the mango is viewed as the "donkey of the market" - demand is always strong. The demand for berseem is stable, if not

increasing as urban residents restock with livestock following the drought of the mid-1980s. Berseem is a perennial that is cultivated for 4 years on the same piece of land. It is harvested every 25 days, and net returns are very high. We have no data for returns to vegetables: prices vary seasonally, usually with higher prices for any given crop at the early and late parts of the season. Abu Sab'in is planted after the vegetables have been harvested. It is harvested after 70 days, and sometimes a second crop is grown. Despite the rosy picture for these crops, there may be problems in the future for vegetables. Large scale vegetable farms are now being developed to the south of Greater Khartoum. These may flood the market with goods at prices that small scale producers cannot match.

The second important pressure is that of competition for land. This occurs within the village, and between inhabitants and outsiders. Private land in the village has undergone two redistributions. First in 1925 as a result of the Land Registration Act, and the oldest families still have up to 10 feddans from this time. In 1970 the 3000 feddan private scheme was nationalised, and land redistributed at 3 feddans per household. But all this land is subject to fragmentation, because of division on inheritance and the large size of families. In general land is either too fragmented, or just too small, to allow leaving it unproductive for a long period of time. The village is also sufficiently close to the city to be subject to land speculation. Agricultural land prices are currently LS 11,000 per feddan, and are expected to rise as the city expands. Development is occurring along the asphalt road leading north from Greater Khartoum, and already merchants and speculators are reputed to have purchased land, hoping to build houses in the future. Farmers, perceiving sale of their own land as a possible opportunity at some point in the future, will not be tempted to plant tree crops that have a long lead time.

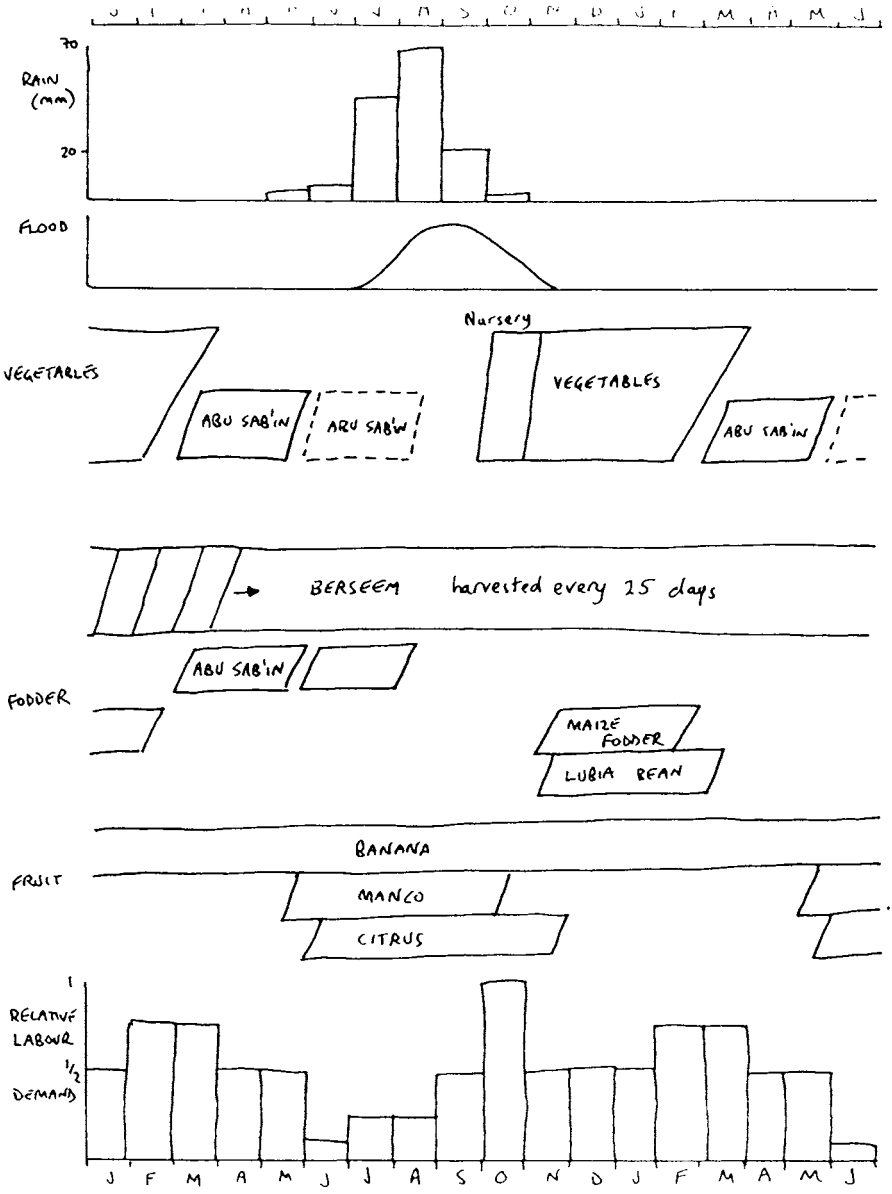


Figure 4 Seasonal Calendar for Irrigated Land in Faki Hashim

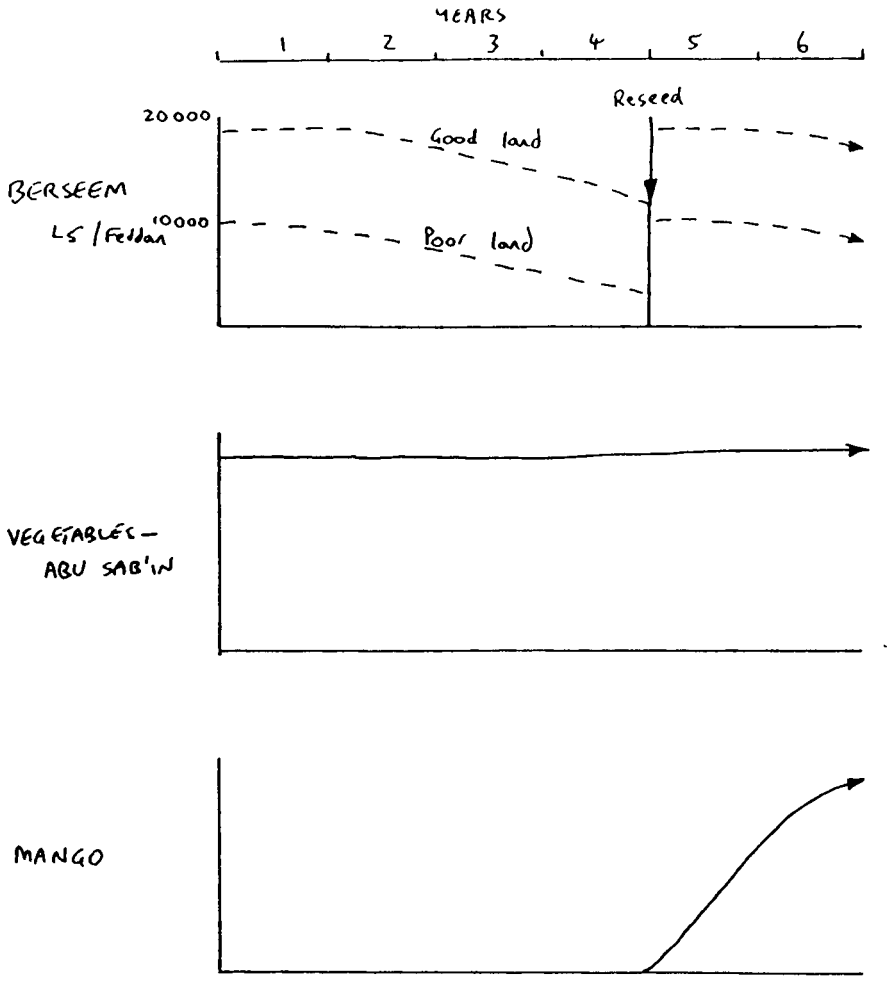


Figure 5 Relative Net Returns from Three Single Feddan Plots of Land used for Berseem Abu Sab'in or Mango

The third factor is the action of climate-driven shocks and stresses. Highly uncertain environmental conditions also influence farmers' perceptions of the riskiness of investment in tree crops. Such environmental factors take the form of:

- droughts, which have killed many trees in the dryland region

- floods, which drowned bananas and berseem (following the floods of September 1988, berseem was back in cultivation by the next February, but many farmers spoke of never growing bananas again because of their ready susceptibility to total loss).

- river migration, where changes in the course of the river have had a major impact upon location of pump sites and the workings of irrigation networks.

- erosion of the river banks, which has been enhanced by the loss of *Sunut* and willow trees from the *jerif* land.

In the village of Faki Hashim, different types of uncertainty about the future have contributed to a general low commitment and investment in tree crops. In particular, local factors have influenced this outlook: the profitability of fodder crops and vegetables, the land speculation because of close proximity to Khartoum and the flooding, river migration and erosion due to the village's site close to the Nile. These factors are not generalisable and the series of interviews with local people that uncovered these themes were necessary to understand the local perspective.

3. Land Use: the Impact of Tenure and Ownership on Incentives

Incentives for tree management are affected by the ownership and tenure of the resources. Different land use categories can be identified in the area of Sheikh el Siddiq. The RRA technique of walking village transects with local people was employed to investigate the patterns of land use and tenure. This was followed up with semi-structured interviews with various key

informants. The results are illustrated in a transect diagram that traverses the area from the banks of the Nile to the gozland 25km to the west (Figure 6). A number of categories of private and communal land can be identified for Sheikh el Siddiq village.

Home areas

Different groups in Sheikh el Siddiq have differing degrees of security of tenure in their home areas. Displaced settlers live on the village periphery on illegal sites, although with the permission of village leaders. Other members of the village have secure home sites in the main village area. If increased security of tenure is an incentive for tree management or planting we would expect that people in the main village are more likely to invest in tree management. This does appear to be the case. No trees were discovered to have been planted in the settlers' home areas, whereas some planting was noted in the main village. However, the investment in watering is high with water being purchased from the village well. The labour required is also significant as watering must be carried out virtually throughout the year. This is particularly for the exotic trees favoured in the home compounds. A few people have experimented with the planting of indigenous species with less water requirements, but knowledge of indigenous species propagation appears to be limited.

The *goz* land is marginal, sandy agricultural land where millet is grown. Rotations are necessary to maintain soil fertility and structure. Frequently people shift their field sites, so that continuous tenure is relatively uncommon. The *goz* land is around 25kms from the village, much of it in Kordofan, and is only visited during the rainy season for agricultural activities and some grazing. There is apparently no active management of woodland resources in this area. Use is made of wood resources that have grown up on fallow fields. This is either given away to charcoal makers, or the field owner gets a share of the charcoal product. The output of this is very low as most of the charcoal is derived from newly cleared fields. Some fields are still being cleared in the *goz*. A few villagers noted that the only significant trees in the *goz* area were large *Acacia* spp. left as shade trees in the fields.

The *jerif* land was allocated under land registration laws in the 1920's. Individual people hold title to the land, which stretches in strips of rich alluvial soil out from the Nile bank to the final point of flood retreat. Allocated strips also fall under the individual owner's title. Much of the strip is cultivated using residual moisture. The only trees on *jerif* land are sited along the high flood level. Only *Sunut* can withstand long term flooding. Because of higher water availability the riverine woodland is more diverse, greener and contains larger trees. Some of these large trees are guarded by herd boys, sons of the land owners, with flocks of goats. This ensures that the valuable pods and leaf fodder that are available in the dry season are for the exlusive use of the owner's goats. Tree products on *jerif* land are locally regarded as individually owned. However, there was much confusion over rights to cut trees on *jerif* land. There was also confusion over tenure rights of trees on the boundary between *jerif* land and the communal forest area. There has been no planting apparently on *jerif* land and little cutting or management of trees.

The communal woodland that surrounds the village consists of dense *Acacia tortilis* woodland. It is a protected forest reserve and cutting of wood in the area is forbidden by law. The area is protected through village institutions and through the operations of the local forest guard. Despite restrictions some wood is cut.

Dead wood is collected for firewood and *Acacia* pods, flowers and leaves are a vital source of fodder. People noted that the density of trees had declined over time due both to drought deaths and cutting.

An understanding of the local system for forest conservation observed in the communal woodland area requires an understanding of the local institutions and their impact on the political economy of the village. A number of actors involved in forest management were identified (Figure 7). Different people had different ideas as to what/who was important in forest management. Figure 7 is an overall impression of institutional interactions gained by the appraisal team after a range of interviews. The overlap of circles represents the degree of contact and the size of the circles represents the relative influence in forest management.

DISTANCE FROM HIGH FLOOD	25	4	3	2	1·5	0 Kms
LAND TYPE	GOZ LAND	COMMUNAL (WADI) (DISPLACED)	VILLAGE	FOREST RESERVE DISPLACED		JER.IF
SOIL	SAND	(alluvium)	GARUD	GARUD		ALLUVIUM
TENURE	TEMPORARY PRIVATE (Taxed)	COMMUNAL (past pute) (illegal settlemt)	PRIVATE	COMMUNAL (illegal settlm't)		PRIVATE
PROTECTN	CUT ± FREELY	TOTAL PROTECTION	CUT FREELY	TOTAL PROTECTION (- illegal cutting) (- exemptions)		CUT WITH PERMISSN.
CONTROL	INDIVIDUALS	SOME LOCAL REGULATIONS	COMP INDIVIDUALS	LOCAL REGULATIONS - SHEIK - VILLAGE COURT - FOREST GUARD		INDIVIDUALS UNDER F.A CONTROL
INCENTIVE ISSUES	LITTLE/NO MANAGEMENT PEN PROSPECTS	PROTECTION EFFECTIVE (near villages)	COMPOUND PLANTING WITH POOR RESULTS	PROTECTION EFFECTIVE; NO MANAGEMENT FOR REGENERATION		CONFUSED UNDERSTDING OF TREE TENURE

Figure 6 Tenure & Control Over Woodland Use in Different Land Categories of Sheik El Siddiq

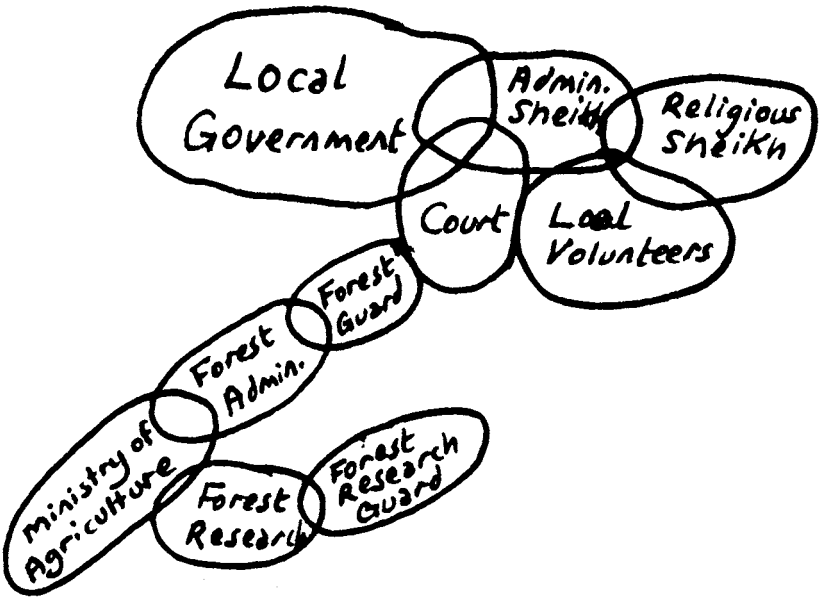


Figure 7 Village Institutions for Forest Management in Sheikh el Siddiq

A key factor seems to be the long term commitment of the Sheikh's family to forest protection. Their role became particularly important during the Native Administration period (1951 - 1971). It appears that the strict enforcement of laws started during the 1960s. In 1971, with the start of the rural councils, the official responsibility was transferred to the government and the Forest Department.

