Livelihood capital, strategies and outcomes in the Taita hills of Kenya

Eija Soini

World Agroforestry Centre
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Abstract

To study the changing farming system and livelihoods in the Taita hills in Kenya, an interview survey was conducted on a transect stretching from the northern side of the hills across the highlands and reaching to the southern slopes and foothills. A sustainable livelihoods framework was used to organize the survey. Information was collected on the different livelihood assets. Temporal change was emphasized. Perceived problems with crops, livestock, trees, off-farm activities, and other spheres of life were documented. Priorities and values related to livelihood assets and strategies were studied. Associations between livelihood assets/capital and livelihood outcomes were studied by using multivariate regression analysis. The three biggest livelihood changes of the interviewed farmers over the last generation are soils depletion, off-farm activity as part of livelihood strategies, and decrease in trees in the landscape. Even though 37% of the interviewed households supplement their farm income by off-farm income, inadequate capital for fertility maintenance and other farm inputs is mentioned as the biggest problem. Other problems mentioned include pests (especially 'Scania' Larger Grain Borer, *Protephanus trancutus*), drought, unavailability of tree seedlings, animal diseases, and insufficient numbers of customers to maintain a business. More than 80% of the farmers interviewed perceive the unavailability of tree seedlings as the most serious problem with tree planting. A big stone house, a dairy cow, establishment of a kiosk or a shop, poultry, electricity, more animals, irrigation, more land, terraces and horticulture are amongst the most important livelihood improvements desired by the farmers interviewed. An outcome index based on acquisition of desired outcome was related to capital assets by regression. The linear multivariate regression analysis shows that only Financial capital has significant positive relation with the outcome. However, the variance accounted for is very little, 11%. Analysis of individual outcomes separately showed some associations. Farmers who have introduced animals are more richly endowed with Financial capital. However, they are less frequently in groups. Further, farmers with off-farm jobs are less likely to introduce new crops, and farmers with plots in two ecological zones (most often highland farmers) score higher with number of children in secondary schools. The general lack of clear associations between the livelihood capital and the livelihood outcomes can be explained simply that there are too many individual livelihood strategies to detect a pattern. One should, however, not completely disregard the indication given by the analysis that Financial capital may be the most crucial of the different types of capital. The shift from agriculture to non-agriculture earning is happening and is going to be more significant in the future. However, the options for off-farm income are seriously limited. Increased efforts are needed in the Taita hills to look for an integrated way to create more income generating agricultural options together with providing the rural human potential with marketable skills and variety of alternative non-agricultural livelihood options.

Keywords

Highlands, East Africa, small-scale farming

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Introduction

The Taita hills, part of the Eastern Arc mountains, is one of the highland areas in East Africa which has gone through significant change in land use over the past decades due to growing population pressure. Government land consolidation policies implemented over several decades have changed the farming system and the livelihood strategies by partly disrupting the Taita farming system traditionally making use of the differing ecological zones on the hills and the adjacent alluvial plains (Nazzaro, 1974; Fleuret, 1988). The Taita hills is also one of the areas once thriving from a profitable cash crop, coffee, which since the 1960s has gradually lost its value.

To study the changing farming system and livelihoods of the Taita an interview survey was conducted on a transect stretching from the northern side across the highlands and reaching to the southern slopes and foothills. The DFID sustainable livelihoods framework (Carney, 1998; DFID, 2001) was used, the aim being to conduct a people centred survey simultaneously investigating people's assets, objectives and livelihood strategies. Carswell (1997) defined livelihood as "comprising the capabilities, assets, both material and social resources, and activities required for means of living. A livelihood is sustainable if it can cope with, and recover from, stresses and shocks, maintain or enhance its capabilities and assets and provide net benefits to other livelihoods locally and more widely, both now and in the future, without undermining the natural resource base".

What are the biggest changes in the farming system since one generation ago? What do the farmers perceive as the most serious current problems in the farming system and in their off-farm activities, and what strategies are they employing to cope with these? In order to improve their current standard of living, what would be the desired livelihood strategies and outcomes as seen by the farmers themselves? By looking at the extent to which these desired outcomes have already been achieved, the analysis aimed at answering the most central question of the study: What livelihood capital/assets are needed in achieving the desired livelihood outcomes?

Study site

Taita hills ($3^{\circ} 24' S$, $38^{\circ} 20'$), an island of fertile mountain area surrounded by the dry bushlands, Nyika –meaning wilderness- of Tsavo East and West National parks, is situated about 150 km from the coast of Kenya immediately south of the main road from the port town of Mombasa to the capital, Nairobi. The hills make up the administrative divisions of Wundanyi and Mwatate in Taita-Taveta District. The study area (Fig 1) for this livelihood survey was a 28 km long and 6.5 km wide transect across the hills. It reached from Mwatate, a trading centre on the plains (800m) on the southern side of the hills across one of the highest peak of the hills, Yale (2104m), to the northern plains (900m) at Kishushe. The biggest urban centre on the hills, Wundanyi, the Taita-Taveta district headquarters was included in the transect. Wundanyi urban area has a population of about 4000 persons (Kenya, 1997).

Five agroecological zones can be distinguished in the study transect, 1. (Midland) Livestock-Millet zone (790-980m), 2. Marginal cotton zone (910-1220m), 3. Sunflower-Maize zone (1220-1520m), 4. Marginal coffee zone (1370-1680m), and Wheat/Maize-Pyrethrum zone (>1680m) (Figure 1). Annual rainfall is received during two rainy seasons (March-May, September-October) and varies between 480-700mm, 600-800mm, 700-900mm and 900-1200mm, and above 1200mm across the five zones respectively (Jaetzold & Schmidt, 1983; Kenya, 1989). Much less rain (250mm) is received on the surrounding plains.

The highland areas (Wheat/Maize-Pyrethrum zone and Marginal coffee zone) are considered as high potential agricultural areas. The actual Wheat/Maize-Pyrethrum zone suitable for agriculture is, however, very small due to steep slopes and shallow soils. Most of the gazetted forests are in this zone. According to the latest development plan (Kenya, 1997) maize, coffee, beans, banana and citrus (Mkangi, 1978), vegetables and zero-grazing of livestock form the major enterprises in the Marginal coffee zone. However, coffee growing was next to nonexistent in the study transect, e.g. only one farmer growing coffee was captured in the sample. Most of the suitable land in this zone is under cultivation. Sunflower-Maize zone and Marginal cotton zone are classified as medium potential area, though here too the landscape is dominated by steep slopes. This leaves little space for maize, sunflower and cotton (Jaetzold & Schmidt, 1983). Maize, beans, sorghum, cowpeas, pigeon peas and green grams are the most typical crops cultivated in this zone. Sugar cane and bananas can be grown in the moister valleys. Livestock-Millet zone (together with the Ranching zone further on the plains) belongs to the low potential agricultural areas. It is normally too dry for maize, but there is some scope for very early maturing sorghum and millet. Even sisal growing is considered marginal with the average rainfall quickly dropping below 500 mm a few kilometres away from the mountains (Jaetzold & Schmidt, 1983; Kenya, 1989). Cattle keeping and charcoal burning have played an important role in this zone. In the 1970s charcoal was exported as far

as UAE and other Arab countries (Mkangi, 1978). Charcoal is still burned within the ranches. In addition to growing crops and keeping livestock, off-farm wage labour supplements farm income in all zones.

Figure 1. Study transect (in white) in the Taita hills, Kenya. Agro-ecological zones drawn according to their altitudinal limits (Jaetzold & Schmidt, 1983; Kenya, 1989; Kenya, 1991).

According to a recent study about 64 % of the population in Wundanyi division and 58 % in Mwatate division live under Poverty line (CBS, 2004). Table 1 quotes the figures. Later the same year, 2004, when the data for this survey was collected, the Government of Kenya issued an alert warning that about 600 000 people at the Coast were faced with a serious food shortage. Taita-Taveta district was singled out as the most affected (FAO/GIEWS).

The upward trend of population growth started in the Taita hills in the mid 1920's. By the end of 1960's population had almost tripled from the 40000 in the early 1930's to about 111 000 in 1969 (Kenya Land Commission 1930, Census 1969; figures cited by Mkangi, 1978). The district is now estimated to have slightly over 300 000 inhabitants out of which about 42 000 are estimated to reside in urban areas (Kenya, 1997). The biggest bulk of those living in urban areas are those living in Voi town on the plains. Population pressure in the highlands has resulted into expansion of agriculture to the more agriculturally marginal lowlands. Lowland population is increasing faster than highland population and it is likely that this trend

continues as more and more people move to the lowlands in search of land as large parts of the lowlands are not yet demarcated.