The forest guard first started operating in the late 1970's. He has a large area of responsibility, but his effectiveness is ensured by widespread awareness of regulations (certainly amongst men) and the cooperation of local people and their leaders. In Sheikh el Siddiq a number of volunteers patrol the area to check on wood cutting activities. Prosecutions are brought by locals reporting contraventions of the laws to the guard. The guard has to check on the offence and then brings the accused to court. Two courts are used: either the local court in Sheikh el Siddiq or the district court. The guard commented that the number of offences has greatly decreased since he started work, although there was a sharp rise during the drought. These were the result of people cutting in order to raise money for food. Lenience apparently was shown to such offenders. The standard penalty for an offence involving tree cutting is 25 lashes or up to LS200 fine, if the offender can get a medical exemption. The last local conviction was reputedly some time in late 1988 for a charcoal burning offence.

Forest guards and regulations exist in many other parts of rural Sudan, but few seem to be as effective as that found in Sheikh el Siddiq. It is interesting to speculate why the forest around Sheikh el Siddiq is apparently so well protected. A combination of factors seem to be important:

- The strong and long standing commitment of local leaders
- Widespread knowledge and apparent acceptance of the rules
- An effective enforcement by local people, rather than external forestry agents

Although protection of existing tree stock is ongoing there was no evidence of active management of the communal woodland resource. The existing, conserved trees are c. 30 years old or more and there is little effective regeneration of young trees. This has been due to long term drought and the effects of goat browsing. This is certainly a concern for the long term viability of the forest area.

Land tenure clearly has a significant impact on tree management in Sheikh el Siddiq. It appears that the more secure the tenure over the land, the greater the incentives to plant or manage trees (eg. home compounds within the village or *jerif* land). Any uncertainty over tenure or tree cutting regulations appears to result in reduced management input (eg. the *goz* land and the uncertainty over control over *jerif* land trees). Communal forest land is different. Management is effected in this area through strong, village level institutions, rather than individual incentives determined by tenure.

4. Group Incentives

In order to assess the true economic value of tree resources, together with the likely perceived incentives for management and use, it is important to understand local perceptions of criteria relating to functional uses. Conventional economic assessments of tree resources tend to concentrate on apparent economic benefits such as wood yield, total fodder biomass, value in soil stabilisation. However, rural people use many more parameters in assessing benefits and costs of different tree species or management practices. In order to get an insight into perceptions of economic value it is necessary to investigate local preferences. Recommendations based on Cost-benefit ratios using outsiders' criteria may not be appropriate to local situations. Local perceptions are manifest in terms of preferences for particular species or mixes of species. Although these can differ between individuals, different cultural groups may hold significantly cohesive perceptions of trees.

There are two main ethnic groups in Faki Hashim, comprising of the long-term inhabitants, the families of whom have mostly been present since land registration in 1925, and the more recently arrived displaced migrants, mainly from western Sudan. Each group lives in geographically distinct regions of the village, has access to different resources and has fundamentally different ways of securing a livelihood. A series of Preference Rankings were carried out in order to assess differences in priorities and cost/benefit criteria between the two groups.

The first interview was of eight men from the migrants' encampment situated on the drylands, but close to the main road. They came from Darfur after the drought of the early 1970s, but still live in semi-permanent huts and compounds. They work as agricultural labourers on the irrigated schemes, some are also sharecroppers, and they keep goats and sheep. They have no formal tenurial status over the land or the trees, but they do make use of the local tree products. They do not plant any indigenous trees. The second interview was of a group of farmers from the settled part of the village. They are representatives of a group in which households own small amounts of irrigated land, and also tend to have at least one member involved in a non-farm income generating activity in Khartoum. They are involved in intensive vegetable and fodder production, and have some trees on field boundaries and in the courtyards of houses.

The two groups of informants were first asked to name the six most important trees to them. The name of each was written on a separate piece of paper. The team then asked pair-by-pair which was most preferable, together with the reasons why. The results of the choices were recorded in a matrix. In this way a ranking of most to least preferred is produced, along with all the criteria used to make those choices. The technique takes up to one hour to complete (see McCracken et al., 1988).

This forced choice technique produces many criteria as each pair is compared by the informant group. The results of the two interviews are shown in Figures 8-10. The most important tree species omitted from the two lists of six included Mesquite (*Prosopis* spp.), Tamarind (*Tamarindus indica*), *Kitir*, *Laot* and *Heglig*. In all, the two interviews produced the remarkable total of 31 quite different valued criteria for the use of resources from these eight trees. About half were common to both groups, with the remainder reflecting particular characteristics of each group.

There are several interesting features arising from this analysis:

- Each group chose different trees

- All except the least favoured trees in each ranking had at

least 5 valued criteria, emphasising the multiple used of favoured trees

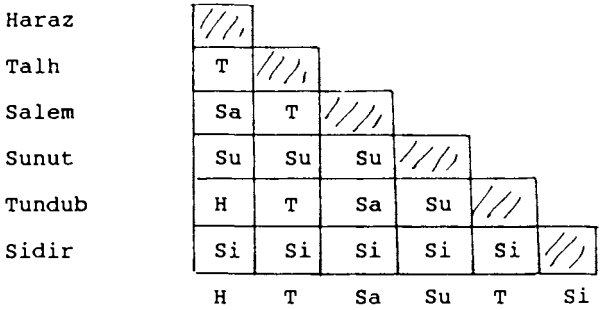
- Some of the criteria are strictly functional, such as value to livestock, wood as a resource for building or for other domestic uses, wood for fuel; some are aesthetic, such as ornamental value and density of shade; and some are strongly culture-based, such as value in funeral and marriage ceremonies.

- Each group had unique criteria: the village residents were particularly concerned with the capacity to grow trees from seedlings and availability of seedlings. Because of the proximity to the Nile only they mentioned the value of *Sunut* for boatbuilding. The displaced migrants described the value of aromatic smoke whilst cooking, important perhaps in their small huts.

- The criteria do not carry equal weighting, for example *Sidir* was the most preferred tree in the displaced Darfur community, yet this was solely because of the critical role of its bark in funeral ceremonies. Because of this it would be difficult to accord a replacement cash value to such criteria.

In conclusion, it is clear that the two groups of people from Faki Hashim recognise a great variety of economic uses for trees, even though they do not actively encourage growth from seedlings-save for in the courtyards. Each group has a different set of criteria to measure the costs and benefits of each species and so comes up with a different overall ranking. This may be equally true for other groupings in the village: men/women, rich/pooretc. These are the factors that determine decisions about planting and management at the local level. The preference ranking techniques therefore provide a valuable insight into the rationale for local prioritisation.

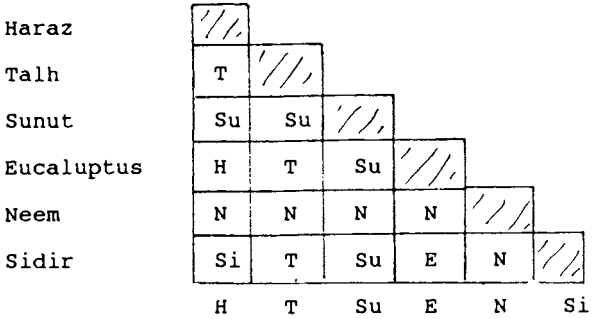
A. Displaced migrants (Western Sudan)



Preference List:

1. Sidir
2. Sunut
3. Talh
4. Salem
5. Haraz
6. Tundub

B. Long-term residents of Faki Hasim



Preference List:

1. Neem
2. Sunut
3. Talh
4. Sidir
5. Haraz
6. Eucalyptus

Figre 8 Results from two preference ranking exercise conducted in Faki Hashim

A. Criteria suggested only by displaced migrants

1. Bark critical component for washing bodies in funeral ceremonies
2. Fruit pods for tanning leather
3. Aroma of smoke whilst cooking
4. Straightness of wood
5. Wood for mortars

B. Criteria suggested only by Faki Hashim residents

1. Regrowth following pruning
2. Grows from seedlings
3. Availability of seedlings
4. Ornamental and beauty value
5. Wood for boats
6. Perfume and skin colouring
7. Wood for writing tablets
8. Fruit pods used in marriage ceremony
9. Nuisance in compounds: attracts stone-throwing young boys after fruits
10. Windbreaks on field boundaries
11. Fuel for brickmaking and bakeries

C. Criteria common to both groups

1. Fruit edible to humans
2. Fruits/pod/flowers for fodder
3. Leaves for fodder
4. Fruit pods medicinal
5. Strength of fire
6. Susceptibility to termites
7. Wood strength
8. Produces gum - valued ingredient in inks and for mixing with sand for building purposes
9. Branches good for hedges
10. Shade tree
11. Wood for handtools
12. Wood for building - walls
13. Wood for building - roofs
14. Smoke anti-rheumatic
15. Wood for furniture, beds

Figure 9 Comparisons of criteria for tree uses given by two different groups in Fakir Hashim

FAVOURABLE	UNFAVOURABLE

SIDIR: Ziziphus spina-cristi

1. Edible fruits	1. Cannot plant
2. Thorny fencing	2. Source of trouble in courtyards because of thieving children
3. Leaves for fodder	
4. Medicinal bark	
5. Windbreak	
6. Break for washing bodies in funeral ceremonies	
7. Wood for building and furniture	

NEEM: Azadirachta indica

1. Shade tree	
2. Fuelwood	
3. Wood for building huts	
4. Trees will grow after pruning	
5. Grows from seedlings	
6. Ornamental	
7. Multiple uses	
8. Wood for handtools	

SUNUT: Acacia nilotica

1. Pods medicinal	1. Cannot plant
2. Pods used in marriage ceremony	
3. Strong burn - used in brickmaking	
4. Wood for roots, boats, furniture, beds, tools	
5. Produces gum - ingredient for inks and strengthens sand when mixed for building	
6. Pods used for tanning leather	

TALH: Acacia seyal

1. Strong fire	1. Very susceptible to termites and wood-borers
2. Smoke with good aroma	2. Wood has to be soaked for 3 months for resistance to termites
3. Smoke anti-rheumatic	3. Never planted
4. Produces gum	
5. Fuelwood	
6. Skin colouring and perfume	
7. Flowers for fodder	
8. Wood for burning	

Figure 10 Combined criteria for eight trees from the two preference rankings

[Figure 10 – continued]

FAVOURABLE	UNFAVOURABLE
SALEM: Acacia raddiana	
1. Wood for building	1. Moderate fire
2. No aroma to smoke	
3. Straight and strong, good for sticks	
4. Flowers and fruits for fodder	
5. Wood for building huts	
HARAZ: Acacia albida	
1. Fruit for fodder	1. Susceptible to termites and wood-borers
2. Wood for furniture and beds	2. Mild fire
3. Wood for mortars for grinding	3. Weak wood
4. Shade tree	4. Wood not straight
5. Best wood for building boats - very light	
6. Wood for tablets for writing Koranic verse upon	
7. Young boys use it to float across river	
TUNDUB: Capparis decidua	
1. Fruit for fodder	1. Mainly branches, no thick stems
2. Used to treat jaundice	
3. Hedges	
EUCALYPTUS: Eucalyptus sp.	
1. Ornamental and beauty value	1. Too tall for dense shade
2. Seedlings available	2. Wood fragile, not tough enough for building
	3. No regrowth after pruning
	4. Susceptible to termites and wood-borers

5. Individual Incentives and the Consequences of Socio-Economic Differentiation

People's attitudes to tree management are coloured by individual socio-economic conditions. It is necessary to understand how economic differentiation affects people's options if a full picture of incentives is to be developed

During the appraisal of Sheikh el Siddiq village a classification of different income opportunites was produced through a series of key informant interviews and a wealth ranking exercise (Gandin, 1988). Different people combine different opportunites, but the classification proved helpful in focussing attention on the range of livelihood options available in Sheikh el Siddiq.

The socio-economic characterisation of the village was used to identify a range of individuals to interview. The major income sources for each person interviewed were assessed in order to further understanding of the range of livelihood options in the village (Figure 11). The aim was to explore in what ways different people have different access to wood resources. Differences in species use were also explored. Eight in-depth interviews were carried out.

It was found that those of lower socio-economic status were more reliant on collection of local wood resources and did not purchase. The displaced settlers were given special dispensation to cut building materials on their arrival from Kordofan. All other people were reliant on the purchase of building poles,which are imported to the village from outside. The only locally derived wood used for construction or tool making that was found to be roots of dead trees. Firewood was locally collected by most households from dead wood in the local forest area. Some households with higher cash incomes supplemented this with purchased charcoal. Those with livestock as significant components of their income sources also purchased some pods for goats. Changes in regional patterns of demand and supply (see above) will therefore affect those linked with the external wood and charcoal economy to a greater extent, while changes in the local resource base will affect others.

The role of women in wood resource use and management was not effectively pursued and remains an area for further investigation. Women are engaged in firewood collection, but those interviewed appeared less aware of the local regulations about woodland protection than the men. One woman, with her husband working away in Saudi Arabia, did not apparently collect or use any local wood resource and was totally reliant on remittance income to purchase all wood products.

There was no clear pattern of differential use of local tree species. The exception being that the displaced settlers used local species for furniture/building more than any other group.

Depending on amount and type of income received different households are reliant on the local resource base to different degrees. In particular, it is the poorest who are most dependent on local resources for all end-uses. In addition, livestock owners are also dependent on the local supply of pods for the nutrition of smallstock during the dry season. These conclusions imply that there is a common interest transcending socio-economic differences, in sustaining the local forest resource. The difference is that the poorer section of the community are principally interested in the harvesting of wood products (firewood, building) that might require some cutting,where as the richer livestock owners are keen to maintain a mature, pod producing forest largely for small stock production.

The appraisal process thus generated a series of questions about how different sectors of the village have interests in tree management. Socio-economic differentiation is clearly an important factor to consider in any assessment of tree management incentives. Different sectors of rural society weight the costs and benefits of different forest management practices in different ways and feel the impact of external changes at the regional level to different extents.

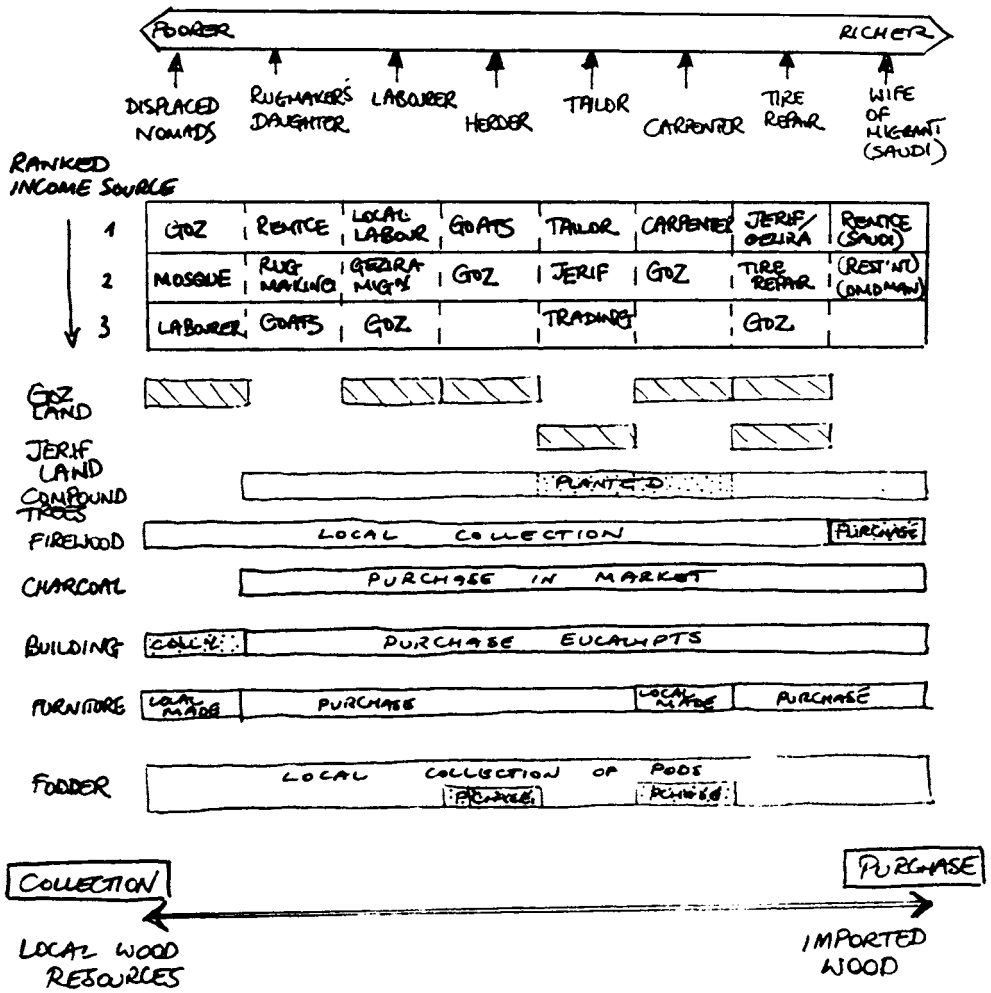


Figure 11 Socio-Economic Differences in Woodland Use in Sheik el Siddiq

Conclusions

A principal objective of any Rapid Rural Appraisal is to generate hypotheses and raise questions about the topic under study. Thus the study of these five different levels has raised a number of important questions about incentives for tree management in rural communities beyond the urban fringe of Greater Khartoum. A sample of the key questions generated by the RRA team are outlined in Table 1.

In communities close to the city, such as Faki Hashim, trees, though important to the household economy, are playing a secondary role to fodder and vegetables. The most important questions relate to the likelihood that these crops will remain just as profitable into the future. Large scale fruit and vegetable farms being developed elsewhere may change the relative benefits of growing these crops compared with other trees.

Trees may further be encouraged if charcoal and wood from the mechanised farming regions does become increasingly scarce as these operations decline. More systematic cultivation of trees on field boundaries could meet some of the local demand for wood and other valued products. Trees on the river bank could certainly increase the sustainability of the production system, but again this would require the provision of seedlings of indigenous species. This requires a major change in how people perceive trees and their cultivation in relation to future uncertainty. The type of trees that might be planted will be affected by local perceptions and assessments of relative costs and benefits. These will differ between groups in the village and so no standard recommendation package can be expected to work.

The final question concerns the expansion of irrigation into the drylands - this could lead to more secure tenure for both the settled and the migrant residents by establishing permanent agriculture before the land is purchased as speculation for housing. In order to increase the tree planting in the dry land areas some significant change in the tenurial system for trees is needed: for example "if you plant a tree, you can use its products, or cut it down, at any time".

Table 1: Key questions developed for the two communities of Faki Hashim and Sheikh el Siddiq.

Faki Hashim

1. What is the likelihood that large scale fruit and vegetable farms elsewhere, together with improvements to transport and roads, will lead to cheaper products that will undercut the small producers of Faki Hashim?

2. Would small scale experiments involving the raising of indigenous species from seed help to demonstrate to local people that the cultivation of trees would be a viable means of increasing the numbers of trees?

3. Would the encouragement of *Sunut* and *Salix* willow trees on the Jerif land succeed in minimising the erosion of the river bank by the Nile?

4. Would expansion of the irrigated land into the drylands to the east of the road improve the sustainability of the agricultural production base of the village?

Sheikh el Siddiq

1. What are the knock-on effects of forest protection in the Sheikh el Siddiq area on regions further away?

2. How can regeneration of *Samur* be improved through the active management of portions of the forest area using the existing and effective institutions as experimenters?

3. Is there a real fodder gap caused by changes in the local woodland that is present every year? Are there locally adapted species that could be introduced or encouraged to fill such a gap to stabilise interannual fodder production?

4. What factors of pricing and marketing of imported wood products would affect the substitution for fuel of local wood sources for imported wood?

The key questions for the more distant village of Sheikh el Siddiq mostly relate to the communal *Samur* woodland. The options for tree planting and management in home compounds are limited by the investment required for watering, although an exploration of opportunities for indigenous tree propagation appear a possibility. On *jerif* land issues relate largely to tenure and the necessity to clarify rights of use.

A combination of factors seem to be important in the maintenance of the communal woodland, including the strong and long standing commitment of local leaders, the widespread knowledge and apparent acceptance of the rules, and effective enforcement by local volunteers, rather than external forestry agents. The structure of local institutions rather than individual economic incentives are seen to be critical in the management of the communal woodland area.

The existing, conserved trees are about 30 years old or more and there is little effective regeneration of young trees. This has been due to long term drought and the effects of goat browsing. This is a concern for the long term sustainability of the forest area, since even in good rainfall years recruitment to the tree population is not taking place. This is of concern both to livestock keepers and those socio-economic groups particularly reliant on the communal woodland resource.

The range of existing tree species may not be meeting local people's needs, particularly those relating to fodder. A number of older informants emphasised the changing species composition of the Sheikh el Siddiq woodland. They noted that a number of tree species have decreased or disappeared, and attribute this to both prolonged drought and cutting. There exists an important complementarity between the different species of *Acacia* resources of fodder, particularly between the dominant *Samur* and others. For instance, *Haraz* has a dry season leaf out, whilst *Samur* has most leaf production during and after the rains. *Laot* flowers and fruits early and has fruit/flower fodder available several months before *Samur*. The reduction or disappearance of certain species that fill critical seasonal fodder gaps could be significant in affecting overall livestock nutrition.

The final issue concerns factors of pricing and marketing of imported wood products. As we have demonstrated earlier, there has been substitution of new wood products for local species in the past. The future preferences of local users and the relative prices of alternative products are uncertain factors, yet ones that could have a significant impact on the local woodland resource base and the ability of particular groups to obtain their wood needs from external sources.

The key questions thus refer to influences operating at the regional, village and household level. The relevant cost-benefit trade-offs relate to issues at each of these levels. It is therefore important to develop an integrated analysis that incorporates factors from the household to the regional economy. Aggregate statistical surveys do not generally acheive this. RRA techniques offer one route to develop integrated insights for a more effective understanding of incentives for tree management.

Acknowledgements

This paper is based upon a study funded by the United States Agency for International Development, and conducted in Khartoum during February 1989. Key members of the Rapid Rural Appraisal were drawn from the Institute of Environmental Studies, University of Khartoum; Sudanese government agencies; USAID, Sudan; Save The Children Federation/US; Sudanese Red Crescent; IIED, London and IDS, Sussex: and included M D El Khalifa, Yagoub Abdulla Mohamed, Mohammed Osman El Sammani, Hassan Osman Abdel Nour, Mustafa Suleiman, Tag El Sir Ahmed Mohamed, El Hag Hassan Abuelgasim Mohamed Mukhtar, Mohammed Omer Mukhier, Joachim The is, Mutasim El Amin, Kamil Osman Mohamed, Amna A Gadir Mustafa, Richard Margoulis, and Robert Chambers.

References

Ahmed A S and El Magzoub El S. 1985. Survey of FuelwoodConsumption in Khartoum Province Industries. National Council forResearch, Energy Research Council, Sudan

Conway, G.R. 1985. Agroecosystem Analysis. Agric. Admin. 20,31-55 Dewees P A. 1987. Consultants Report on Charcoal and Gum ArabicMarkets and Market Dynamics in Sudan. Prepared for the UNDP/WorldBank Energy Sector Management Assistance Program, Washington, DC.

Grandin, B. 1988. *Wealth Ranking*. ITDG, London.

IIED and IES. 1989. Rapid Rural Appraisal in Sudan: EconomicIncentives to Tree Management. Report of workshop proceedings, 20Feb - 2 Mar, 1989. International Institute for Envirnment andDevelopment, London and the Institute of Environmental Studies,Khartoum

McCracken, J.A., Pretty, J.N. and Conway, G.R. 1988. AnIntroduction to Rapid Rural Appraisal. IIED, London

Pretty J N and Scoones I C. 1989. Rapid Rural Appraisal Trainingin Sudan: Incentives to Tree Management. Report to the US Agencyfor International Development, Sudan.

El Sammani M O, El Had Abu Sin M, Talha M, El Hassan B M andHaywood, I. 1989. Management problems of Greater Khartoum. In:Stren R E and White R R (eds). African Cities in Crisis. ManagingRapid Urban Growth. Westview Press, Boulder, San Francisco and London.

APPENDIX A: Arabic Glossary

Abu Sabin	Short duration fodder sorghum
Berseem	Alfalfa-like fodder crop
Feddan	0.42 hectare
Goz	Sandy soil savanna
Haraz	*Acacia albida*
Hashub	*Acacia senegal*
Heglig	*Balanites aegyptiaca*
Jerif	Flood retreat land
Kantar	100 lbs (45 kg)
Kitir	*Acacia mellifera*
Laot	*Acacia nubica*
Neem	*Azadirachta indica*
Salem	*Acacia raddianes* var. *spirocarpa*
Samur (sayal)	*Acacia tortilis* var. *raddiana*
Sidir	*Ziziphus spina-christi*
Sunut	*Acacia nilotica*
12 Sudanese Pounds (LS)	1 US $ (at February 1989)
Talh	*Acacia seyal*
Tundup	*Capparis decidua*

Appendix B:

Major tree species by land-use type and use (Shiek el Siddiq)

Goz land: *Boscia angustifolia, Acacia mellifera, Zizyphus spinocrusta, Acacia seyal, Cordia* spp.

Wadis: A. nilotica, A. nubica, A. tortilis

Compounds: *Citrus* spp, *Z. spinocrusta, Tamarindus indica, A.albida, Eucalyptus spp, Neem, A. tortilis, Albizzia lebbeck.*

Communal forest: *A. tortilis* var. spirocarpa [Samur], *A. tortilis* var. radiana [Sayal], *Balanites aegyptiaca.*

Jerif: *A. nilotica, A. albida, A. mellifera, B. aegyptiaca, A.tortilis.*

INDIGENOUS AND EXOTIC FRUIT TREES: WHY DO PEOPLE WANT TO GROW THEM?

Gumbo, D. J., Mukamuri, B. B., Muzondo, M. I.[1], *and Scoones, I. C.*[2]

1 *ENDA-Zimbabwe, PO Box 3492, Harare, Zimbabwe.*

2 *International Institute for Environment and Development 3 Endsleigh Street, London*

CONTENTS

Abstract

The 'community management of woodland project' is based on a system of village level planning where communities plan their own planting strategies. The first years of the project's experience has shown that between a quarter and a third of all trees planted were fruit trees. These include both indigenous species and exotic species. The reasons for this local enthusiasm for fruit trees are explored. The reasons people want to plant fruit trees can be explained according to historical factors, marketing and transportation, local preferences, seasonal roles and economic value. Each of these issues is explored with comparisons between project areas. It is concluded that in order to understand why people plant fruit trees it is necessary to address the full range of factors and take account of local conditions.

Introduction

The ENDA-Zimbabwe 'commmunity management of woodland project' operates in four project areas in Chivi and Zvishavane districts in southern Zimbabwe. This is a dryland agricultural area with average rainfall between 500mm and 650mm. The project approach is based on a process of community planning at village level. Community workers carry out research with farmers and develop a village plan for woodland management. Village level research highlights three key issues that form the basis of the project:

* Trees are essential in maintaining the ecosystem and where depleted need to be planted;

* Trees are a multipurpose resource, and to meet the communities' woodland resource needs, a diverse woodland is required;

* Farmers perceive indigenous woodland management as a necessary strategy.

The village plan is thus suited to local needs. A list of local tree requirements is produced through the community worker's village appraisal, and planning meetings. Trees from the list are grown in the community nursery for planting during the wet season. Trees are planted as part of the communal management of grazing lands, or individual planting in fields and at homes.

The value of any woodland product and by-products can only be understood within the context of the prevailing state of the woodland. To this must of course be added the historical perspective which through a number of influences: social, political, religious as well as economic may have contributed towards the current states of the woodlands in the areas that the project is working in. Local perceptions have been investigated through a number of exhaustive interviews and these have assisted the team to gain insights about the present state of the woodland resource.

The project area is divided into four distinct areas each with its own characteristics and levels of woodland stress. In the hilly, sandy soil areas of Chivi south and Mazvihwa a host of indigenous fruit tree species are found. These are areas of relatively low population density and low woodland stress. On areas of clay soils there are fewer fruit trees. In the other two areas of Runde and Chivi north where, in general, woodland stress is higher, the bulk of the indigenous fruit trees are found in the fields and also in the surrounding hills and riverine tracts.

The woodland resources vary within the ENDA project area both in extent and composition. Different socio-economic factors are significant in each of the areas. This paper addressess the question of how biophysical, historical, and socio-economic factors affect farmers' priorities in fruit tree planting.

Although the economic value in terms of cash is clearly an important determinant in guiding farmers' planting priorities, other factors also intervene. These additional factors are important to understand if a full assessment of local incentives to fruit tree planting is to be made. Trees have multiple and complementary uses; all of these need to be taken into account if a useful economic analysis is to be carried out. Not all of the complementary uses are immediately obvious to the

outsider. Gaining a farmer perspective on priorities allows a fuller insight.

Community planning and the demand for fruit trees

During the 1987/8 season, when the project was at a pilot stage in one ward in Mazvihwa CA, 3600 trees were planted. Of these 41.2% were fruit trees (39% of fruit trees planted were indigenous and 61% were exotics). A total of 18 different indigenous tree species were planted, half of which were fruit trees. In addition, 6 exotic species were planted.

During the 1988/9 season, planting was carried out by communities and individuals in 24 village development committee (Vidco) areas in each of the four project areas. The data on community planting activities is not yet fully compiled, but the preliminary results are shown in Table 1. The list of different species planted is contained in Appendix 1.