Table 1. Population and poverty by location in Wundanyi and Mwatate in the Taita hills

Division/Location	Percent of Individuals below Poverty Line ¹	Number of Individuals, Census 1999²
Wundanyi Division	64	48194
Mgange	51	9287
Kishushe	59	3339
Mwanda	62	3739
Wundanyi	62	9784
Werugha	65	8008
Mbale	68	5178
Wumingu	78	8859
Mwatate Division	58	51246
Kishamba	46	6850
Mwatate	54	8537
Mwachabo	54	10026
Bura	60	9354
Chawia	61	5570
Mwakitau	61	7197
Kidaya (Ngerenyi)	69	3712

¹ CBS, 2004; ² GoK, 2001

Methods

Fifty-one households were interviewed in January and February 2004, 21 in the highlands, 15 in the northern slopes and lowlands and 15 in the southern slopes and lowlands. Grid sampling was used to select the households. Points one kilometre apart were drawn on the whole study transect. Point coordinates were saved on a handheld GPS receiver. The receiver was used to measure distance from the point when approaching a point. When the receiver showed 0.5 km from the point the second household on the left was selected for the interview. This rule was kept until about two thirds of the households were interviewed. After that, the aim was to adjust the selection in order to have an equal number of old heads of household (above 50), middle-aged heads of households (36-50) and young heads of households (up to 35 years) from each three zones. This was to be done by selecting the closest household to the one selected representing the desired age group. However, it proved very difficult to find enough young families close to the sampling points in the highlands and the southern side of the mountain.

An interview questionnaire organized according to the DFID sustainable livelihood framework was used (Figure 2). According to the frame *assets or capital* endowments (human, social, natural, financial and physical capital) are the basic livelihood building

blocks, the capacity that people use in striving for their objectives or the *livelihood outcomes*. Government and private sector structures, laws, policies, institutions and the culture influence the *livelihood strategies* people adopt to achieve livelihood outcomes. Strategies may never be articulated, but they nevertheless influence people's choices of which activities to combine, which outcomes to pursue, and which assets to invest in. The aim of using this framework was to try to identify crucial assets or combinations of assets (human, social, natural, physical and financial capital) that enable the farmers to have strategies in order to gain better livelihood outcomes.

Figure 2. Sustainable livelihoods framework simplified by Ashley and Carney 1998.

Information was collected on the different livelihood assets: human (family structure, education, occupation, links to outside the farm sources of income), social (collective action, access to knowledge), natural (land, livestock, trees and crops grown, access to common resources), financial capital (markets, off-farm jobs), and physical capital (access to markets, technologies). Temporal change was emphasized. For this, information on the reason and time of introduction and abandoning activities, crops, trees, livestock and technologies was collected. Perceived problems with crops, livestock, trees, off-farm activities, and other spheres of life were documented. To measure priorities and values, farmers were asked; 1) which on-farm or off-farm activity they would prefer to improve their livelihoods given that they had all the money and the ability to realize their dream; or 2) what they would purchase for the farm or their household to improve their life.

To study interrelationships of livelihood capital and livelihood outcomes several variations of multivariate regression analysis were tested. The analysis aimed at identifying key livelihood capital or combinations of capital that play an important role in livelihood outcomes. An indicator representing livelihood outcomes was the mean of six components that were selected on the basis of desired outcomes perceived by the interviewed farmers. All the components were calibrated to be either 0 or 1, or between 0 and 1, and consequently the indicator ranged between 0 and 1. The components measured *Housing* (stone 1 or mud house 0), *Children's schooling* (1 at ≥ 5 children in secondary school), whether the farmer has *Bought land* (1 yes, 0 no), *Introduced animals* (1 yes, 0 no) or *crops* (1 yes, 0 no), or *Established a business* of his/her own (1 yes, 0 no). The indicator representing livelihood outcomes was used as the dependent variable in the analysis.

Independent variables represented four (out of five) livelihood capital - human, social, natural and financial. Indices (0 or 1, 0-1) for each capital were constructed by measurable components representing the four types of capital (Table 2). As the sample showed very skewed distributions of many of these variables, indices, I , were calculated on the 0-1 scale as

$$I = x/k \text{ for } x < k$$

$$= 1 \text{ for } x > k$$

Here x is the measured amount and k an upper limit considered.

In addition to using indices, associations between the different components of both the livelihood outcome and the four capitals were studied. Also, other possible correlations were looked at separately e.g. can fertilizer use be affected by farmer's education level, by off-farm income or by farm size, or further, is farmer's education level correlated with having an off-farm job.

Extensive literature review covering mainly from the late 1960's to 1980's was done to put the study into historical perspective.

Table 2. Independent variable used in the multivariate analysis. Each component scored either 0 or 1 or was an index defined between 0 and 1

Natural capital		Human capital		Social capital		Financial capital	
Component	Scores	Component	Scores	Component	Scores	Component	Scores
Total acreage	1 at ≥ 5 ha	Labour force: (Number of dependants ≥ 10 y old living at home)	1 at 7	Outside contribution	1 = yes 0 = no	Mother's off-farm job	1 = yes 0 = no
Inherited acreage	1 at ≥ 5 ha	Young farmers	0 at 15 1 at > 40	Mother's in a group	1 = yes 0 = no	Father's off-farm job	1 = yes 0 = no
Improved cow	1 at > 1 cow 0.75 at one cow	Old farmers	1 at < 40 0 at 70	Father's in a group	1 = yes 0 = no	Children's off-farm jobs	1 at 3 jobs
Number of hens	1 at 40 hens	Fathers and mothers school years	1 at 22				
Number of animals	1 at 10 animals						
Plots in two ecological zones	1 = yes 0 = no						
Cash crops (Number of crops grown mainly for sale)	0.5 at one 0.75 at two 1 at $> two$ cash crops						
Number of crops grown	1 at 10 crops						

Major early changes in the farming system

Perhaps the first immigrants to the Taita hills, which forced the aboriginal people (Prince, 1952) to give up their land, arrived between 1300 and 1400 AD (Bostock, 1950). Several dialects and cultural aspects refer to the multiple origins of the inhabitants. Several waves of immigrants from several regions around the hills moved to the hills. In addition intermarriages between the immigrants and the aboriginals, and Maasai who took up cultivation, form the origins of the present inhabitants.

Regular market places developed on the plains to accommodate early trade with Arabs, Kamba, Kikuyu, Pare and Shambala, none of the markets being on the hills. As time passed many of these market places transformed into more permanent trading centres of the area (e.g. Voi, Bura, Ndara, Kasigau, Mackinnon Road Centre) (Nazzaro, 1974; pers.comm. E.W. Mbinga, 2005).

By the first missions in the late 19th century both Christianity and European technology started to diffuse to the hills. Soon after, the expansion of European commercial activity

began in East Africa. Proximity to the railway attracted early estates to the Taita hills and the adjacent plains. Establishment of sisal estates and the Tsavo National Park badly disrupted the cultivation of the lowlands and movements of cattle. The estates offered wage labour to the Taita as well as attracting population from other parts of Kenya. Prior to the 1930s substantial tracts of land, both in the hills and on the plains, totalling over 600 sq km were alienated by settlers, missions and commercial concerns (Fleuret, 1988). Disputes over land and cultivation rights occurred, but land shortage was mediated by emigration and by renting land in other areas. For example the missionary pressure on the upper valley of Bura encouraged movement to and utilization of the lower valley (sugar cane) to a larger extent than previously (Nazzaro, 1974). In addition to land areas of the two main missions, Nazzaro (1974) reports in the late 1960s quite a number of other churches and church land properties, which had however been acquired through local community involvement, action and decision.

One of the greatest impacts of the missions in the long term was their experimentation with plant varieties such as coffee, vanilla and coconuts. Coffee came to Bura in 1892. However, succumbing to the complaints by European settlers on fears that diseases can spread to European coffee farms from African grown coffee, the Kenya government prohibited the growing of *arabica* coffee by Africans (Great Britain, 1925; Kenya, 1933). It took as much as half a century, till 1945, when an agriculture officer visiting the area recommended that all the coffee in Wundanyi be uprooted and destroyed and licenses be granted to Natives one year after. As a result areas above contour 4500 ft were gazetted as a Native coffee area (Kenya, 1945). However, coffee growing by African farmers started very slowly due to fears that it would lead to more land being alienated by the Europeans. Soon after, Land consolidation disrupted coffee growing seriously. Disagreements on ownership of coffee bushes on plots which changed ownership even lead to trees being destroyed out of fear of losing land under coffee.