Table 1 Data on community plantings in three project areas (preliminary results)

	Chivi N	Runde	Mazvihwa
No of species	26	15	17
No of fruit spp	13	7	9
No indig fruit spp.	10	5	7
% planted fruit trees	24	34	17
% planted indig fruit	14	27	16
% fruit trees indig	60	81	96
% fruit Mupfura	8.5	23	18

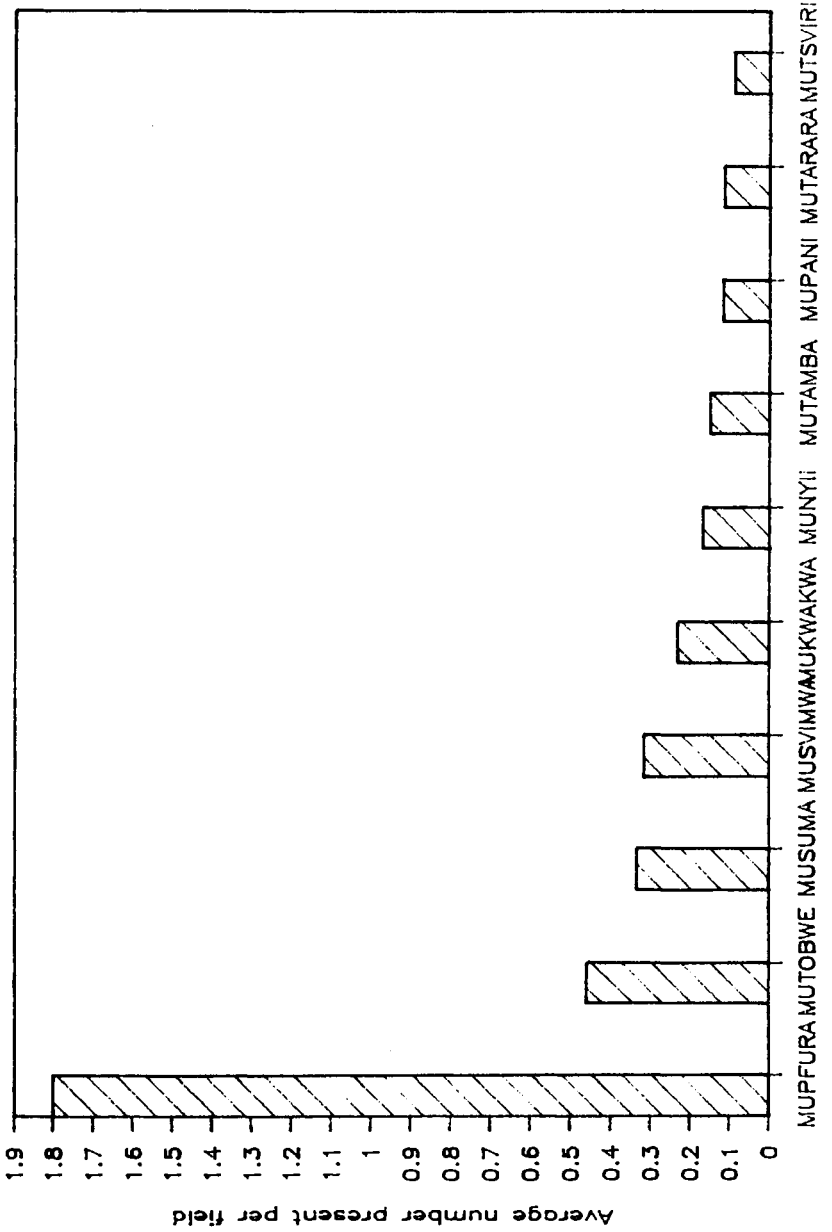


Figure 1 Occurrence of Trees in Fields
Gundekunde, Manyarira, Gen'ere, Murowa

From the data available it can be seen that between a quarter and a third of all trees planted are fruit trees; the major portion of these being indigenous species.

The existing fruit tree resource

In this section we attempt to outline the position of fruit trees in the project area. A review of fruit trees at homes, in the fields and in the grazing areas is given.

Fruit trees in fields

Deforestation in Zimbabwe's communal areas is largely a result of clearance for cultivation. There is selective clearance with a clear bias towards saving fruit trees. Data from the Mazvihwa project area shows that the majority of species found on arable lands are indigenous fruit tree species. Figure 1 illustrates this graphically for the ten most dominant trees found in fields in a survey carried out in Mazvihwa.

Of all trees in fields, 81.6% are fruit trees, all of which are indigenous. The ten most important trees that were selectively left in fields in Mazvihwa were: *mupfura, mutobwe, musuma, musvimwa, mukwakwa, munyii, mutamba, mupani, mutarara* and *mutsviri.*

Campbell (1988) found that, through clearance, total canopy cover was reduced from 52% in *Mutondo* woodland to 8% in cultivated lands. However the cover of particular fruit tree species was found not to decrease. Species that were preferentially retained included:*Musuma, Muzumi* and *Mutobwe*, while *Mukwakwa, Munengeni* and *Munhunguru* were reduced.

Fruit trees at homes

Most of the trees found at homes are fruit trees. Of these over 90% are planted exotic fruit trees. The indigenous fruit trees in the home were selectively left out during the establishment of the homestead and very few were planted. The enthusiasm for

planting indigenous fruit trees is increasing with improved access to seedlings at the village nurseries. Since the start of the project people have been experimenting increasingly with *Mutobwe*, *Munyii*, *Mupfura* etc. (see Appendix 1). In general, the most common fruit trees found around homes are: Mangos, guavas, lemons, peaches, bananas, naartjies and pawpaws.

The bias towards fruit trees for home planting is reflected in the patterns of collection of seedlings from the village nurseries. Of the trees collected by individual farmers from the Chivi North nursery, 75.8% were fruit tree seedlings. Of these, 53.2% were exotics.

Fruit trees in grazing areas

Trees with edible fruits never form a major component of climax woodland in Zimbabwe. It has been found that in different climax vegetation types, the average canopy cover of edible fruit trees ranges from 2 - 7% (Campbell, 1988). Table 2 shows the average canopy cover of fruit trees in the climax vegetation types found in the study area.

Table 2: Fruit trees in climax vegetation types (after Campbell, 1988).

Climax type	Ave canopy cover
Julbernardia globiflora	7%
Colophospermum mopane	2%
Combretum - Acacia	4%

Tree clearance in the grazing area is highly selective. Generally, fruit trees are left. Commercial or agricultural extension influences have resulted in a certain amount of clearance. In addition, under high woodland resource pressure some fruit trees can be removed for woodfuel or other products.

In all project areas, communities have designed enrichment planting interventions for grazing area plots. To date, 33 Vidco's have established plots in their grazing areas. The size of these plots average 30m x 30m. Data from two such plots is shown in Table 3.

Table 3 Trees planted in Vidco plots (Runde project area)

Plot	% Fruit trees	% Indigenous	% Exotic
Ngombeybani	28.8	93.3	6.6
Mbilashaba	31	86.5	13.5

At this stage it is necessary to ask what determines local preferences for different fruit tree species in order to understand further the factors that have conditioned farmers' responses to the community planning process in the project areas.

Farmers' preferences

A series of preference rankings were carried out with farmers in the Runde project area in order to investigate the basis on which farmers make choices about planting fruit trees. The method used was pairwise ranking (McCracken, Pretty and Conway, 1988). Farmers were asked what they thought the six most important fruit tree species (both indigenous and exotic). Pairwise comparisons were then made and the trees ranked according to the farmer's preference for planting. Both women and men of different ages were interviewed. The ranking results are shown in Table 4.

There was a general preference shown for exotic fruit trees across all groups (old/younger men and old/younger women). However, older women showed a higher preference for indigenous fruit trees than other groups. Men's criteria focussed more on cash value, whereas women's focussed on food value.

The criteria that distinguished each choice were also recorded. The positive and negative qualities of each of the fruit trees that were investigated are listed in Table 5.

The dominant positive criterion for exotic fruits was their role in cash generation. As discussed earlier they have a wider market and receive higher unit price than indigenous trees. This is particularly true of mangoes. By contrast, indigenous fruit trees have a wider range of uses beyond fruit production. These include beer, nuts, medicine, artefact manufacture etc. An advantage of indigenous fruits is their storage properties which allows marketing or consumption throughout the year.

Despite the wider range of potential uses the exotic fruit trees generally ranked higher. This implies that the cash value criterion was probably weighted higher in people's minds than the other criteria shown by the indigenous fruits.

The community plans for tree planting are clearly based on the desire to plant a mix of fruit species, both indigenous and exotic. An explanation for these locally generated strategies can be found in the results of the preference rankings where the multiple functions of trees were stressed by farmers. An additional perspective can be gained by examining the roles of different fruit trees in a seasonal context.

Table 4

Ranking results - all groups combined

Sex	M	M	M	M	M	M	F	F	F	F	F	F	F	F
Age	O	O	O	O	M	M	O	O	O	M	M	M	M	M
AVOCADO	3				1									
MANGO	6	1	1		2	2	1	3	2	1	1			3
NAACHI					3									
ORANGE	2	2			6					5			2	
APPLE	1											1		
PEACH	5		5							4				4
GUAVA						1	2		3	3	1			
BANANA													1	
LEMON				1										
PAWPAW										2				
MUNYII					3									
MUZUMI			3	2	3		3		4					5
MUSHUKU	4													
MATOBWE		3		3		3	4	1	1		3	3	4	2
MUTAMBA		5				4			5			6		
MUCHAKATA		4	2	4										1
MUTENGENI		6												
MUPFURA				5		5	6	4	3			2		
MUSUMA			6				5	5			4		3	6
MUSVITA			4											
MULBERRY								2						
MUONDE						6			6					
MUNUNGURU											5		5	
DZVIR											5			
MUKWAKWA												4		
MUKOSVO												5		
MUCHECHETE				6										

KEY: Sex: M = Male; F = Female
Age: O = Old; M = Middle aged
Rank: 1 (highest) to 6 (lowest)

Table 5

Ranking criteria - combined from preference ranking in Runde project area

FRUIT	GOOD THINGS	BAD THINGS
Exotic fruits		
Mango	Good fruit, cash, shade	Fibres on teeth, cannot store, attract mosquitoes, when unripe affect mouth
Avocado	Nutritious fruit, marketing, high growth rate, baking, butter.	Needs watering
Orange	Tasty fruit, drink, Cash, 'adds blood', prevents disease.	Watering, turn to lemons
Lemon	Fruits, juice for tea, slimming, put in porridge, cures flu	Sour and bitter, thorns
Apple	Good to eat	
Paw Paw	Good fruits	Male trees
Peach	Good fruits, sales, germination easy,	Fruit has no food, too many cause upset stomach
Banana	Body building food	Babies' umbilical cord slow to heal.
Indigenous fruits		
Muzumi	Eating, selling, porridge	Vomit if eat hora, constipation if swallow seeds
Mushuku	Good fruit	Seed damages gums

[**Table 5** - Continued]

Matobwe	Can be cooked and stored, cash, eaten any season, makes teeth and jaws strong whitens teeth, leaves ear medicine, shade, windbreak, browse.	Stomach ache, 'block embryo's gullet', kids can break necks when falling from tree.
Chakata	Beer, stored, food porridge, exchange with mealie-meal, sale	Bad smell
Mutengeni	Good fruits	Thorns
Mutamba	Porridge, storage	
MuDzvirimombe	Fruit soft and nourishing	No trade
Musuma	Cash, easy to collect, storage	Seeds block gut stomach ache
Musvita	Fruits	Can attract mosquitoes when bad
Mupfura	Fruits, beer, dovi, nuts, animal food.	Social problems (beer) eg fighting; stealing.
Muchechete	Fruits to eat, entertain kids	Might meet baboons when collecting - dangerous
Mutunguru	Fruits good	Thorns, no trade
Mukosvo	Fruits good, 'jelly liquid loosens stomach contents'	No taste, darkens teeth, causes 'dzviti'
Mukwakwa	Fruits good, stored	
Mukubvu	Fruits, cash	

Historical perspectives

We cannot really understand the presence of trees in an area without looking at the historical background, both in terms of government extension policies and local institutions of resource control. Both these factors have greatly influenced the pattern of fruit trees in the project areas. Historical factors in many ways condition present management practices and the economic potential of the fruit tree resource.

Oral historical interviews have shown that the four areas have a long history of an extension package promoting exotic fruit trees. This dates as far back as the 1930s. This is particularly true for Chivi North and Runde CAs where the influence of the agricultural demonstrators was earlier and more extensive. The success of the exotic fruits in these two areas has been enhanced by the relatively favourable environmental conditions in these areas.

Regulations enforced as part of the Native Land Husbandry Act (1952) have encouraged the removal of trees in fields. Extensive removal of fruit trees was carried out under the instructions of the agricultural demonstrators. The Master Farmer certificate was conditional on the complete removal of trees in fields (Wilson,1989). Interviews with farmers have demonstrated that this was widely resisted in all areas; especially in the sandy soil areas of Chivi North and Runde. Trees such as *Muchakata*, *Muonde*, and *Mupfura* are regarded as important for shade, fruit and as an additional source of organic nutrient input to poor sandy soils (Wilson, 1987; CSC, 1988). Farmers saw this enforced removal as not only an infringement on their traditional practices of protection of large trees, but an additional intervention from the colonial administration that they regarded as of little worth.

The presence of fruit trees can also be attributed to the social and religious significance of the particular tree species. Traditional-religious control of certain indigenous species is evident in the four project areas (Mukamuri, 1987; 1988). This relates in particular to indigenous fruit trees especially,*Muchakata*, *Mupfura*, *Muvonde*, *Mutobwe*, *Mutamba*, *Mukusi*, etc.

The major custodians of religious-political control are the local ruling lineages. They exert power over the natural resources of the area, protecting key components with taboos and local laws enforced by local leaders. The Karanga High God, Zame, is also incorporated into the system of religious resource control to enhance the protection of indigenous fruit trees (Mukamuri,1987). Cutting indigenous fruit trees is considered a breach of taboos and the offenders may be fined a goat. There are also sometimes restrictions on the sale of fruit and other tree products. Stories which deify the indigenous fruit trees are often told to young children in which strangers are said to have survived by eating fruits of mythical trees where ancestral spirits are said to dwell. Cutting the indigenous trees would mean that the spirits have no place to stay. In this regard having large fruit trees, especially *Muchakata*, is an added advantage to the home, thus keeping the useful *Midzimu* (ancestral spirits) in close proximity to the home.

The extent of local religious-political control varies between the project areas. It is particularly strong in parts where established lineage groups have managed to maintain a degree of local power through Independence. In some areas, strong degrees of protection are afforded by newer local authorities who employ local bye-laws to enforce regulations preventing cutting.

Marketing of fruit products

The degree to which fruits are sold for cash differs between the four project areas. This is dependent on the availability of fruit, its shelf life, ownership and tenure, demand patterns and access to markets, the sale price, and social factors that regulate and control the sale of fruit products.

The availability of indigenous fruits is dependent on environmental factors prevailing. The sandy soils of the dry miombo woodlands which occupy a large part of the project area support larger numbers of indigenous fruit tree species (see Table 2). Of the four project areas Chivi South and Mazvihwa are relatively better forested than Runde and Chivi North and as such hold more indigenous fruits than the latter. The shortage of

fruits in Runde and Chivi north is often compensated for by (illegal) access to commercial ranches. In areas where the availability of indigenous fruit trees is high there is effectively no local market for the fruits produced thereof. However, in other areas where deforestation or unsuitable environmental conditions (eg heavy soils/ *Mopane* woodland) prevail (which often results in low local availability) specialist collectors, usually children, collect for local sale from the ranches or from well forested areas well away from their areas of residence. The destination of these fruits if sold is usually the local business centre, and in the case of Chivi North this is usually either Madamombe or Mandamabwe growth points where some of the fruits like *matobwe* will sell for about 3 cents per unit. However at this point the amounts sold per individual and returns realised still have to be determined.

Exotic fruit trees are available in large numbers in areas of relatively higher rainfall and where government extension has promoted them for a longer periods. There is generally an active local market for exotic fruits, and in such areas fruits such as mangos, oranges will be sold for as much as 10 cents. For most of the exotic trees the problem lies mainly in the storage techniques available at the local level. Losses are high if the fruits are not purchased or marketted in time and this aspect often lowers the price quite considerably. Preliminary figures obtained from households that have been very active in the sale of exotic fruit trees indicate that as much as $40 to $60 per season can be realised from one single mango tree (Muguti and Kege, personal communication).

As already pointed out fruit trees are individually owned if they are within the home compound. In the fields, trees and their products are held privately only during the period when crops are present. Adults are prohibited from entering another's field during the cropping season, although the restriction does not apply to children (who however will require some kind of permission). During the non-cropping season, fields can be communally used. Trees in the communal grazing land can be cropped by anyone and there are no restrictions, except where one attempts to gather unripe fruit. Access to fruits is therefore determined by these ownership patterns. Exotic fruit trees are almost exclusively planted in the home area and are thus

available for individual marketing. This is the case even for abandoned home (*matongo*) and garden sites. Indigenous fruit trees are found in all land types and collection of fruits from trees under communal tenure is based on a first-come-first-serve basis. In areas of low availability this may mean a committed rush to harvest the fruits.

Unit price of exotic fruits is high because of high local and urban demand and relatively lower supply. Indigenous fruits have a low unit price in rural areas because there is a relatively high supply, competition amongst sellers and a relatively low rural demand (low cash flow?). Indigenous fruits have a good urban demand where they are regarded as "exotic". The price of *matamba* per unit is known to increase quite considerably between Siboza (road side business centre) and Zvishavane (from 2 cents to 5 cents). For most indigenous fruits the local market has little to offer and value in money terms is only realised outside their area of origin.