Traditionally farms were held and used by individuals, but the user rights, especially transfer of land, was controlled by clans. At the death of the person holding a user right to his farm, this user right must pass to a male or males of the same lineage, preferably his legal sons. Others had the right of use to the unused parts of someone's land. Clans traditionally formed neighbourhoods in which the majority of the farmers belonged to the same clan (Harris & Harris, 1964). A clan land was a cluster of ridges, with the settlements on top of the ridges. Locations, today's administrative unit, correspond to these old clusters (Mkangi, 1978). The tradition of securing land to everyone by inheritance and user rights has not worked for a long time due to population pressure. Already in the mid 1970's 30% of the population were landless or residing on sub-economic units (Kenya, 1976).

The Swynnerton Plan published in 1954 (Swynnerton, 1954) espoused both tenurial and agrarian reforms. Systems of customary land tenure were to be reformed from a presumed communal to an individual freehold basis. According to the Native Land Tenure Rules of 1956 the reform was to proceed in three stages from *adjudication* to *consolidation* i.e. aggregation of dispersed or highly fragmented parcels into one holding, and *registration* of the parcel to an individual and issuance to him of a title deed. The agrarian reform component of the Swynnerton Plan included such elements as promotion of valuable cash crop cultivation and exotic livestock, provision of credit, marketing, extension and educational services, and introduction of land conservation measures (surprisingly similar activities as today's rural development projects promote!). Land consolidation in which each landowner received a single plot equivalent in size to the sum of his pre-existing multiple plots deprived farmers of the security of farm production offered by multiple temporally varying ecological conditions, and provided different families with very unequal opportunities for farming based on the natural resources of the location where the consolidated single plot happened to become registered. The traditional fragmentation of holdings represented an attempt to equalize the comparative advantages and disadvantages among individual farmers by recognizing the widely varying levels of soil fertility, drainage characteristics and labour input requirements from one plot to another (Nazzaro, 1974).

Both land alienation with the ensuing cultural influences by the first settlers (both religious and secular) and the land consolidation happening slowly in the hills, starting in the 1950's and going on for decades, have caused spatial differentiation in the technological and social development of the hills (Nazzaro, 1974). Land consolidation had also the effect of changing the traditional settlement patterns. Traditionally houses were clustered in groups of 15-20 houses on land with massive rock outcrops or on a ridge with shallow soils. After land consolidation families built their houses on the consolidated plots, the old 'villages' disappeared and houses were scattered further apart in the entire cultivable landscape (Nazzaro, 1974).

Prior to substantial human settlement the hills were covered in forest. However, deforestation became a serious problem early on. Already in 1926 a 'native forestry Instructor' was employed by the Native Council to encourage individual reforestation efforts. Large-scale reforestation was also undertaken by the forestry department in certain seriously eroded parts of the hills. But recent analysis of Landsat TM satellite imagery by the USDA Forest Service reveals the Taita Hills have experienced a 37% loss of indigenous mountain forest between 1987 and 1999 (USDA, 1999).

The Taita hills have a long tradition of soil conservation. Inclusive to the Kenya Land Commission Policies, soil conservation measures were applied in the area. Every farmer needed to dedicate six days in every three months were to communal schemes which included hillside terracing, grass planting, grazing enclosure erection, river bank reinforcement (van Zwanenborg & King, 1975). The early efforts and continuing tradition of soil conservation is clearly seen today in the landscapes of the hills.

Results

Table 3 summarizes basic information on farmers' education, families, off-farm activities, group memberships, plots and housing.

Table 3. Some important farmer and farm characteristics in the study transect in the Taita hills, according to the interview survey of 51 households

Socio-economic indicators	Frequency
Average number of years at school	6.8 fathers, 5.5 mothers
Less than 7 years at school	34 % fathers, 50 % mothers
More than 8 years at school	32 % fathers, 10 % mothers
Vocational training	61 % fathers, 25 % mothers
Off-farm job (both casual and permanent)	50 % (fathers), 19 % (mothers)
Farmers belonging to groups	39 % fathers, 54 % mothers
Average number of persons living in a household	5.5
Average family size	6.5
Highland farmers who have a lowland plot	10/21
Average number of plots per family	2.1
Average plot size	2.3 ha
Farmers who have inherited/been allocated land	Inherited 84 % / allocated 27 %
Farmers who have sold land	8 %
Farmers who have bought land	27 %
Farmers who rent land	6 %
Average distance between different plots	1 hour (about 5km)
Average total plot area per family	4.6 ha (range 0.4 –26 ha)
Farmers living in a stone house/mud house	29 / 71 %
Access to irrigation	4 %
Farmers having bunds on their land	94 %

Human resources on farm

There is a big difference between the proportion of fathers and mothers who have studied past primary education. While ten of the fathers had had an opportunity to finish secondary school and two of them had even continued further, only two of the mothers had finished secondary education (11 years). It is important to notice that there is no clear correlation between the age and number of school years in either of the gender groups. That is, younger farmers of either groups are not generally more educated than older farmers.

Fathers' vocational training was usually in the fields of building (carpentry, masonry, painting etc), driving and mechanics, but there was a large range of other fields as well such as teaching, hotel keeping, agriculture, police, store keeping, theology, sign painting, office administration, cooking, army training, finance or civil engineering. There was no correlation between fathers' educational level and having a job. This is due to the fact that most of the jobs available do not require formal training. Mothers' vocational training represented much less variation the majority being in tailoring. Others mentioned included clerk, typist, pot making, teaching and forestry.

More than half (27/51) of the households have grandparents, grandchildren and others living on the farm. These additional people can be considered both as labour force on the farm as well as additional consumers of the farm produce. However, one fifth of the farmers consider lack of labour as a serious limiting factor to their farming activity. In places tillage of land is considered as too hard work and parts of farmland is left uncultivated. None of the farmers told they earn off-farm income by working on other farmers land as paid labourers, however, women tend to informally work together, just helping each other.

Collective action

Taita households are very actively involved in group activities. Most of the groups are women's merry-go-rounds or village merry-go-rounds, but there are few specialised project based groups as well. In the merry-go-round groups money is collected regularly and every member has his/her turn to get the collected money. All except one of the women and four of the men belonging to groups mentioned some benefits. In most cases it is money to buy assets or pay school fees. Some mention spiritual support and new ideas from the group as benefits. One fourth of the farmers think they can have credit from their groups. In addition to group activities i.e. organized collective action, most of the households (41/51) help each other with things like firewood, water, food, labour, cash by borrowing, and lending and borrowing household assets like wheelbarrows, bicycles, kitchen utensils etc.

One fifth of the households receive financial contribution from someone outside the farm, usually adult children. But interestingly, a higher percentage (35%) of households contribute in some way to the well-being of someone outside the farm. These beneficiaries are most often grandchildren, parents or other family members.

The farming system

Land

According to the Taita Taveta district development plan (Kenya, 1997) there is a significant difference in land size between the high potential, medium potential and low potential zones being 0.9 ha, 1 ha and 4.8 ha respectively. However, this survey did not reveal any significant differences in land size between the different zones. In all the three areas, highlands, northern slopes and plains and southern slopes and plains land size was approximately 4.6 ha with a very large range from 0.4 to 26 ha. According to Fleuret (1988) plots in the most desirable zones, particularly valley bottoms and margins, have been subdivided more frequently than plots in other locations, and their size was already in the 1980s generally less than 0.1 ha. A surprisingly large percentage (65%) of plots (n=110) in general had not been divided when the present owner obtained his land. Only third (35%) of the plots had been divided when being acquired by the present owner. These had been divided on average into four pieces. Now the farmers interviewed plan to subdivide their land between their children on average into three pieces. However, according to the farmers, 25% of the plots will remain undivided.

A lot of young couples build their houses on the husband's parents land. Neither customary nor legal subdivision of land takes place. This often prevents young farmer families from making any considerable investments to develop their land (Pers.comm. A.M. Kiasi, 2005).

Forty-three out of 51 had inherited land 18 of which inherited two or more plots. The average area inherited by a family had been 3.1 ha. Only one farmer out of 51 had not inherited nor was allocated any land. He had bought 0.8 ha of land which is now all he has. In general 27 % of farmers have increased their land acreage by buying land. Most (70%) of the bought plots are in the lowlands. The sample of this survey did not pick many farmers who had sold land. This may imply that most of those who have sold land have moved away.

Taita farming system has traditionally made use of the varying ecological conditions of the different altitudes of the hills and adjacent plains (Nazzaro, 1974; Fleuret, 1988). In the years of adequate rains many cultivators have moved to the plains to plant and harvest crops in the lighter alluvial soils. During times of inadequate rainfall, these cultivators retreat to the more dependable moisture of the hills. The practice of retaining multiple land holdings correlates with the differing harvesting times of the two ecological zones. Other explanations to the development of this 'transhumance practice' are the needs of a polygamous society and the traditional female male division of labour. More importantly, by planting crops both in the plains and hills, a family can more nearly assure themselves of a dependable food supply from season to season. Many families are both pastoralists and cultivators. Cattle are often grazed

collectively (Mkangi, 1978) and moved between the hills and the plains according to the rains.

Land consolidation has obviously not completely disrupted the utilisation of different ecological zones by the highland farmer families. The current survey revealed that 10 families in the highland out of 21 had a lowland plot under cultivation. Most of these families had the lowland plot on the northern side of the hills. However, due to population pressure in the highlands an increasing number of people are forced to dependent on lowland plots only.

Population density varies across the agroecological zones. Landscan data (ORNL, 2000) was used to calculate population densities in the Taita hills. The following figures were obtained calculating population density means from an area covering a topographic 1:50 000 map sheet, Taita hills, 189/4, (and by the study transect) using Lanscan data: 150 (217) persons per sq km in the upper highland over 1680 m altitude, 76 (121) in the Marginal coffee zone, 68 (121) in the Sunflower-Maize zone, 38 (44) in the Marginal-Cotton zone, and 45 (50) persons per sq km in the Livestock-Millet zones. The most densely populated places are Ngerenyi (734 persons/sq km), Mgambonyi (555) and Werugha (522) trading centre areas.

Fifty years has passed since the Swynnerton Plan and the Land Tenure Rules of adjudication, consolidation and registration, but the process is still going on in the Taita hills. Wundanyi division was completed mainly in the 1960's and 1970's, but thousands of title deeds remain uncollected in the Lands office. In Chawia farmers refused land consolidation as they found the exercise too cumbersome involving displacement of people and thus creating conflicts. Even adjudication of lands in Chawia has not yet been done. Land adjudication is currently going on in Kishushe (Pers.comm. A.M. Kiasi, 2005).

Crops

Maize is grown by every farmer interviewed. The average size of maize cultivation is 0.9 ha. Thirty-seven out of 51 farmers specifically say they use certified shop seeds for maize. Others use seeds from the previous harvest or seeds bought from the market places. Most of the other seeds (beans, vegetables) come from home or from neighbours. Table 9 lists all the main crops grown by the interviewed farmers. Other crops grown by few farmers only (fewer than 7 farmers in the sample) include arrow root, avocado, kales, beetroots, cauliflower, coconut, coffee, cotton, guava, hot pepper, kales, lettuce, loquat, macadamia, onions, oranges, passion, paw paw, pumpkins, sweet pepper, Swiss chard, sugar cane, sunflower and tree tomato.

Information on crop production was collected from farmers. But as it became obvious that most of the Taita farmers do not keep any track on how much they produce in a year or a

season, estimating one's production proved to be an extremely difficult task and seemed more like guesswork. For that reason farmer's estimates on crop production are not presented in this report. However, it was easy for the farmers to estimate whether their production has increased, decreased or stayed the same over the years. Table 4 presents these perceptions.

Table 4. Percentage of farmers perceiving their production as either decreasing or increasing in the Taita hills (n=51)

Crop (number of cultivators in the sample)	Perceive an increase (%)	Perceive a decrease (%)
Banana (12)	58 (but have increased area)	25
Beans (50)	20	60
Cassava (31)	23 (but have increased area)	48
Cowpeas (23)	9	65
Green grams (11)	18	64
Maize (51)	6	71
Millet (11)		55
Pigeon peas (12)	8	42

Fertility management

In the Taita hills farmland is often used intensively and farmers would need to add more and more inputs to maintain soils fertility (see later *Coping with shocks and trends*). Fertility management of the soils is done mainly by adding cow dung. Fifty-nine percent of farmers use dung on their land, few of which on more than one of their plots. Farmers estimated the amount of manure per year in lorry loads as lorries are used to transport the manure to the fields. On average 5.4 tonnes (range 44 to 34000kg) of manure per hectare per year (usually twice a year) is applied on these fields. When the three top users and the three lowest users are omitted from the analysis, an average usage is about 3.3 tonnes per hectare. Artificial fertilizers are used by fifteen farmers out of which five use it on more than one of their plots. Average of 64 kg per hectare in a year is applied with very large variation of 486-0.8 kg/ha¹. Only two farmers use compost, which is surprising as compost and mulching is a very typical practice for example in the neighbouring highlands of Mt. Kilimanjaro (Soini, 2005 a). According to farmers, the high cost of farm inputs and inadequate level of knowledge of recommendations prevents them from making better investments in their farming. However, the survey data does not show any correlation between fertilizer use and whether the farmer

¹ KARI (Kenya Agricultural Research Institute, 1995) has published fertiliser use recommendations for Werugha area. In summary, maize showed positive yield responses to N; yields from intercropped maize were lower than yields from mono-cropped maize; potatoes and cabbages showed positive response to N and strongly responded to P; application of 5t of manure/ha shows clear yield increase in potatoes and cabbages; combination of manure, N and P resulted in marked positive response in potatoes and cabbages; application of potassium did not result in significant yield increases. Calculations following the principle that one shilling investment in fertilisers should bring two shillings additional income in crops resulted in the following recommendations: 60-75kg of N per ha for maize; 75kg/ha of N and 75kg/ha of P for cabbages; 65kg/ha of N and 75kg/ha of P for potatoes; 15kg/ha of N for mono-cropped beans. Average yield increase if applied: maize 1970-1830kg/ha; potatoes 16400kg/ha; cabbages 10400kg/ha. additional 5t manure applied for potatoes and cabbages bring additional yield increase of 3670kg/ha for potatoes and 3160kg/ha for cabbages.

has an off-farm income. That is, the income that is derived from an off-farm job is used for something more pressing or less risky than farming and farm inputs. There was no correlation of fertilizer use and farm size either. That is, farmers with more land are not more professional, nor are farmers with small plots cultivating more intensively.

Livestock

Improved cows are typically kept in the highlands while goats play an important role in the lowlands (Table 5). Practically all farmers who keep improved cows cultivate fodder grass(es) on their land, and most of them have enough fodder from home. The rest supplement their fodder needs by collecting from common land or from neighbours. No-one buys fodder.

Table 5. Numbers of domestic animals and poultry in the highlands, northern side and southern side of the Taita hills

Animal	Average number (or range) amongst those having	Proportion of households having	Highland farmers N=21	Southern farmers N=15	Northern farmers N=15
Improved cows	2	32/51	18	6	8
Zebu cows	4.25	4/51		1	3
Mixed cows	2.75	4/51		1	2
Dairy goats	3.3	3/51			3
Goats or Sheep	7.4	26/51	3 (goats) 8 (sheep)	13 goats	10 goats) 1 (sheep)
Donkeys	1 and 9	2/51			2
Hens	11.2 (range 1-89)	45/51	16	14	15

Trees

Farmers were asked to list five most important tree species that they have on their land. Table 6 is a list of trees that were mentioned by farmers more than once. In addition 25 other species were mentioned, but only by one farmer.

Sixty-one percent of the interviewed say they have enough firewood from their own land. Crop residues, particularly maize cobs and stalks, are also used as fuel. Those who do not have enough firewood from home collect it from neighbours, bushland, roadsides, a ranch, or forest. The usual distance to these firewood sources is about 2 km from home. Eleven percent of the farmers buy firewood. Fleuret in the 1980s found that the bulk of the firewood is collected from the 'bush' even if a large number of people secure at least a portion of their fuel supplies from their currently cultivated or fallow farm plots. Timber requirements are slightly more difficult to meet. Twenty-seven percent of the farmers say they have enough trees to meet their timber needs. Most of these (10/14) farmers live in the highlands, the rest

on the northern side of the hills. Timber requirements are obviously more difficult to meet on the southern slopes and plains. Those who do not have enough, buy it from timber sales or from neighbours.