Exotic fruits are more expensive per unit (than indigenous) in most of the rural areas and become even more so where the fruits are "imported" into the area. For instance a mango will cost 5 cents in Runde (where farmers have planted them) while the same unit will cost 25 cents in Chivi south where most exotic fruits have to come from as far afield as Masvingo some 80 km away. The costs of a mango in Runde communal lands is 5 cents while the same unit will go for 10 cents in the nearby mining town of Zvishavane. The greater the distances the fruits (whether exotic or indigenous) are transported the higher the differential between source and sale-point price subject to the state of the market which varies seasonally (see below).

The proximity of markets is a significant factor in determining the commercialisation of fruits, and this is directly linked to the forms of transport available. For most of the farmers the easiest form of transport is the bus, but if near enough they will use an ox-cart. Charges vary from $8 for a donkey drawn cart to $4 per bucket (20 litre tin) by bus. The four project areas have significantly different degrees of access to market centres (see Figure 2). Points of sale include towns, business centres and busy roads. The Runde project area has marketing opportunities at roadside business centres such as Siboza, in the

mining towns of Zvishavane and Shurugwi and as far afield as the provincial capital of Gweru.

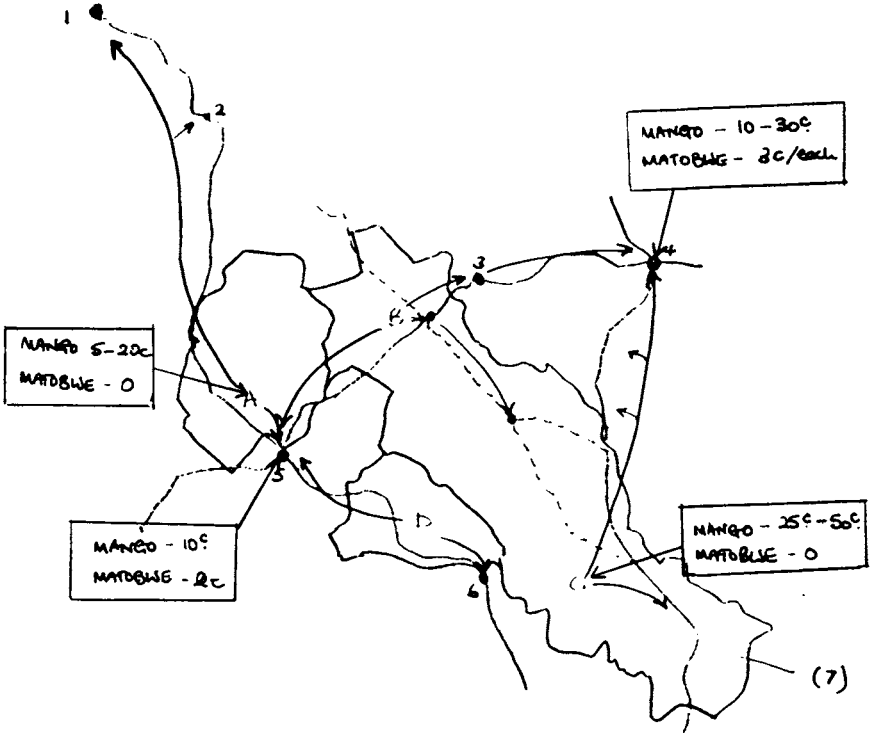
By contrast, Mazvhiwa is more inaccessible with poor transport to Zvishavane and Buchwa. Other producers, usually from outside these areas, easily undercut sales. This is particularly so for the Buchwa market which is supplied by the local Muchipisi valley farmers who have a long tradition of exotic fruit tree growing based on prolific water supplies from Buchwa mountain.

Ownership and marketing of fruits is a fairly gender specific venture. Due to the location of almost all exotic fruit trees on and around the homestead they become the property of the head of the household who is in most cases a man. Marketing outside the area has to be approved by the household head. The actual marketing is carried out by the woman and/or the children. Much as the trees may be owned by the man, the tree care process is usually the responsibility of the children. The marketing of the indigenous fruits is one exercise wholly controlled by women. The children gather fruits during cattle herding forays or go out specifically to gather fruits and are also involved in the actual selling of the fruits on the roadside or at the nearest commercial centre.

Marketing is to a large extent constrained by transport as briefly outlined above. However storage also plays an important part in limiting sales. For fruits like *matobwe*, sales can be boosted by cooking, drying and salting such fruits and then marketing them during the months when there is none available. This will increase the value per unit by as much as an extra 2 cents per unit in the urban areas. The other exciting prospect here is that fruits in this form will also find some limited commercial value even in their areas of origin.

Social factors also influence the degree of marketing of fruit products. Some areas have had a long association with urban markets and are well integrated with the urban economy. Such areas as Siboza in the Runde project area are highly commercially orientated and production of fruit is very much geared towards sale. This is due to the fact that this is an area where there is a large population of immigrants whose respect for social taboos has remained limited and so have been involved in the sale of

Figure 2 Patterns of Fruit Tree Marketing: Zvishavane and Chni Districts



Towns	Project Areas	Marketed Fruit Trees	
1. Gweru	A. Runde	Orange	Mango
2. Shurugwi	B. Chivi North	Guava	Peach
3. Mashava	C. Chivi South	Avocado	Lemon
4. Masvingo	D. Mazvihwa	Apple	Mulberry
5. Zvishavane		*Mutobwe*	
6. Buchwa		*Mutamba*	
(7) Chiredzi		*Musuma*	
		Makosvo	
		Dzvirimombe	
		Munyii	
		Mushuku	
		Mukwakwa	
		Muchakata	
		Musumi	
Scale 1:1000 000		*Dhorofia*	

fruits for a long time. However in the other areas taboos still govern the sale of indigenous fruit products. These are areas where there has been a long standing religious-political control by lineage groups, such as the case in some parts of Chivi South, Mazvihwa and Runde. Fruit trees are generally regarded as belonging to *Mwari* (God) and so are the property of everyone. It is therefore offensive to the guardians of the resource, the autochtonous ancestral spirits, to sell fruits or their products.

These taboos have changed over time. They regained ascendency during the war of liberation and continue to do so after local disasters (such as drought, baboon population explosions, epidemics etc.). Such disasters are regarded as a sign of disapproval of commercialisation in any form by the ancestors. In Chivi South, Mazvihwa and some parts of Runde project areas, there have been increasingly strong restrictions on sales since the 1982/3 drought after a period of more extensive sales in the early 1970's.

A wide range of factors therefore determines the marketing and sale for cash of indigenous and exotic fruits. Specific local conditions determine the economic role of fruit trees in the four project areas (Table 6).

Seasonality - understanding the interrelationship of indigenous and exotic fruit trees

The seasonal patterns of fruit production is illustrated in Fig 3 for 10 exotic and 17 indigenous fruit tree species. This is based on a series of interviews with farmers in the four project areas. There is a certain amount of variation in species phenologies between areas, but a general pattern is presented here. The overall availability of fruit trees varies considerably between areas (see above).

The seasonal calendar illustrates the pattern for a diverse dry miombo woodland. However many of the species mentioned are widely distributed. The results show that indigenous fruits are available throughout the year, except in May and June when no fruits are available (according to the interviews). Their availability is also extended due to the storage properties of

certain fruits. On the other hand, exotic fruits are largely available in the rainy season. Certain exotic species can provide fruit in the dry season (*chirimo*), but usually only with good access to water.

The availability of fruits can be related to other activities. Relative labour requirements are described by a simple labour calendar (Fig. 3). This is derived from a series of interviews where farmers are asked to rank the relative amounts of labour required in different months/seasons. Exotic fruits are available at a peak labour season, especially during weeding and early harvests. This may hinder marketing opportunities especially if attempts are made to market outside the area. However since there is an active local demand for exotic fruits in most of the project areas this may not be a major constraint.

Indigenous fruits are available at other times of year, particularly in the dry season, when labour requirements are lower and more flexible. This is the time when 'work at home' is dominant; such activities include building, fencing, thatching etc. There are no herding obligations during this period also. The labour involved in the collection and marketing of indigenous fruits may be higher. This is because most harvested indigenous fruit trees are found either in the grazing areas or in the arable areas away from homes. Similarly, the principal cash market for indigenous fruits is outside the area, requiring travel to market centres. In addition, the possiblities of storage of indigenous fruits means that they can be marketed throughout the year and be responsive to labour availability or cash needs. For both indigenous and exotic fruits, there is a seasonal variation in price with a peak during highest production. Indigenous fruits, because of their storage properties, may be sold outside the production season and so gain a good price and ready markets.

The seasonal calendar shows that exotic fruits are available when other foods are also around. Crops can be harvested from Feb/March, depending on area and season. Collected vegetables and other wild foods are available with the onset of the rains (Wilson, 1987). Exotic fruits therefore are important to nutrition in the early part of the rainy season, while indigenous fruits are available during the dry season. The importance of

Figure 3 Labour Calendar

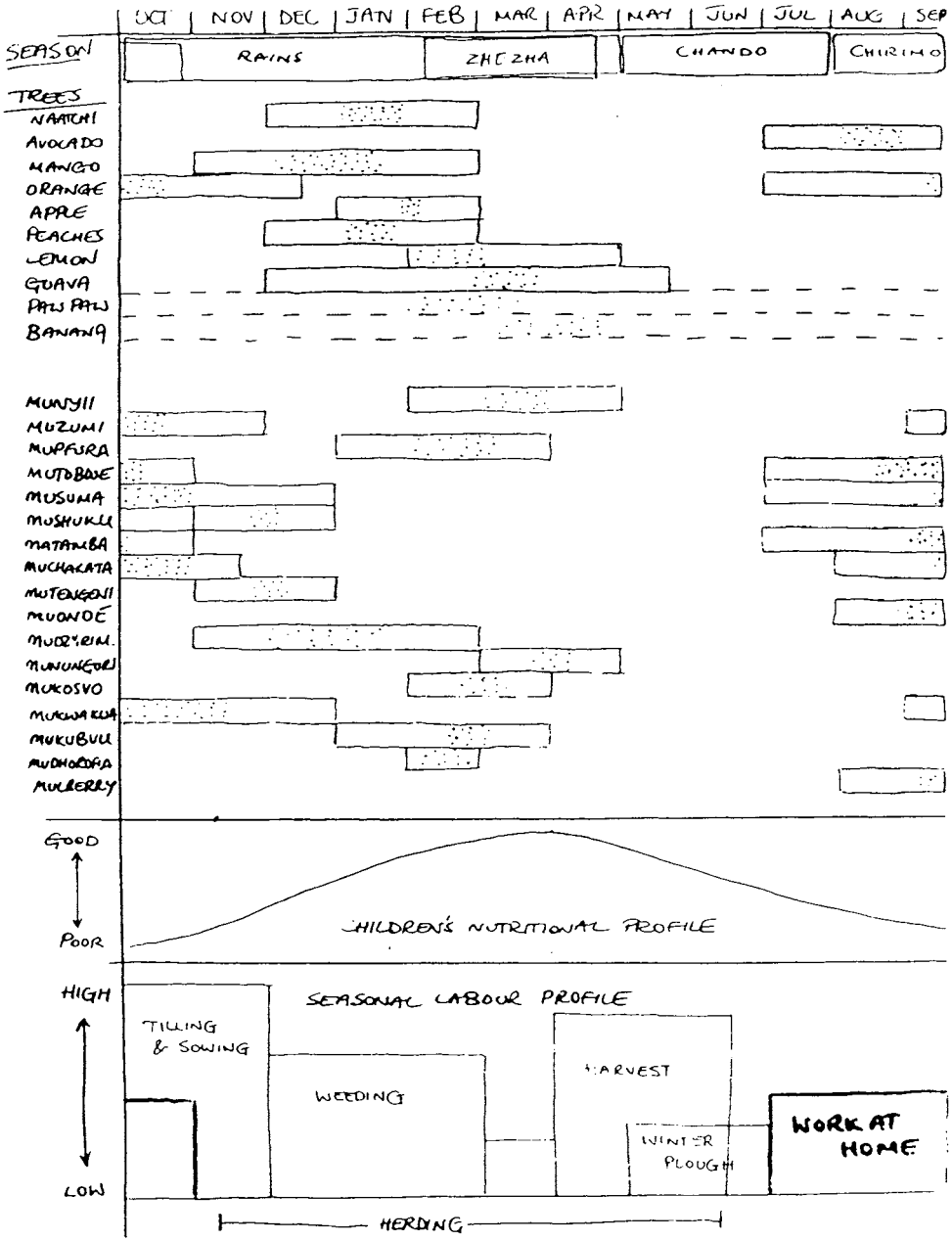


Table 6

Marketing of fruits - combined results from appraisal in Runde project area

SPECIES	STORAGE	PRICE	MARKET	TRANSPORT
Exotic fruits				
Orange	No	10-20c/each	Local/Zvish	Bus
Guava	No	2-10c/each; $7/bkt	Local/Zvish	Bus
Avocado	No	80c/each	Local/Zvish	Bus
Apples	Short	5-20c/each	Local/Zvish	Bus
Mango	No	5-10c/each; $1,5 - 4/bkt	Local/Zvish	Bus
Peach	No	3c/each	Local	
Lemon	Short	10-15c/each	Local/Zvish	Bus
Indigenous fruits				
Mutobwe	Cook, dry salt	2c/each	Zvish/Gweru	Bus
Mutamba	Short	5c/each	Zvish	Bus
Musuma	Dried, under ash	20c/small cup; exch for grain	Local/Zvish/ Gweru	
Makosvo	No	20c/bunch	Zvish	Bus
Hubvu		50c/cup	Zvish	Bus
Dzviri-mombe	No	10c/cup	Zvish	Bus
Muonde		-	-	-
Munyii	Dried	20c/small cup/plate	Local	
Mushuku	Dried	1c/each		
Mukwakwa	Dry, roast			
Muchakata	Compress, form meal	20c/plate; exchange w. grain flour	Zvish	Bus
Mulberry	No	20c/plate	Zvish	Bus
Muzumi	Dried	5-15c/each	Zvish	Bus
Dhorofia		2c/each	Zvish	Bus

indigenous fruits for dry season nutrition, particularly for children is regularly emphasised in interviews. This is supported by research that show wild fruits to be an important source of carbohydrates, vitamins and minerals. Wehmeyer (1966; quoted by Campbell, 1988) observes that local fruits tend to have a higher Vitamin C content than exotics, while other constituents are comparable. Because of the storage properties of certain indigenous fruits, they can be made available as food at any time of year. However, drying is likely to affect their nutritional and digestion qualities.

The economics of an indigenous fruit tree: a case example

The *Mupfura* tree, (*Scelerocarya birrea*) is one of the most desired indigenous fruit trees. Table 1 of preliminary returns shows quite clearly that this tree is in high demand. The demand is due to its multiplicity of uses (cf preference ranking results). The *mupfura* tree provides, at the peak of its production season, fruits which can provide a kind of wine which can be sold or used for work parties (*humwe*); the bark on the other hand can be used to cure a number of stomach ailments, while the trunk (if the tree is male) is used to make drums, stools and mortars, *Mupfura* trees are also thought to have a positive effect on crops. The fruits are cracked open to produce a nut that is highly desired and has a ready market, both locally and in the urban areas. The cash value of the *mupfura's* by-products is well recognised, but like most of the fruit trees in the project area it faces a number of taboos which will have to relaxed if any commercial value is to be realised.

It is often wrongly assumed that labour is not a constraint in the rural areas. In Mazvihwa a limited study indicated that each rural household had on average two full time adult working residents in the home, in addition to part-time assistance from children. A majority of such households experience labour problems during the peak periods of ploughing, weeding and harvesting. In some households, however, the labour issue is resolved by hiring people to do the work either on a part-time or full-time basis. Where employed full-time, such persons will be paid between $45 to $60 per month (Gumbo and Mukamuri 1988). This

is a common feature in those households where remittances are received. In families where labour is scarce, and with no means of paying for the labour, the best way out is to use work parties (*humwe*). Labour is provided on a goodwill basis, but people need to be given refreshments while they work. These refreshments take a variety of forms from tea for the followers of the Zionist Church (an indigenous Church) through home brewed beer to *mukumbi*, an alcoholic drink made from the *mupfura* tree (Gumbo and Mukamuri 1988).