Table 6. The most important tree species in the highlands, southern side and northern side of the Taita hills, and niches in the farm. Number indicates how many farmers named the species among his/her five most important tree species (n=51)

Tree species	North	South	Highland	On the boundary/ inside field area	On the boundary	Close to house	Inside field area	In a woodlot
<i>Grevillea robusta</i>	4	7	20	1	3		27	
<i>Mangifera indica</i>	7	13	5	1		4	20	
<i>Persea americana</i>	1	2	13		2		13	
<i>Melia volkensii</i>	6	7	1		2		12	
<i>Lannea stuhlmannii</i>	2	4	1	1	1		5	
<i>Acacia mearnsii</i>			6		2		2	2
<i>Cupressus lusitanica</i>			6		3		2	1
<i>Eucalyptus sp.</i>			6		3		2	1
<i>Psidium guajava</i>			6			1	5	
<i>Acacia mellifera</i>	2	3			1	1	2	1
<i>Acacia sp.</i>	3	2			1		3	1
<i>Citrus spp.</i>	1	1	3			3	2	
<i>Carica papaya</i>	1	1	2				4	
<i>Macadamia tetraphylla</i>			4		1		3	
<i>Annona squamosa</i>	1	2					3	
<i>Azadirachta indica</i>	2	1				1	2	
<i>Bridelia micrantha</i>	1	2			1	1	1	
'Chariso' (local name) ¹	3						3	
<i>Combretum molle</i>	1	2					3	
<i>Eriobotrya japonica</i>			3			1	2	
<i>Cassia sp.</i>	1	1				2		
<i>Combretum exaltatum</i>	1	1					1	1
<i>Croton sp.</i>	2					1	1	
<i>Cyphomandra betacea</i>			2			2		
<i>Leucaena leucocephala</i>		1	1				2	
<i>Maesa lanceolata</i>	2						1	1
<i>Passiflora spp.</i>	1		1			1	1	

¹Scientific name not known to the author. This species is used to add flavour to milk. Hot charred stick is inserted into milk in a gourd (Pers.comm., A.M. Kiasi, 2005).

The data reveals an interesting pattern of household decision making in planting or harvesting trees. Slightly more often it is the mother who plants a tree, but much more often the father decides when to harvest (Table 7). Looking at the data, species by species (Table 8), one can see that fathers typically plant *Grevillea robusta* while mothers plant *Mangifera indica*. The table gives an impression that mothers cannot control even those trees they have planted themselves. That is true due to the fact that harvesting *Mangifera indica* – which means picking the fruits or just collecting the fallen fruits from the ground – can often be decided upon by anyone in the family including children. However, harvesting *Grevillea robusta* -

cutting the tree - is decided upon by the father of the family. Fathers seem to even decide upon harvesting some of the *Grevilleas* planted by mothers.

Table 7. Who has planted the trees currently in the farms, and who decides to harvest in the Taita hills? Fifty-one households were interviewed

Family member or other	Who has planted? (Freq)	Who decides to harvest (Freq)
Mother	60	31
Father	53	58
Son	27	19
Grows naturally	25	
Extension	12	
Daughter	6	
Parents together	6	53
Chief	2	
Grandfather	2	
Children	1	
Green belt movement	1	
No rule	1	22
Women's group	1	

Table 8. Top ten tree species in the Taita hills: Decision to plant and to harvest. Fifty-one households were interviewed

Species	Who decides to harvest?			Who has planted?		
	Mother	Father	Parents	Father	Mother	Parents
<i>Grevillea robusta</i>	3	19	4	12	6	1
<i>Mangifera indica</i>	5	5	7	6	13	0
<i>Persea americana</i>	1	6	4	6	4	1
<i>Melia volkensii</i>	4	6	2	0	8	1
<i>Eucalyptus sp.</i>	1	2	2	3	1	2
<i>Lannea stuhlmannii</i>	1	2	2	1	3	0
<i>Cupressus lusitanica</i>	1	3	1	3	0	1
<i>Acacia mearnsii</i>	2	1	1	2	2	0
<i>Carica papaya</i>	0	1	1	1	3	0
<i>Annona squamosa</i>	1	1	1	1	2	0

Where to obtain cash?

Table 9 lists the main crops grown by the farmers interviewed and the proportion they use or sell. On Taita hills, most of the crops are sold at home to the middlemen that travel around the countryside. According to the data most of the farmers cultivate mainly for home consumption. However, even selling a little proportion of their crop production is a significant cash source.

More than half (53%) of the interviewed farmers sell some tree products, the most typical being fruits (33 %). Twenty-two percent of the farmers sell timber, 16 % firewood (out of one

charcoal), 6 % nuts, some few sell fodder and poles. *Mangifera indica*, *Persea Americana*, *Carica papaya* and *Psidium guajava* are clearly the most important trees to yield fruits for sale. Top five species for timber and firewood sales were *Grevillea robusta*, *Cupressus lusitanica*, *Eucalyptus* spp., *Melia volkensii* and *Acacia* sp. However, the biggest proportion of fruits, firewood or timber is used at home.

Poultry plays a very important role in Taita households. Nearly all households keep hens, some of them large numbers (up to about 90). Naturally to those who keep large numbers it is a family business. Both eggs and broilers are sold.

Table 9. Main crops grown by the interviewed households (n=51) in the Taita hills, and proportion of home usage and selling

Crop	Number of farmers who...				Total number of farmers growing
	use all the produce at home	use more at home than sell	use half and sell half	sell more than they use at home	
Maize	42	8		1	51
Beans	37	8		4	50
Cassava	22	2	3	4	32
Cowpeas	22	3		1	28
Mango	7	6		1	14
Pigeon peas	11	1		2	14
Banana	8	4		1	13
Millet	11	1			12
Green grams	6	4		1	11
Cabbage	1	1		6	8
Irish potato	4	1		3	8
Sweet potato	6	1			7
Tomato	6	1			7

A very important income source to many (33%) families on Taita hills is milk sales. All except one of those who sell milk consider it an Important or Very important addition to the household income. One to ten litres is sold per day (mean 4.5), which makes between 20 and 240 KShs per day.

A lot of more fathers (50%) than mothers (19%) have an off-farm job. However, both figures are relatively high and reflect the need to supplement farm income by non-agricultural income in order to get cash for the many needs of the household, one of the biggest needs being school fees of older children. In 37% of the households either mother or a father has an off-farm job.

Selling land is probably the most extreme method that a farmer needs to use in order to cope with his/her cash needs. Only four farmers out of 51 admitted they have sold some of their

land. In three cases land was sold to obtain school or college fees for their own children or for their brothers.

Seventy-six percent of the farmers interviewed told they cannot get credit from anywhere. One fourth of those in groups think they can have credit from their village or women's merry-go-round groups. Other places mentioned include FSA (Financial Service Agency) (3), Kenya Women Finance (2), SMEP (Small and Micro Enterprise Program) (1) and friends (1). Difficulty in obtaining credit has significant consequences as with 69% farmers, heaviest cash demand and availability within a year do not match.

Coping with changes

Trends (long term)

Farmers were asked what has changed in crop growing, livestock keeping, and tree coverage and number of tree species since their father was a farmer and they were young themselves living in their father's household. Table 10 shows the perceived trends by categories.

Soil depletion is generally perceived the most negative trend affecting cultivation and resulting to more work and demand of farm inputs. It is interesting that the perception of whether there are fewer or more trees, or fewer or more tree species at present than before, varies from one farmer to another. When answering the questions, farmers were mainly assessing their own neighbourhood. It seems that some neighbourhoods have planted more trees and introduced new species while some other neighbourhoods have done the opposite. There is no significant association between farmer's age and whether s/he perceives an increase or a decrease in the number of trees. This suggest that the difference is mainly spatial. Those farmers who perceive an increase are in the highlands or on the northern plains and are between ages 36 and 70.

Table 10. Perceived trends since fathers' time in the Taita hills. Frequency indicates how many farmers mentioned a particular trend (n=51)

Category	What is different now compared to when your father was a farmer?	Freq
Cultivation	One needs to use manure, fertilizer, (compost)	24
	Use of spacing in cultivating	14
	Soils have depleted	9
	Using deep tillage	8
	Use of certified seeds	7
	More crop species	6
	Use of pesticides	5
	We have improved knowledge to cultivate and keep livestock	5
	Bigger area of land under cultivation	5
	Soil conservation (bunds)	5
	Intercropping	3
	Timely planting	3
	Agroforestry	3
Trees	There are fewer trees/more trees	27/10
	There are fewer tree species/more tree species	15/13
	New tree species like <i>Grevillea</i> , <i>Avocado</i> , <i>Cypress</i>	6
Animal rearing	Animals are kept in zero-grazing	20
	Farmers keep fewer animals	16
	Planting/cutting grass for animals	13
	We obtain more milk	9
	Improved animals	8
	Animals in the farm not group grazing	7
	Poultry keeping	4
	Dipping or spraying of animals	4
	More manure obtained from zero-grazing	4
	De-worming of animals	4
	Artificial Insemination	2
Other	Off-farm cash income source	11
	We cultivate vegetables	6
	Rains have decreased	4

Farmers mention *Grevillea*, *Persea americana* and *Cupressus* as the most typical new species introduced to the landscape. However, a lot of *Eucalyptus* is also seen. When the farmers were asked what trees have they introduced on their own land, *Grevillea* scores highest (18) followed by *Mangifera indica* (16) and *Persea americana* (11). *Grevillea*, *Cupressus* and *Eucalyptus* were originally intended for use as building timber or for erosion control. *Macadamia*, *Psidium*, and *Pennisetum* were introduced as food-producing plants, the first two for humans and the last for animal fodder. *Acacia mearnsii*, or black wattle, was introduced into Taita as a cash crop, the bark being stripped and sold to extract plants for the manufacture of shoe polish and tanning agents. Although the market for wattle bark has contracted and the wattle produced in Taita can no longer be marketed efficiently, the trees left to would-be cash croppers are valuable as a source of fuel and of building timber (Fleuret, 1983).

Due to pressure on land most of the animals in the highlands have been put under 0-grazing. Farmers estimated the average number of animals their fathers used to have as 11 cows and 13.9 goats. This implies a marked reduction of animals on farms. Reduction of number of animals on farms is happening all the time. Most of the farmers had had the biggest number of animals between 5 to 10 years ago.

One can assume that introducing new crops would be one strategy to obtain more cash and variety of food. Almost half of the farmers (21/51) had introduced some new crops to their farms. This has happened between 1982 and 2003 (mean 1996). However, it is not possible to pick typical choices. They include tomatoes, onions, groundnuts, beans, cowpeas, cotton, green grams, potatoes etc. Twenty-eight farmers mention spacing as a new introduced way of cultivating (introduced between 1983-2002). Fifteen say they have started to add manure or fertilizer (1978-2003), 7 have introduced pesticide use (1990-2003), 6 constructed bunds (1985-1999), 5 introduced deep tillage (1998-2003) and 4 started to harvest rain water for irrigation (2000-2003).

How many have introduced any new animals and livestock rearing technologies since they began farming? Forty out of 51 mentioned something. The most typical new rearing technology being zero grazing (19 farmers) (introduced between 1974 and 2004). Others include de-worming (8), introduction of dairy cows instead of Zebus (6), a dairy goat (1), dipping cows (6), and fodder production (2).

Twenty-three farmers out of 51 have abandoned some activities or technologies. These represent again a very large variety of things such as cultivation of tomatoes, keeping rabbits, using fertilizer or manure, keeping poultry and sheep, cutting all the *Cupressus* trees etc. According to the introduced and abandoned farm activities or technologies one can see no trends at all emerging, no shift in the farming system as a whole towards anything different. When one farmer introduces groundnuts another abandons the crop, when one starts using fertilizers and manure another farmer abandons such practice.

If the above changes are associated with projects or impacts of extension service promotion/emphasis or not is not clear.

Shocks (short term)

When a sudden need of cash arises in the village or at home due to a funeral, sickness or a wedding, strategies are needed to cope with the additional expenditures. This often means disposing of some household assets/capital. One third of the farmers have needed to sell an

animal in order to cope with a sudden need at home. Village collection is an important way to help each others in coping with sudden or emergency cash needs. However, only 14% of the farmers mentioned they have been able to rely on collection only during times of additional sudden expenditures. Table 11 lists the most often mentioned strategies farmers use in coping with addition expenditures at home and in the village.

Table 11. Strategies to cope with sudden cash needs at home and in the village. Frequency indicates how many times a certain strategy was mentioned (n=51). Usually a combination of strategies are used

Strategy mentioned	Need at home (Freq)	Need in the village (taking part in village collection) (Freq)
Selling an animal	16	5
Selling chicken	10	13
Selling timber	2	1
Family (children) helps	8	7
Relying on shop/kiosk/hand craft	7	5
Selling crops	7	10
Casual work	4	5
Borrowing	3	1
Selling milk	3	3
Selling eggs	1	2
Selling fruits	1	1
Gemstones	1	1
Selling charcoal		1
Squeezing the family budget	2	14
Relying on village collection	17	

What are then the typical coping strategies to cope during drought? Thirty-five percent of farmers mention they have needed to sell animals, goats or cows, 29 % have been able to rely on their business, 25 % by selling hens, 22 % by being helped by children and other family members' help, 14 % by casual labour, 12 % by using previous harvest, 10 % by selling timber, 8 % by relying on milk sales, and some exceptions by cropping hot pepper, cassava and banana in a swampy area in order to sustain during drought.

Challenges to cope with

Table 12 is a list of problems perceived by farmers themselves as the most difficult ones concerning crops, trees, livestock, and off-farm activities. Pests are a serious problem with cropping. These include Larger Grain Borer, *Protephanus trancutus*, locally referred to as 'scania' which probably in places destroys a bulk of the harvest. Farmers complain that even the repellent does not protect their stores. Lack of capital for farm inputs and drought are perceived as the next most difficult problems. Animal destruction is serious in the lowlands. Usually it is baboons and monkeys, but in the northern side of the hills it is more often

elephants that destroy cultivations. There is also some dissatisfaction that extension is not proactively helping farmers by travelling around and educating on new farming techniques and crop options.

Table 12. The most common problems perceived by farmers in the Taita hills

Problems with crop growing	Number of farmers out of 51
Pests (Larger Grain Borer, <i>Protephanus trancutus</i>)	37 (10)
Lack of capital to invest in farm inputs	33
Drought	29
Animal destruction (baboons, monkeys, but elephants in 11 cases in the lowlands)	23
Extension is not available ¹	11
Shortage of labour	10
Theft / flooding / moles	3 (each mentioned only once)
Problems with tree growing	
Unavailability of seedlings (especially grafted)	42 (23)
Drying	5
Too small a plot / pests on fruit trees / seedlings expensive	3 (each mentioned only once)
Problems with livestock	
Diseases (tickborne, newcastle in chicken, foot and mouth, east coast fever, ccpp)	36
Lack of enough fodder esp. dry periods	20
Expensive drugs and vet services	10
No dipping facilities	6
Problems with off-farm activities	
Lack of capital to keep good stocks	7
Lack of enough customers	6
Getting permits	2
Lack of timber for furniture making / no good equipment / customers do not pay / transportation	4 (each mentioned only once)

¹The question on extension service availability was not mentioned amongst the most important problems. It came up when asking about the availability and access to farm inputs and knowledge. All the rest (40) say it is available, but only on request. 41 farmers say veterinary services are available on request, one mentions that vet people even travel around on farms.

Despite all the tree planting programmes over the years in the Taita hills, farmers perceive unavailability of seedlings as the most important hindrance that prevents them from planting trees. It is interesting that in the 1980s Fleuret (1983) reports that pressure of land amongst other things prevents farmers from planting trees. In the present survey this reason is given by only two farmers. On the contrary some farmers complain that due to lack of labour they leave part of their land uncultivated. Why is this uncultivated land not made into a woodlot? Two issues emerge, i.e. farmers are not sufficiently encouraged by the farm extension to plant trees, and seedlings are not made easily available to encourage tree planting.

Inadequate availability of funds to buy veterinary services is behind the first most serious problem of livestock diseases. It is also very difficult to find enough fodder for animals during prolonged droughts. In addition, six households on the northern-north-western slopes did not have a dipping facility in their use.

What activities to start, what assets to acquire to improve?

How would farmers themselves think they could cope better and improve their livelihoods? What additional on-farm activities or investments would they select? What would be their choice as an off-farm activity? What assets would they think as the most desirable and critically needed? Table 13 is a list of answers to these questions.

Table 13. Desired on-farm and off-farm activities, and desired assets/investments in the Taita hills as perceived by farmers (n=51)

On farm activity:	Freq	Off-farm activity:	Freq	Assets:	Freq
Acquire a dairy cow or goat or expand dairy farming	31	Establish a kiosk or a shop	29	Construct a good and big stone house	37
Expand or start poultry	25	Improve current business	7	Invest to a water tank	17
Acquire more animals	12	Bakery, grocery, tailoring, timber sales, rental houses		Have electricity to their house, 5 of which mention specifically solar power	14
Arrange irrigation to the farm	11			To have water pumped to compound, some especially for irrigation purposes	6
Expand land area	10			Tv, furniture, tractor, plough, mill and rental houses	
Build terraces	9				
Start or expand horticulture	9				
Buy farm inputs like fertilizers, manure, pesticides	8				
Plant fruit trees	7				
Beekeeping, groundnuts, proper planning, timber trees					

Interrelationships of capital, strategies and outcomes

Desired activities or assets were used as a basis to select the components of the livelihood outcome index. The outcome index which is the average of the six components varies between 0 and 0.67. All the components are roughly equally prevalent (means for components 0.22-0.29), Introduced crops (0.39) slightly more so. The two components, Bought land and Children's schooling' are significantly correlated. This must be due to the fact that older couples have more often secondary school aged children and this coincides with the fact that due to their age they have in general had more opportunities to invest and buy assets. However, the general lack of correlation between the livelihood outcome components suggests that there is no consistent pattern in achieving outcomes – people do not consistently get one then the next.