The making of *mukumbi* is a special art which not every woman in the rural areas knows. Those families that use *mukumbi* in general cannot raise sufficient labour to carry out all the agricultural tasks in their homes. Work parties whose source of refreshment is *mukumbi* usually do meaningful work. If the charges for labour quoted above are taken as a baseline, the earning rate of labour under rural conditions in Mazvihwa, it would mean that labour is charged at the rate of $1.75 a day or 22c per hour for an 8 hour day. *Mukumbi* takes about three days to reach maturity and in that time 1.5 days will have been spent by the woman making it. Using the mean earned per day this will mean that the woman will have put in $2.64 worth of work. (This takes into account the fact that the total fermentation process will take close to 1.5 days during which time little if any work will be expected from the brewer concerned). Once the brew is ready the woman calls for a work party. Between 10 and 16 people will come, but it should be noted that some of these may not drink *mukumbi* and that none of these will arrive early as they have to work in their fields first before joining the work party.

Most people will aim to arrive around 11.00 am and thus just in time for *chifemba* (the first serving of the brew) and by the time of the *chisayino* at approximately 4.30 pm they will have put in close to 4.5 hours of work with an hour's break for lunch. In that time they will have got an extra two servings of *mukumbi*. Thus for 16 people coming to such a *humwe* will in total contribute close to 72 hours of work. A total of 72 person-hours will mean potential earnings of $15.84 or work worth that much if valued at 22c/hour (see above). If the *humwe* is meant to be for weeding the actual amount of work done will depend on the type of the crop and also as to whether it is the first or second weeding. Here is a situation whereby the *Mukumbi* will have played

a positive role in helping a family to carry out meaningful and purposeful work.

Some families, especially immigrants, do also sell *mukumbi*. This is only so because taboos do not mean much to them. These people belong to groups that are not under the strict control of local ruling lineages. On average 8 litres, of *mukumbi* are brewed and sold for a single brew. The *mukumbi* is sold in 100ml cups at 10 cents a cup and will after small losses experienced through *nzwisa* (tasting) the family will gross about $32. Considering that a total of 12 hours (1.5 work days) will have been spent making the *mukumbi* this is equivalent to $2.64 and thus a profit of $29.36 is realised. This is another way in which *mukumbi* is of use to rural households. The potential annual output of a single mature tree is difficult to estimate, but between 3-4 such brews are potentially possible.

An equally important source of income for some households is the by-product of the *mukumbi* making process: *shomwe*. *Shomwe* are nuts found in the *mupfura* fruits. These are cracked manually and the *shomwe* are sold in small 3 gram containers for 20 cents in the local areas. The same container can fetch up to 30 to 40 cents in the urban areas. The production of the *shomwe* is very labour intensive and for better returns, whole nuts must be produced. In order to be able to do this the dry fruits are often boiled. The nuts are usually stored in 800 gram tins and to fill a tin of this size will require a total of 24 working hours. The revenue works out to a gross of $53.33 and if the labour time of 24 working hours is deducted then then such a venture would realise $48.05. The off take estimated here is very small in relation to the full potential annual production of a mature tree. If fully exploited and successfully marketed the returns could be huge.

Throughout the project area, farmers preferentially retain *mupfura* in their fields (see Figure 1). They value it for shade and for the perceived positive benefits that the leaf litter provides for improving soil nutrient content and structure. This reduces the need to apply fertiliser in the area of the tree (Wilson, 1989;CSC, 1988).

The bark of *mupfura* is used for a number of medical purposes. These include the treatment of stomach ailments, eye complaints

and backache which are commonly known. The availabilty of such products reduces the requirements for purchased medication. Specialists know further medical uses and these are usually available at a cost.

Another type of industry also thriving on the *mupfura* tree is that of stools and drum making. Both the drums and the stools are made from the thickest part of the tree and so there is a necessity for the tree to be cut completely. Trees used in this regard are the ones the people classify as male in the sense that they do not produce fruit, and also those felled by wind and lightning. Drums sell for about about $6, while a mortar will cost about $5 and a stool $3. A mature tree will produce about 2 to 3 mortars and the upper ends of the tree trunk will produce a couple of stools. A tree that has been felled by the wind will only realise about $24 depending on where the artefacts produced are marketted. The making of a mortar will take on average about 12 hours with the carving done in between the more profitable labour tasks like weeding. The labour involved in the carving of a single mortar can be valued at $2.64 and the profit made will therefore be $2.36.

Harvesting of the mature tree for the wood is therefore not as profitable as the returns realised from *mukumbi* or *shomwe*. This provides an economic rationale for why people do not cut and are keen to plant the *mupfura* tree. The potential returns discussed above are realised from mature trees. These take 20–30 years to reach full production, although fruits are available from age 4–5. Therefore the planting of a *mupfura* is a long term investment for the home as people expect returns only over a long time horizon. From the data on farmers' planting priorities in the project areas it can be seen that people regard that the long term returns are worth it.

Conclusion

The economic basis for understanding why people in the project area want to plant fruit trees is complex. Many factors are involved and these differ between project areas. It is important to take a local, farmer perspective on economic issues to investigate planting priorities. Our understanding of these

interacting factors is at an early stage and the ENDA project intends to pursue research into the determination of the economic value of fruit trees and potentials for further commercial exploitation (Muzondo, 1989).

Acknowledgements

This research was made possible by grants to ENDA-Zimbabwe from Ford Foundation and NORAD. Community workers and village researchers in the four project areas are: M. Chakavanda, C.Magwizi, N. Muguti, T. Ruzvidzo (CWs), O. Chikamba, J.Madyakuseni, V. Mukamuri, B. Ndhlovu, S. Vhashiko, P. Kege, T.Moyo, J. Magwati, H. Chuma, K. Chitsika, S. Mushure, M. Matshazi, N. Zhakata, R. Mangena, M. Ndhlovu, M. Munhangu, B. Moyo; all of whom have been involved in the research for this paper.

Appendix 1: Trees planted in the project area (1988/9 season)

Total: 47 tree species; 24 fruit tree spp.

Local name	Fruit	Scientific name
Mubvumira		*Kirkia acuminata*
Muchakata	*	*Parinari curatellifolia*
Muchecheni	*	*Zizyphus mucronata*
Mudohonya	*	*Ficus soldanella*
Mudziyavashe		*Combretum apiculatum*
Mufuti		*Castor oil*
Mukamba		*Afzelia quanzenzis*
Mukusi		*Teak*
Mukwakwa	*	*Strychnos madagascarensis*
Munhunguru	*	*Flacourtia indica*
Munyii	*	*Berchemia discolor*
Muonde	*	*Ficus sycamorus*
Mupani		*Colsphospermum mopane*
Mupanda		*Lonchocarpus capassa*
Mupfura	*	*Sclerocarya birrea*
Mupfuti		*Brachystegia boehmii*
Mupwezha		*Combretum collinum*
Murovamhuru		*Combretum hereroense*
Musasa		*Brachystegia spiciformis*
Musekesa		*Piliostigma thonningi*
Mushavi	*	*Ficus spp.*
Mushuku	*	*Uapaca kirkiana*
Musuma	*	*Diospyros mespilliformis*
Musvimwa	*	*Lannea stuhlmanni*
Mususu		*Terminalia sericea*
Mutamba	*	*Strychnos spinosa*
Mutobwe	*	*Azanza garckeana*
Mutondo		*Julbernardia globiflora*
Mutondochuru		*Schotia brachypetala*
Mutsviri		*Combretum imberbe*
Muvora		*Albizzia amarra*
Muvuyu	*	*Adansonia digitata*
Muzumi	*	*Strychnos cocculoides*

[**Appendix 1** – Continued]

Rukato		*Acacia ataxacantha*
–		*Acacia polycantha*
Flamboyant		
Guava	*	
Gum		
Jacaranda		
Lemon	*	
Leucena		
Mango	*	
Mulberry	*	
Naartjis	*	
Orange	*	
Paw paw	*	
Peach	*	

Trees not planted but mentioned in the text:

Dhorofia	*	*Opuntia sp.*
Dzvirimombe	*	*Vangueria sp*
Muhubvu	*	–
Mukosvo	*	*Artabortrys brachypetalus*
Mukute		*Syzygium sp.*
Mutarara		*Gardenia spatufolia*

References

Campbell, B. (1987) The use of wild fruits in Zimbabwe. Economic-Botany, 4, 375-385.

Commonwealth Science Council (1988). Guidelines for trainingin rapid appraisal for agroforestry research and extension.Technical Series No. 256.

Gumbo, D. and Mukamuri, B. (1988). Traditional managementapproaches to dambo cultivation in the Mazvihwa and Ungovacommunal lands, Zvishavane district. WRI, Washington.

McCracken, J, Pretty, J. and Conway, G. (1988). An Introductionto Rapid Rural Appraisal. IIED, London.

Mukamuri, B. (1987). Karanga religion and environmentalprotection. BA thesis, University of Zimbabwe.

Mukamuri, B. (1988). Rural environmental conservation strategies in south-central Zimbabwe: an attempt to describe Karangathought patterns and environmental control. Paper presented toAfrican Studies Association conference, Cambridge. September1988.

Muzondo, M. (1989). Indigenous fruit trees: a preliminaryproposal by ENDA- Zimbabwe. Unpublished mimeo.

Scoones, I. (1988). Community management of indigenous woodlandproject: Zvishavane and Chivi districts. A series of reports(1-9) to ENDA- Zimbabwe. Unpublished report.

Wehmeyer, A. (1966) The nutrient composition of some edible wildfruits found in the Transvaal. Sth Afr Med J, 40, 1102-1104.

Wilson, K. (1987) Trees in Mazvihwa and surrounding areas.Unpublished report to ENDA-Zimbabwe.

Wilson, K (1989) Trees in fields in southern Zimbabwe. J.Southern African Studies (forthcoming).

AGROFORESTRY AND HOUSEHOLD FOOD SECURITY

Julia Falconer
Oxford Forestry Institute
Department of Plant Sciences
University of Oxford
South Parks Road
Oxford, OX1 3RB
UK

CONTENTS

Introduction

"Food security" has the ring of a new buzz word in development circles. The subject of household food security, however, includes a number of issues of central importance for the economics of agroforestry. The problem of household food security is not restricted to issues such as agricultural outputs, crop prices, or international debt, but encompasses all factors affecting a household's access to an adequate year-round supply of food. Thus, it is likely to involve not just the household's production of next season's rice crop, but can also include factors as diverse as deforestation, the availability of income with which to purchase other foods, the seasonal variations in food supply and income, the nutritional quality of the foods available, shifts from subsistence to the cash economy, and even the timing of other cash needs such as school fees.

In many rural areas, forests, fallow and farm trees play an important role in household food security. In many tropical and sub-tropical landscapes, forests and woodlands may protect the land against erosion, flooding and desertification. Throughout the agroforestry literature the protective functions of farm trees are emphasized; trees can protect the soil and crops against damage from wind, rain and the sun. And in many tropical regions tree cover provides the only means of restoring soil fertility, through systems of intercropping or forest fallow. Many rural households depend on forest fallow and farm trees for food, medicines, fuel with which to cook and process foods, for livestock fodder and products which can be sold for cash income. This discussion focuses on the socio-economic aspects of agroforestry's role in household food security. (It synthesizes the findings of a longer study conducted for the FAO, see Falconer and Arnold, 1989).

The Relevance of Food Security for Agroforestry Economics

While few would question the importance of food security issues, some may still wonder about their relevance here in a book on economic methodologies for agroforestry. As household food security is an important goal and concern of many rural people, examining the links between agroforestry and food security

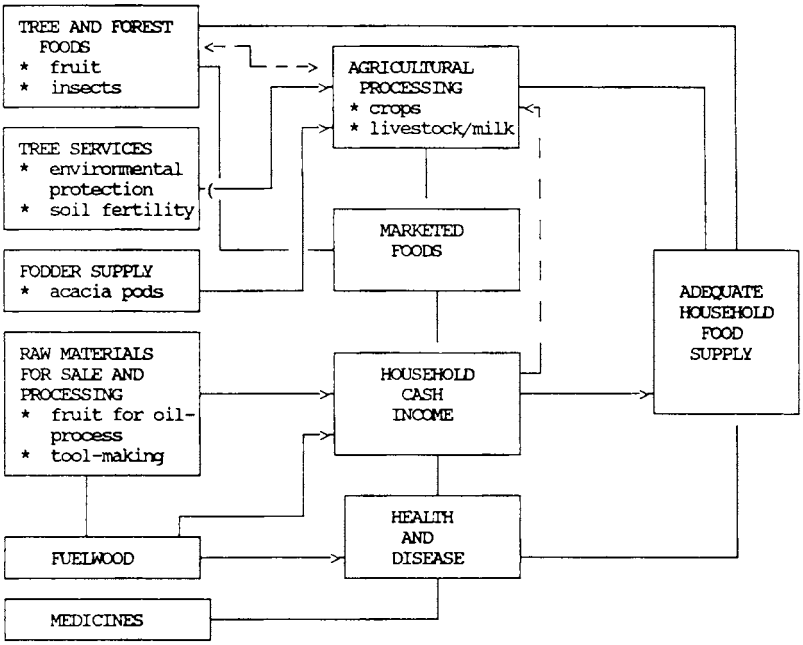


Figure 1 Agroforestry and Food Security

problems will help focus the discussion on issues of central concern to farmers and other rural people and may highlight some of the factors affecting their choice for or against tree-growing.

Assessing agroforestry systems and designs in light of household food security expands the discussion beyond that of benefits and costs of a particular intervention or practice and places it in the dynamic realm of the household economy.

Agroforestry practices are often seen as systems which bring the benefits of forests onto farms. Consideration of the contributions of forests to food security illuminates some important limitations of agroforestry systems in terms of rural development. Most notably, forests have provided resources (land, foods, fodder, medicines, and products for cash income) to those with least access to other resources. Poorer people, especially the landless, have thus been able to exploit the forests for food, fuel and marketable products. While forest gathering activities are not restricted to the poor, they do depend on these activities to a great extent. The poor, and especially poorer women, often dominate forest product gathering and processing activities, both for household products and income. Forests have also provided resource buffers during emergencies. On farm agroforestry systems cannot provide the buffer resources of forests, nor can they address, to any great extent, the needs of the landless poor.

The goal of many agroforestry programmes is to improve the productivity and sustainability of existing farming and agroforestry practices. There is a need to examine these systems in the light of farmers' production goals which may (or may not) be revealed in examining household food security. Focussing on food security should direct the discussion to one aspect of people's well-being - their nutrition.