Principle component analysis on the livelihood outcome components is shown in Figure 3. The 51 sampled households are arranged in two dimensions (labelled PC1 and PC2) with households with similar outcomes being close together. The outcome components outside the circle are those that contribute ‘significantly’ to the arrangement. Outcomes in the same direction from the origin are correlated. Arrows in opposite directions are negatively correlated and those at right angles are uncorrelated. Thus Bought land, Established business and Introduced crops are as close to unrelated as possible. The dots for each farm show how they score on outcomes. For example a dot far from zero in the direction of the Bought land arrow, scores well on that outcome. The two obvious groups of households are those with and without Introduced crops. Otherwise there is no sign of grouping, farms do not fall into a few distinct groups as far as outcomes go. However, when the data is grouped in three representing farms in the highlands, southern side and northern side of the hills clear differentiation can be seen in outcome scores. Highlands and the southern slopes and plains are better off on all outcomes except crop introduction (Table 14).

Table 14. Average scores in outcome index components in the northern and southern slopes and the highlands of Taita hills

Average of...						
Zone	Housing	Children in secondary school	Bought land	Introduced animals	Introduced crops	Established business
North	0.13	0.20	0.13	0.13	0.47	0.17
South	0.33	0.23	0.20	0.27	0.33	0.27
Highlands	0.38	0.45	0.43	0.24	0.38	0.24
Grand Total	0.29	0.31	0.27	0.22	0.39	0.23

Although the process is dynamic, with each household following a different time trajectory, it is expected that some detectable links between the assets/capital and the outcomes in cross-sectional data can be found. A linear regression model, with the livelihood outcome related to the four livelihood capital indices, is an approximation used to explore possible correlations.

Figure 3. Principal component analysis of the linkages of livelihood outcome components.

Results of the linear multivariate regression analysis are shown in Table 15. Only Financial capital has clear positive relation (significant at $p=0.01$) with the outcome. In addition, Natural capital has a positive relation, but it is not statistically significant. Both Human and Social capital show no relationship at all with the livelihood outcome.

Relationship with financial capital is different in the three zones (Figure 4). Importance of financial capital is clearest in the highlands.

Table 15. Results of the linear multivariate regression analysis aiming at detecting relationships between four groups of livelihood capital (indices) and livelihood outcomes as an index measuring desired outcomes as perceived by the interviewed farmers in the Taita hills

Four livelihood capitals	estimate	s.e.	t(46)	t pr.
Constant	0.0646	0.0839	0.77	0.445
Natural capital	0.225	0.142	1.59	0.120
Financial capital	0.284	0.105	2.69	0.010
Social capital	0.021	0.134	0.15	0.877
Human capital	0.099	0.129	0.76	0.450
Percent variance accounted for = $r^2 = 11.0$

Figure 4. Relationship of outcome index with financial capital in highlands, southern and northern side of the hills. Financial capital is most important in the highlands.

It is important to note that the variance accounted for is very little i.e. most of the variation in the outcome index is simply not linearly accounted for by the four assets.

Several explanations are explored.

First, one can claim that the simple linear model is unrealistic, particularly as the outcome is constrained between 0 and 1. A logistic model was tested. However, the result using this model is almost exactly the same. Financial capital is still the only one clearly important.

Second, it is recognized that the Sustainable livelihoods theory claims that all the capitals are needed for successful livelihood outcomes. However, the two previous models assume that all four have independent influences to the outcome. So a new variable 'All capital' was used. It is the product of all the four capitals and reflects the overall score of all of them together, being zero if any one component is zero. However, even this does not make any difference to the model.

Third, it is assumed that the influences of the assets are different for each outcome, so no clear results are seen when we analyse the average outcome. This is investigated by analysing

each of the six components of the livelihood outcome separately. As these have many 0 and 1 values, the logistic model (1) is used. Some associations show up. ‘Introduced animals’ is positively associated with Natural and Financial capital. It is, however, negatively associated with Social capital (Table 16). One may argue that group people are those with no opportunities to get animals, or further, that farmers with animals are too busy to take part in group activities. As expected ‘Established business’ show associations with Financial capital. ‘Introduced crops’ is negatively associated with Financial capital (Table 17). One explanation to this may be that Financial capital often means having a job which leaves limited time for labour intensive activities like new crop enterprises. In the sample, when both the mother and the father have off-farm jobs, they do not invest in new crops at all (Table 18) while those with no off-farm jobs are much more likely to introduce new crops.

Table 16. Frequency of ‘Introduced animals’ by Social capital. Those who have introduced animals are less likely to be ‘group people’

	Social capital					
Introduced animals	0	0.1667	0.3333	0.5	0.6667	0.8333
0	13	14	10	1	1	1
1	6	4	1	0	0	0
Proportion	0.32	0.22	0.09	0.00	0.00	0.00

Table 17. Frequency of Introduced crops by Financial capital

	Financial capital								
Introduced crops	0	0.111	0.222	0.333	0.444	0.556	0.667	0.778	0.889
0	6	2	2	14	2	1	2	1	1
1	9	0	3	5	1	1	1	0	0
Proportion	0.60	0.00	0.60	0.26	0.33	0.50	0.33	0.00	0.00

Table 18. Frequency of Introduction of crops by father’s and mother’s off-farm jobs. Farmers with off-farm jobs are less likely to introduce new crops in the Taita hills

Father’s off-farm job	Mother’s off-farm job	Introduced crops		Proportion
		0	1	
0	0	18	14	0.44
0	1	2	3	0.6
1	0	7	3	0.3
1	1	4	0	0

Fourth, a further explanation is simply that there are many individual livelihood strategies, and it is not possible to pull out many general patterns (at least in a sample of 51). This can be looked at by calculating the errors from the model. The logistic model shows up the best relationship we can find, but some households are far off what could be expected. There are households with no livelihood outcome scores, yet they can be reasonably endowed with some of the capitals. There are also some farms with high scores in outcomes yet some of their capital types as 0.

Further explanations were sought by replacing the four capital indices with their components. A few modifications were made: Inherited acreage was dropped as it is highly correlated with Total acreage. Number of improved cows and Number of hens were also dropped as these are almost the same as Introduced animals which is one of the components of the livelihood outcome index. Number of animals still remains to measure livestock influence. Father’s and mother’s group membership were merged as they are highly correlated (either both men and women or neither tend to be in groups, with some men in groups on their own.) Table 19 shows the results of the analysis.

It is surprising that Total acreage does not show association with the livelihood outcome index. Having plots in two ecological zones has a clear positive influence. As the index Young farmer is small for young farmers and increases to 1 at age 40, the positive relationship indicates that older farmers up to age 40 have a higher outcome. This is reasonable if people take some time to acquire assets and outcomes. The trend does not continue after the age of forty (Old farmer does not show association). The off-farm income variables are not strongly correlated with overall outcomes (they were, however, strongly correlated with Established business). It seems that a business or an off-farm job does not contribute to agricultural outcomes. Agriculture is supposedly less important once a farmer has a job – the job replaces agriculture rather than supporting investment in it.