The Links Between Agroforestry and Household Food Security

The main links between agroforestry and food security are illustrated in Figure 1. Products such as tree foods, fodder and environmental benefits (such as ameliorating soil conditions) all

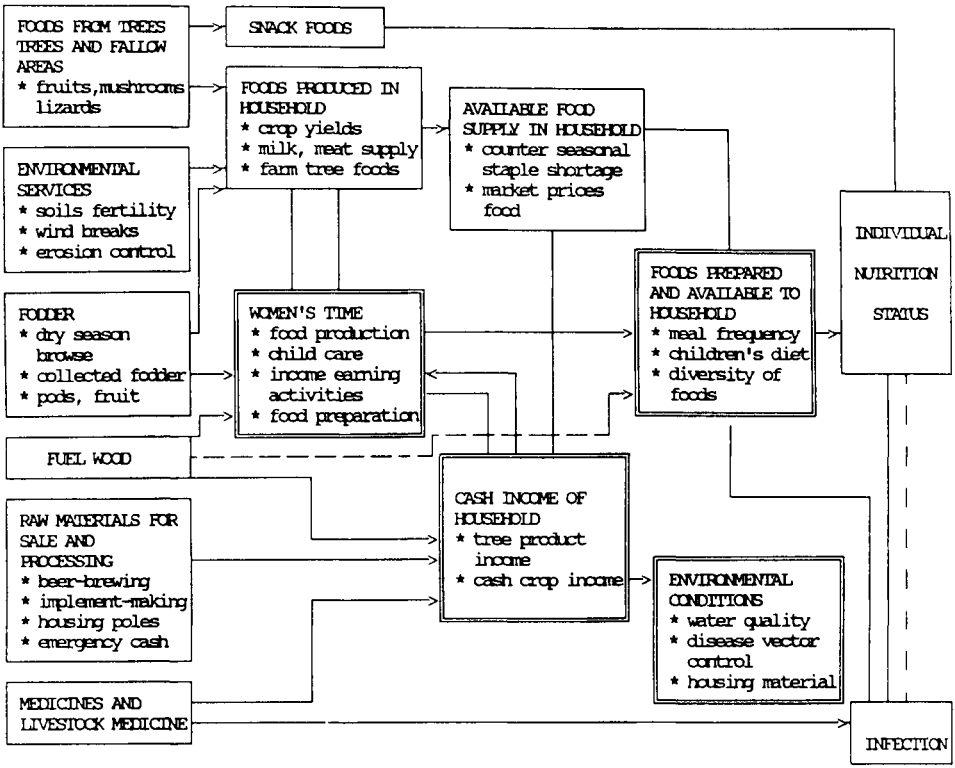


Figure 2 Agroforestry and Household Food Security: Some Key Factors

contribute directly to the quantities of foods available to the household. In addition to these products, fuelwood and raw materials for processing provide cash income for food purchasing. Finally, tree products such as fuelwood and medicines may have an impact on people's health and therefore on their nutritional well-being (while the links between health and nutrition can be quite complicated, a few nutrient-related health problems are described in Table 1).

The boxes on the far left represent tree products and benefits on which agroforestry projects often focus (e.g. fuelwood production and windbreaks). Moving to the right, some major links between tree outputs and a household's food situation are suggested. Most agroforestry programmes and designs focus on measuring the outputs of tree products, rather than examining the impact of these products and services on the household food situation.

The second diagram (Figure 2) adds a few more details- illustrating some key elements of household food security - or more specifically, individual nutritional status. It emphasizes the links between household income, women's work loads and the household availability of food as well as environmental conditions (in highlighted boxes) - all are factors which agroforestry activities can influence.

Cash income earned from tree/forest dependent activities (e.g. palm oil production, fuelwood sales) may be spent directly on food purchases or may be invested in agricultural assets such as livestock, land, farm implements, or seeds; thus it contributes to a household's future food situation, by improving its production potential.

Consideration of the **available household food supply** incorporates factors such as seasonal fluctuations in food supplies and food diversity. It is generally assumed that farm trees provide foods during the seasonal hunger periods and produce during droughts and other emergencies. While this is true of some tree species, it is not necessarily the case with all of them. A clear understanding of the fruiting and leafing periods of species in particular environments is important. Also valuable are species which "hold" their fruit or seed over long periods or whose produce survives on the ground (Becker, 1983).

Table 1 Some common nutrition problems and the potential role of forest food

Nutrient-related problems	Forest food with potential for combatting deficiencies.
Protein-Energy malnutrition: due to inadequate food consumption causing reduced growth, susceptibility to infection, changes in skin hair and mental facility.	Energy rich food which is available during seasonal or emergency food shortages, especially, nuts, seeds, oil-rich fruit and tubers; e.g. the seeds of *Geoffroea decorticans*, *Ricinodendron rautanenii*, and *Parkia* sp.; oil of *Elaeus guineensis*, babassu, palmyra and coconut palms; protein-rich leaves such as baobab (*Adansonia digitata*); as well as wild animals (e.g. snails) incl. insects and larvae.
Vitamin A deficiency: in extreme cases causes blindness and death; responsible for blindness of 250,000 children/yr.	Forest leaves and fruit are often good sources of Vitamin A; e.g. leaves of *Pterocarpus* sp., *Moringa oleifera*, *Adansonia digitata*, the gum of *Sterculia* sp., palm oil of *Elaeus guineensis*, bee larvae and other animal food; in addition fats and oils are needed for the synthesis of Vitamin A.
Iron deficiency: In severe cases causes anaemia, weakness and susceptibility to disease; especially women and children.	Wild animals including insects such as tree ants, mushrooms (often consumed as meat substitutes), as well as forest leaves such as *Leptadenia hastata*, *Adansonia digitata*.
Niacin deficiency: common in areas with a maize staple diet; can cause dementia, diarrhoea, and dermatitis.	Forest fruit and leaves rich in niacin such as *Adansonia digitata*, fruit of *Boscia senegalensis* and *Momordica balsamina*, seeds of *Parkia* sp., *Irvingia gabonensis* and *Acacia albida*.
Riboflavin deficiency: common throughout southeast Asia; among those with rice diets causes skin problems.	Forest leaves are especially high in riboflavin, notably *Anacardium* sp., *Sesbania grandiflora*, and *Cassia obtusifolia*, as well as wild animals, especially insects.
Vitamin C deficiency: common to those consuming monotonous diets; increases susceptibility to disease, weakness.	Forest fruit and leaves often supply the bulk of Vitamin C consumed, especially good sources include fruit of *Ziziphus mauritiana*, *Adansonia digitata* and *Sclerocarya caffra*, leaves such as *Cassia obtusifolia*, and the gum of *Sterculia* sp., are also good sources of this vitamin.

Women's work has been closely linked to household nutrition. In many regions women play an essential part in food crop production. Women are generally responsible for food preparation processing and preservation. In addition, several researchers have found that women's cash income-earning is also directly linked with the household food situation (Cecelski, 1987). For this reason, their labour was chosen as a variable to illustrate the links between physical tree outputs and household resources (in this case, labour) and household nutrition. Thus, rather than measuring the benefits and outputs from an agroforestry system in terms of fuelwood produced, palm fruit available for processing, or additional fodder, an analysis of the impact (of an agroforestry intervention) on lessening women's time pressures might be a more significant measure in terms of the impact on household food security.

The links between agroforestry, nutrition and medicine are extremely important. Many intestinal diseases, for example, cause malnutrition by preventing the absorption of foods by the body. Disease also debilitates and can affect food production by reducing labour efficiency during peak periods of the agricultural year. Forests, bush fallows and farm trees provide the main supply of medicines to the majority of rural people in developing countries. While the effectiveness of many traditional treatments are under considerable dispute, their importance in combatting at least some illnesses is widely recognized.

Environmental conditions are also important factors influencing infection - the quality of water resources and housing conditions are two areas where agroforestry activities can have an impact. Some trees have properties which can directly affect the quality of water supplies. The seeds of the Moringa trees, for example, are used in Sudan and Egypt to clarify turbid water. They contain coagulants which can clear water to near tap quality in a few hours (which is accompanied by a 98% elimination of indicator bacteria) (Jahn, 1986). The fruits of *Balanites aegyptiaca* and *Swartzia madagascariensis* contain saponins which are lethal to both the snails which act as host to bilharzia and to the water flea which harbours guinea worm. Planting these species along irrigation banks might help prevent these diseases (Wickens, 1980).

By focusing on food security issues such as those illustrated above, assessments of agroforestry systems will examine factors which are more closely linked to rural people's well-being, and thus their development potential.

The Contribution of Forest Fallow and Farm Tree Products to Household Food Security

In terms of household food security, fallow and farm tree resources serve to supplement existing food resources and income, fill in seasonal shortfalls of food and income as well as provide seasonally crucial agricultural inputs, and help reduce risk and lessen the impact of droughts and other emergencies. In addition, farm trees and forests can be especially important for the rural poor, as frequently they must rely on off farm employment opportunities and forest (and fallow) resources to help meet their household needs (Table 2 summarizes some important roles of trees).

Supplementary Role of Farm Tree Products:

For the majority of rural people, and especially the rural poor, forest and farm tree foods add variety to diets, improve palatability, and provide essential vitamins, minerals, protein and calories. Although the quantities consumed may not be great in comparison to the main staple foods, they often form an essential part of otherwise bland and nutritionally poor diets. Diet diversity is an extremely important element of nutritional well being, in part because more vitamins and minerals are consumed, and also because it improves the taste of staple foods – thus encouraging greater overall consumption. Some species are noteworthy as particularly rich sources of vitamins, minerals, proteins and fats.

Few studies focus on the nutritional importance of tree and forest foods. While information is available on the nutrient value of different foods, few studies have assessed the frequency and extent to which they are consumed or the nutritional value they impart. The most common supplementary foods are leaves and wild animals, both of which are generally added to sauces and

soups which accompany staple foods. For example, the leaves of *Boscia senegalensis* are consumed year-round by the Peuhls in Senegal, where they are added to sauces which accompany their grain staple (Becker, 1983). This combination is important because, in addition to increasing nutritional value, these wild leafy vegetables add flavour to bland staple foods, thereby encouraging greater food consumption. Little attention has been paid to the importance of improved palatibility provided by wild foods, yet it may have significant nutritional implications.

Trees are often left or planted on farms for the food and fodder they provide. For example, home gardens (intensively managed farm systems combining tree and herbaceous crops) supplement food production from other sectors of the farm. The few studies which have examined their nutritional impact show that home gardens increase the total quantities of foods consumed by households (Soemarwoto 1985, Immink, 1981). In addition, trees may be maintained or planted to provide wild animal habitat. In Thailand, for example, trees are left in paddy fields and on dikes, in part to provide a habitat for commonly consumed wild animals such as lizards, birds and tree ants (Grandstaff, 1985).

Fallow and farm tree products are also valued throughout the year as snack foods. Fruits and nuts are the most common snack foods, especially for children. They are commonly eaten on the job, while working in fields, while herding and gathering fuelwood. There is little information on the consumption of snack foods and their nutritional significance, as most nutrition studies focus on meals or food markets. However, some authors suggest their role is important: a study in Swaziland, for example, estimates that wild fruits are a major source of vitamin C (Ogle and Grivetti, 1985).

Tree foods such as fruits can be used to combat nutrient-related health problems. For example, many tree fruit and leaves are good sources of vitamin A; vitamin A deficiency is a common cause of blindness in many developing countries. Table 1 illustrates some of the ways in which tree foods might be used to combat specific nutritional problems.

Trees and forests also contribute to the food supply indirectly - providing fodder for livestock, thereby helping maintain a supply of milk, blood and meat. In addition, where available, trees and woody shrubs are the main source of energy used for cooking and food processing. Some foods such as beans cannot be consumed without cooking and many others are difficult to digest or unpalatable, or may carry diseases if eaten raw or partially cooked. Fuelwood is also used to process many foods such as fish, seeds, and oil, which are generally smoked, dried or cooked. Processing serves to extend food supply and, in some instances, provides a source of cash income.

While there is little concrete evidence linking fuelwood supply to nutrition, some researchers have noted that its supply may influence the **amount** and **quality** of foods cooked, as well as the quantities and quality of processed foods. Fuelwood shortages could also indirectly affect household food security, forcing women to spend more time collecting fuelwood leaving less time for income-generating activities.

Tree and forest fallow resources also provide supplemental sources of income for many rural households. Many gathering and processing activities are undertaken as part-time activities to provide supplemental income. These activities are especially important for the poor as they may have access to fewer income-earning alternatives.

In many rural communities where poor farmers cannot raise enough to be self-sufficient in food, and are forced to earn cash for food purchases, trees grown as cash crops may provide a low input alternative land use. In addition, products collected from fallow and farm lands such as fruit, fuelwood, or building materials may provide supplemental sources of income. The burgeoning fuelwood trade for example, illustrates farmers' ever-growing need to supplement their farm income as well as the growing demand for fuelwood (e.g. Kamara, 1986).

Seasonal Importance of Forest and Farm Trees

Forest and farm trees are most extensively used to help meet dietary shortfalls and to supplement household income during

particular seasons in the year. Many agricultural communities suffer from seasonal food shortages generally known as "hunger periods". They commonly occur at the time of year when stored food supplies have dwindled and new crops are only just beginning. During this period the consumption of tree foods increases. In many areas the consumption of wild animals and fish is also highly seasonal. Forest fallow and farm tree produce are also valued during the peak agricultural labour period, when less time is available for cooking and people consume more snack foods.

In many arid regions, trees provide an important source of dry season fodder, ranging from nil to 100% of the livestock diet. In the Sahelian region, browse represents an estimated 30-40% of the dry season feed (Le Houerou, 1986).

Home gardens are widely designed to make use of variations in the timing of the harvest of different component tree crops; in this way, they supply foods and saleable produce during the period between harvests of staple crops. Another important feature of such gardens and other systems incorporating trees is that work on the latter can often be undertaken during the slack season, thus helping to even out the peaks and troughs in the demand for farm labour.

For example, in Northern Brazil, babassu palm kernels are gathered and processed during the agricultural slack period. During this period the income earned from these activities represents more than a third of the family's overall budget (May **et al**, 1985). In Sierra Leone, the collection of fuelwood for the market closely mirrors the work requirements for agriculture; during the slack months, fuelwood collection increases (Kamara, 1986). This income is of particular importance as it is available at a time when food supplies are at their lowest.

In other cases tree-based activities may be dictated by seasonally induced cash needs such as loan payments or school fees. As the markets for many locally processed tree products are dependent on rural people's purchasing power, they too are tied to the cyclic nature of agricultural incomes. Several authors have remarked that income earned from tree products is often used to purchase inputs such as seeds, needed for the

Table 2 Farmer Responses based on Tree-Growing Components

Tree subsystem	Changes in Resources	Farmer responses	Contribution of tree subsystem
Home gardens, Java	1. Declining landholding size, minimal or no rice paddy, minimal capital	Increase food and income output from home gardens component of the farming system	Highest returns to land from increasing labour input, flexibility of output in face of changing needs and opportunities
	2. Further fall in landholding size below level able to meet basic food needs	Concentrate on low management tree crops to release labour to off-farm employment	Most productive stable use of land with reduced labour input
Compound farms, Nigeria	Declining landholding size and site productivity, minimal capital	Concentrate resources in compound area, raise income-producing component and off-farm employment	Improves productivity, highest returns to labour, flexibility
Home gardens, Kerala, India	1. Declining landholding size, minimal capital	Bring fallow land into use, intensify home garden management	Multipurpose trees maintain site productivity and contribute to food and income
	2. Capital input substantially increased	Transfer land use to high value cash crops, substitute fertilizer and herbicide for mulch and shade	Trees removed unless they are high value cash crop producers
Farm woodlots, Kenya	Farm size falling below basic needs level, minimal capital, growing labour shortage	Low input low management pole cash crops, off-farm employment	Lower capital input than alternative crops and higher returns to labour
Farm woodlots, Philippines	Abundant land, limited labour	Put land under pulpwood crop	Expands area under cultivation increases returns to family labour

following agricultural season (Engel 1984, May **et al** 1985). In these cases, forest-based income is quite closely linked to the agricultural production cycle.

Forests, Farm Trees and Risk Reduction

Traditionally, in Africa at least, trees have been important in emergency periods, especially in times of droughts, famines, floods and wars (Becker 1983, Campbell 1986, Irvine 1952, Turton 1977). In times of crop failure they may provide emergency foods as well as products which can be gathered for sale. These emergency foods often differ from resources exploited in other periods. In famine periods, roots, tubers, rhizomes and nuts are most sought after. They are characteristically energy rich, but often require lengthy processing. For example, in Zimbabwe the stems of *Encephalartos poggei* are soaked in running water for three days, sun-dried and crushed into a fine powder before being consumed (Malaisse, 1985). In many regions, the increasing commercialisation of rural markets and the advent of food aid have led to a decline in use and knowledge of these emergency foods (Turton, 1977).

Trees are also valued by farmers as insurance. They are planted where drought threatens; or they are planted in order to help diversify farm production, increasing the variety of crops available and guarding against the risk that a crop may fail. Trees may also be viewed as a form of savings which can be drawn upon when needed, or as providing more flexibility in planning expenditures. For poor farmers who have access to few resources, trees may provide one of the few assets they can liquidate in emergency periods (Chambers and Leach 1987).

Dynamics of the Rural Household Economy: the Changing Uses of Forest and Farm Tree Resources

Rural people, especially the poor, employ a diversity of means to help meet basic needs: food crop production, forest and tree product gathering, consumption, processing and sale, cash crop production and income-earning enterprises both on and off the farm. Changes in the physical, social and economic environment

will affect people in different ways, depending on their available resources and opportunities.

The following section focuses on two aspects of change: the diminishing forest resource base and the implications of the growing importance of the cash economy in rural areas.

Impacts of Diminishing Forest Resources

Throughout the developing world, forest resources are rapidly being logged, degraded, cleared for agriculture and cordoned off for private or government use. In many regions, the result is that an ever-expanding rural population must rely on decreasing forest and land resources. In terms of household food security, this trend implies diminishing availability and use of forest food resources as well as diminishing knowledge about their utility, fewer income earning opportunities for the rural poor, and increased burdens on households in their efforts to meet their basic needs. People's responses to these changes depend to a large extent on whether there are any available substitutes; what constitutes an available substitute depends on its associated costs (e.g. labour) and social acceptibility (e.g. taste).

In many areas, forest food consumption is declining - a result of the decline of forest resources, changing tastes, and commercial markets. The impacts on household food security are unclear: in many areas the diversity of the diet has declined as people rely increasingly on purchased foods. Perhaps the worst impact of the loss of forest foods is that poorer people's food options will be further reduced during seasonal and emergency hardship periods.

The trend is not universal, however. In some areas forests still supply foods and fodder. In addition, commercialisation and rapid migration have led to expanded markets for some forest foods. In other instances they are sought after for their traditional social value, while in still other cases they are valued for their medicinal qualities.

As the availability of land and forest resources decline, some communities are facing problems of fuelwood shortages. As was illustrated in Figure 2 above fuelwood supply can influence the time women have for childcare, food production and income earning, the quality of cooked food, and possibly the prices of processed foods. As women are forced to spend longer collecting fuelwood they may have less time to spend on food production or income earning activities.

Incorporation of Trees into Farming Systems

Throughout history, farmers have protected, planted and managed trees on their land in order to maintain supplies of sought after products no longer readily available from forests. Generally, trees are incorporated into these systems for a variety of products and overlapping motivations. Thus, while trees may be planted for marketable fruits or poles, these products and many others are also valued for consumption and use by the household. For example, in Zimbabwe, farmers in severely deforested regions selectively maintain their favourite fruit species on farms. As a result, Campbell (1986) found that in this study region, the frequency of consumption and availability of the most popular forest fruit species was not affected by the conditions of the forest resource.

The intensification of management of farm and fallow lands for a combination of tree and annual plant products can be seen as a response to the changing availability of resources (including forest and land, labour and capital) and opportunities for the farmer. Analysis of tree-growing practices of farmers facing a range of resource situations reveals some important factors which encourage (and discourage) farmers to adopt agroforestry techniques as a major component of their farming practices. These are summarized in Table 2.

It has often been argued that cultivation of trees is something that is possible only for wealthy farmers. This assumption is based on the premise that the main objective of poor farmers is the production of staple foods. Hence the assumption that as farm sizes decline farmers will be forced to abandon tree crops for staple food production. However, the evidence suggests that in

many cases poor farmers' resources are too limited for them to meet their basic food needs, so that income generation becomes increasingly important.

Contributions of Tree Products to Household Food Security - Summary

Supplementary role:

* farm tree and forest fallow foods add diversity to the diet increasing palatability and in some cases increasing overall food consumption;

* they also contribute essential minerals and nutrients to diets;

* these foods are often consumed as snacks contributing added energy and nutrients;

* supplement fodder supplies thereby helping to maintain year round milk, meat and blood supplies;

* farm and fallow trees are important sources of fuel used for most cooking and processing;

* income earned from the sales of tree products (or processing) may supplement the household budget - especially important for poorer households who must supplement food production with cash income earning in order to meet their food needs;

Seasonal importance:

* forest and farm trees provide food during the "hungry season" common in many seasonal agricultural systems;

* farm trees may provide snack foods during the planting season when there is little time for cooking;

* trees and fallow areas provide sources of dry season fodder;

* integration of trees on farms helps insure a year round supply of food;

* farm and fallow tree products provide seasonal cash income; in some cases this income may be invested in the following agricultural season, for fertilizer, implements, seed, or livestock.

Risk reduction:

* farm trees provide insurance: assets which can be liquidated during hard times, diversifying crop production, as well as spreading harvests across seasons.

* foods from farm trees, fallow and forest areas provide a buffer food source for emergencies: these foods are different from those garnered in other periods-- they are characteristically energy rich but may require lengthy processing, taste unpleasant or be difficult to collect;

* gathering and processing forest and tree products may provide a source of cash during emergency periods.

Increasing Dependence on the Cash Economy

As the physical resources (both agricultural and forest lands) available decrease, farmers are forced to rely increasingly on the cash economy. In many cases, diminishing size and productivity of farm holdings force farmers to rely on off-farm cash earning opportunities. The resulting decline in labour available for farming forces them to plant low input cash crops on their farms.

In some cases farmers increase the value of production from farm land by processing higher value products such as coconut sugar, and making more products from the same area such as fuelwood and charcoal, both by-products of land clearing. In a farming study in rural Sierra Leone, many farmers noted that non-

agricultural activities such as fuelwood collection, hunting, fishing, oil processing, craft production and palm wine tapping are of major importance for them, both in terms of their time and the benefits for their households (Engel, 1984).

As farm productivity decreases to a point where farmers must turn to earning cash income, trees may be grown as cash crops in order to take advantage of growing markets for forest products. For example, in Haiti, where trees are being planted by farmers for the pole and charcoal markets, they are often chosen over other cash crops as they tend to entail low establishment costs and require less labour, minimal costs throughout the year, less water after establishment and thus lower susceptibility to drought (Conway, 1987). For poor farmers, the possibility of accumulating capital through tree growing may also be important.

In situations where land rather than labour is the limiting factor, joint tree/crop/livestock systems may give better returns than monocrops. Trees are also planted by the poor to help maintain the productivity of their land when the cost of alternatives such as fertilizer, herbicide, and irrigation are beyond their means (Lagemann 1977, Soemarwoto and Soemarwoto 1984, World Bank 1986).

The Impact of Cash-cropping on Household Food Security

While it is generally assumed that increases in cash income will improve the well-being of rural households, some studies suggest just the opposite-- that increases in cash income can have a negative impact on household nutrition. In some cases, overall household nutrition conditions decline with increasing reliance on cash crops (Longhurst 1987, Hassan 1985). The quality and diversity of purchased foods may not compare to those traditionally gathered and cultivated (Hassan, 1985). In other instances, reliance on the cash economy introduces different risks - in terms of market availability of foods as well as changes in purchasing power.

Production for cash crops may lead to increasing food prices as land is transferred from food production. Reliance on cash crops makes households dependent on the vagaries of market prices for

these products: a drop in cash crop prices will mean a household has less cash with which to purchase foods. Farmers are especially vulnerable if they are dependent on a narrow range of cash crops and market outlets. Cash crop income is likely to be "lumpy" with periods of little income. Finally, a shift to cash crops may reduce employment opportunities as frequently they require less labour than food crop production.

In situations where the shift from food to cash crop production entails a shift in control of household income from women to men, household nutrition may be affected as women are most closely involved with provision of the household's food. There are some studies which indicate that women are most concerned with subsistence needs, while others suggest that they are equally involved and interested in cash earning. Obviously these factors vary greatly, depending on the culture, economy, available opportunities for women, and the household situation. Nonetheless, some nutrition studies indicate that where women have control of household income, overall family nutrition may improve.

Potentially, therefore, tree crops could have a negative impact on household food security. Tree growing can transfer land from food crop production with a loss of employment; tree promotion services are concentrated on male farmers; often there is only one marketable product; and trees take years to mature.

However, in many cases the potentially negative aspects of cash crop production may be offset by other features of tree growing. As was discussed earlier, the transfer of land from food to tree crops is often a response to changing conditions, such as increasingly scarce land and labour, which make food crop cultivation impracticable. Thus the shifting emphasis from food to cash crops may be unavoidable.

The impact of tree-growing on household food security depends on the species grown and the ways they are managed. Most trees provide other products in addition to those for cash sale. Virtually all species will produce some fuelwood. Fruit, fodder, shade, mulch, soil amelioration are all positive features of tree production which can contribute to food supplies as well as household income especially during seasonal shortfalls. These

features, however, apply only to multipurpose agroforestry systems.

The more narrowly focused single- species (or product) tree crops, such as eucalyptus, rely on their efficiency in using available household land labour and capital resources to generate income. Such tree monocrops provide "lumpy" income flows. They are feasible options only if the household has alternative sources of food or income. This does not, however limit their effectiveness to large farmers. Poor farmers dependent on off-farm income often rely on tree crops to keep their land in productive use with minimum labour.

The lumpiness of income flows from tree crops needs to be balanced against the magnitude of that income and the flexibility it provides. Tree crops can be harvested when the farmer most needs them, i.e. for emergencies and to meet lump sum cash needs. For these reasons, they may be most appropriate for poor households.

Agroforestry Development: Building from the Food Security Needs of Rural Households

Agroforestry's contribution to household food security must be viewed in perspective. Farm trees (and forest fallow) are components of complex rural environments. Forestry efforts alone cannot substantially alter fundamental social, economic and political factors at the root of many food supply inequalities. Nor would it be correct to conclude that the answer to declining availability of foods, income or employment from forest based sources necessarily lies in forest and tree based interventions. Alternatives to forest and tree foods, fuels and products exist or could be made available in nearly every situation.

However, forest and tree resources have played an important role in household food security, especially during seasonal and emergency hardship periods. Incorporating household food security concerns into agroforestry analyses and programme development requires an understanding of the dynamics of the rural household economy, an understanding of people's food security goals, as well as the particular nutritional problems they face. Focusing

on household food security problems will require a dynamic approach; one which accounts for the changing uses and roles of tree products within the household economy, as well as the variations in their importance from community to communities as well as between households and household members within communities.

References

Becker, R. 1983. The contribution of wild plants to human nutrition in the Ferlo, Northern Senegal. Agroforestry Systems 1:257-267.

Campbell, B.M. 1986. The importance of wild fruits for peasant household in Zimbabwe. Food and Nutrition 12(1):38-44.

Campbell-Platt, G. 1980. African locust bean (Parkia sp.) and its fermented food product Dawadawa. Ecology of Food and Nutrition 9(2):123-132.

Cecelski, E. 1987. Energy and rural women's work: crisis response and policy alternatives. International Labour Review 126(1): 41- 64.

Chambers, R. and Leach, M. 1987. Trees to Meet Contingencies: Savings and Security for the Rural Poor. Discussion Paper 228, IDS, University of Sussex.

Conway, F.J. 1987. Case Study: The Agroforestry Outreach Project in Haiti. Paper presented at the IIED Conference on Sustainable Development, London.

Engel, A. et al. 1984. Promoting Smallholder Cropping Systems in Sierra Leone. An Assessment of Traditional Cropping Systems and Recommendations for the Bo-Pujehun Rural Development Project. Studien No. IV/86, Technische Universitaet, Berlin.

Falconer, J and Arnold J.E.M. 1989. Household Food Security and Forestry: An Analysis of Socio-economic Issues. FAO, Rome.

Grandstaff, S. et al. 1985. Trees in paddy fields in Northeast Thailand. Series in Ford Foundation Project Socio-economic Studies of the Farmers in Rainfed Areas of N.E. Thailand. Khon Kaen University.

Hassan, N. et al. 1985. Seasonal patterns of food intake in rural Bangladesh: Its impact on nutritional status. Ecology of Food and Nutrition 17(2):175-186.

Havnevick, K. 1980. Analysis of rural production and incomes, Rufiji District, Tanzania. Institute of Resource Assessment, University of Dar es Salaam, IRA Research Paper No. 3, published jointly with CHR Michelsen Institute, Bergen (Norway), DERAP No. 152, 137.

Le Houerou, H.N. (ed.) 1986. Browse in Africa: The current state of knowledge. IBPGR and Royal Botanic Gardens, Kew, London.

Immink, M.D.C. et al. 1981. Homegardens and the energy and nutrient iontakes of women and preschoolers in rural Puerto Rico. Ecology of Food and Nutrition 11:191-199.

Irvine, F. 1952. Supplementary and emergency food plants of West Africa. Economic Botany 6(1):23-40.

Jahn, S.et al. 1986. The tree that purifies water: Cultivating multipurpose Moringaceae in the Sudan. Unasylva 38(152): 23-29.

Jambulingam, R. and Fernandes, E. 1986. Multipurpose trees and shrubs on farmlands in Tamil Nadu State, India. Agroforestry Systems 4:17-32.

Johnson, D.V. and Nair, P.K.R. Perennial crop-based agroforestry systems in Northeast Brazil. Agroforestry Systems 2:281-292.

Kamara, J. N. 1986. Firewood energy in Sierra Leone: Production, marketing and household use patterns. Verlag Weltarchiv Studies No. 9 Hamburg.

Laburthe-Tolra, P. 1981. Les seigneurs de la foret: Essai sur le passe historique, l'organisation sociale et les hommes ethiques des anciens Betis du Cameroun. Publication de la Sorbonne, Paris.

Lagemann, J. 1977. Traditional Farming Systems in Eastern Nigeria: An Analysis of Reaction to Increasing Population Pressure. Africa Studien, Weltforum Verlag, Munich.

Longhurst, R. 1987. Cash crops, household food security and nutrition. Cash Crops Workshop, Institute of Development Studies, University of Sussex.

Malaisse, F. and Parent, G. 1985. Edible wild vegetable products in the Zambezian woodland area: a nutritional and ecological approach. Ecology of Food and Nutrition 18:43-82.

May, P.H. et al. 1985. Babassu palm in the agroforestry systems in Brazil's mid-north region. Agroforestry Systems 3(39):275-295.

Ogle, B.M. and Grivetti, L.E. 1985. Legacy of the chameleon: Edible wild plants in the Kingdom of Swaziland, Southern Africa: A cultural, ecological, nutritional study. Ecology of Food and Nutrition. In four parts: 16(3):193-208, Parts II-IV:17(11):1-64.

Parent, G. 1977. Food value of edible mushrooms from Upper Shaba. Economic Botany 31:436-445.

Soemarwoto, O. and Soemarwoto, I. 1984. The Javanese rural ecosystem. In: Rambo, A.T. and Sajise, P.E. (eds): An Introduction to Human Ecology Research on Agricultural Systems in Southeast Asia. University of the Philippines, Laguna.

Soemarwoto, O. 1985. The Javanese homegarden: an integrated agro-ecosystem. Food and Nutrition Bulletin 7(3):44-47.

Surin, V. and Badhuri, T. 1980. Forest produce and forest dwellers. In: Proceedings of a Seminar on the Role of Women in Community Forestry, December. Dehra Dun, India.

Turton, D. 1977. Response to drought: The Mursi of south-western Ethiopia. Disasters 1:257-287.

Wickens, G. 1986. Alternative uses of browse. In Browse in Africa: Current State of Knowledge, (ed) Le Houerou. Pp 155-185.

World Bank 1986. Economics Issues and Farm Forestry. Working Paper prepared for the Kenya Forestry Sector Study, Washington (mimeo).