Table 19. Regression analysis of associations of livelihood outcome (index) with livelihood capitals replacing the four capital indices with their components

	estimate	s.e.	t(36)	p
Constant	-5.35	1.19	-4.48	<.001
Total acreage	-0.032	0.368	-0.09	0.93
Number of animals	0.512	0.37	1.39	0.17
Plots in two ecological zones	0.53	0.278	1.9	0.07
Cash crops	-0.054	0.3	-0.18	0.86
Number of crops	-0.366	0.696	-0.53	0.60
Labour force	0.063	0.449	0.14	0.89
Young farmer	1.555	0.825	1.88	0.07
Old farmer	0.307	0.64	0.48	0.63
Father's and mother's school years	0.541	0.499	1.08	0.29
Outside contribution	-0.173	0.317	-0.55	0.59
Father and mother in groups	-0.133	0.66	-0.2	0.84
Mother's off-farm job	0.291	0.284	1.02	0.31
Father's off-farm job	0.419	0.262	1.6	0.12
Children's off-farm jobs	0.296	0.449	0.66	0.51

When the analysis above is repeated for each of the outcome components separately, one can find the following associations (Table 20). Children's schooling is correlated with having Land in two ecological zones. As farmers who have plots in two ecological zones are almost always highland farmers, this may show that highland farmers educate their children more often up to secondary level. Correlation with age and Children's schooling is simply because younger farmers do not yet have secondary school age children. Bought land is associated with Plots in two ecological zones. This is due to the fact that 68% of all the plots bought were lowland plots. This coincides with the fact that half of the highland farmers have a lowland plot. Negative correlation between Introduced animals and group memberships has been explored earlier. Also, Established business naturally correlates with father's off-farm job. Negative correlation of Established business with farmers schooling is odd and may not be real.

Table 20. Analysis of associations of separate livelihood outcome components with livelihood capital components

	Housing		Children's schooling		Bought land		Intr. animals		Intr. crops		Est. business	
	est	p	est	p	est	p	est	p	est	p	est	p
Constant	-3.58	0.25	-12.96	0.00	-3.4	0.34	-9.95	0.01	-3.54	0.17	-4.13	0.01
Total acreage	0.245	0.80	0.007	0.99	0.21	0.83	0	1.00	0.053	0.95	0.87	0.10
Total num of animals	0.21	0.83	0.772	0.30	-0.53	0.65	1.84	0.14	0.578	0.45	-0.701	0.23
Plots in 2 ecol zones	1.022	0.17	1.094	0.03	1.159	0.07	-0.001	1.00	-0.133	0.85	-0.473	0.35
Crops grown for sale	1.067	0.24	0.021	0.97	-0.882	0.29	-0.434	0.60	0.309	0.66	0.531	0.40
Number of crops	-2.72	0.14	0.96	0.45	-1.44	0.44	1.92	0.40	-1.4	0.39	0.35	0.76
Labour force	0.15	0.90	0.485	0.58	-0.34	0.76	-1.09	0.47	0.46	0.65	0.349	0.67
Young farmer	0.3	0.88	8.63	0.02	0.65	0.80	1.86	0.44	1.08	0.49	-0.13	0.90
Old farmer	-0.22	0.90	0.17	0.90	-0.89	0.60	3.53	0.12	0.58	0.72	-0.455	0.59
Father's and mother's school years	-0.35	0.83	0.11	0.92	1.14	0.38	1.38	0.31	-0.2	0.85	-1.852	0.06
Outside contribution	-9.8	0.64	-0.517	0.40	0.64	0.41	0.628	0.44	0.133	0.85	-0.764	0.28
Father and mother in groups	0.24	0.87	-0.11	0.92	-0.23	0.90	-6.01	0.06	1.05	0.48	0.328	0.74
Mother's off-farm job	1.157	0.11	-0.217	0.76	-0.631	0.53	-0.72	0.49	0.002	1.00	2.075	<.001
Father's off-farm job	1.214	0.11	0.725	0.21	0.256	0.74	0.88	0.28	-1.074	0.13	2.347	<.001
Children's off-farm job	1.31	0.28	0.472	0.56	0.87	0.46	1.87	0.21	-1.08	0.33	-0.541	0.51

Discussion and conclusions

The biggest livelihood changes perceived by the interviewed farmers in the Taita hills are that soils require more manure and/or artificial fertilizers than before; livestock needs to be kept under 0-grazing at the same time as number of animals has gone down; there are fewer trees in the landscape than before; and off-farm activity has been introduced to supplement farm income. Some of the biggest problems are related to these changes. Inadequate capital for fertility maintenance and other farm inputs is mentioned as the biggest single problem in farming. Other problems mentioned include pests (especially Larger Grain Borer, *Protephanus trancutus*), drought, unavailability of tree seedlings, animal diseases, and insufficient numbers of customers to maintain a business.

The requirement for increased efforts in fertility maintenance of farmland is problematic as livestock numbers are at the same time going down providing less manure on the farm, and as capital is scarce for any farm inputs. More often than seeing an increase in their crop production, farmers perceive their production going down. One option would be to investigate to what extent intercropping nitrogen fixing trees, or improved fallows could improve soil fertility in the Taita hills. This would potentially address another problem of inadequate fodder listed amongst the most serious problems by almost half of the farmers interviewed. Also, dairy goats could be an alternative to dairy cows requiring smaller space and less

fodder. However, trees and improved fallows can only be part of the solution. There must be considerable nutrient export in the intensive farming system, which would in the end make increased amount of fertilizers necessary, requiring, however, agricultural enterprises profitable enough to pay for it. A shift to significantly more profitable cash crops is crucial.

Most of the farmers who saw a change in number of trees in the landscape thought there are less trees now than before. Nazzaro (1974) at the end of 1960's describes many of the steeper slopes being covered with forests of both natural distribution or human planted. Fleuret (1983) concluded in the 1980's that "Despite the long-standing programs of reforestation, nurseries, and encouragement of individual planting efforts, few of the trees and shrubs used as fuel in Taita are deliberately planted." This was, according to Fleuret (1983) due to land shortage, uncertainty of tenure, and acts of land consolidation, and unwillingness to sacrifice valuable agricultural land to other purposes, particularly when the exercise will not yield food and when the activity will have no demonstrable productive outcome for a number of years ahead. However, according to this survey, land shortage is not considered amongst the main reasons why trees are not planted. Some farmers told they leave part of their land uncultivated due to lack of enough labour force. Why are these farmers not planting low labour crops, i.e. trees? Species such as clonal *Eucalyptus* may provide an option with low labour demands and returns in about five years. Potential markets for high value hardwoods should also be investigated. There is evidence from elsewhere in East Africa of trees having become a method of 'extensification' (reduced labour input) for farmers busy with off-farm activities (Snyder, 1996). According to the current survey, some selected species are, however, planted for firewood, timber and fruits, and some think there are currently more trees in their neighbourhood and on their farm than there used to be when they were young. Most of these farmers who see an increase of trees are in the highlands or on the northern plains. It is important to notice that more than 80% of the farmers interviewed perceive the unavailability of tree seedlings as the most serious problem with tree planting. Forty-five percent of the farmers interviewed would be interested in planting improved (crafted) fruit trees but cannot obtain seedlings. The latest District development plan (Kenya, 1997) states that there are over 600 nurseries with production capacity of 300 000 seedlings per year. Why do not the supply and demand meet? How much of the 300 000 seedlings are planted and where, calls for further investigations in order to properly plan tree seedlings supplies and demand. It is important that tree planting is also seen from the environmental perspective, not as an 'extensification' method alone. More tree diversity and more indigenous species are needed on farms to help support biodiversity as the original forests have become extremely fragmented.

None of the farmers mentioned land consolidation amongst the changes. Nor was there any mention of decreasing coffee price. In fact only one farmer cultivating coffee was captured by the survey. One farmer had abandoned coffee growing due to non-existent markets. This is surprising as the District development plans (Kenya, 1976; 1989; 1997) have continued mentioning the importance of coffee amongst the cash crops in the district. In 1989 the plan states that “coffee faced stiff competition from horticultural crops and farmers tended to neglect coffee... However the targeted hectareage was realized. It is only the yield/ha that did not increase...” The targeted hectareage for 1988 was 600ha having been 572ha in 1985. However, the hectareage halved over the next ten years being only 274ha in 1995. The last District development plan for 1997-2001 is still surprisingly hopeful stating that “with the liberalized coffee industry the yields are expected to increase” and “Once the coffee sector is streamlined at the national level it is hoped that coffee production will increase enough to warrant the setting up of more processing factories in the district”. Little seems to be known of the facts that in the current situation with cheap coffee flooding to the world markets, coffee may not be one of the easiest and wisest sectors to concentrate on. Special eco-friendly, fair trade coffee growing seems the only real alternative for making the coffee sector in Africa slightly more profitable (Giovannucci and Koekoek, 2003), though the existing less than 300 ha in the Taita hills is probably not worth developing due to marketing problems with too small amounts of produce.

To improve livelihoods farmers would construct a good and big stone house, they would acquire a dairy cow, establish a kiosk or a shop, expand or start poultry, have electricity, acquire more animals, arrange irrigation, buy land, build terraces, start horticulture (for cash) amongst other less frequently mentioned improvements. Some of these are problematic.

Even if 57 % of the farmers dream of being able to establish a shop or a kiosk, it is hard to believe that the enterprise (without any specialisation) would bring any considerable change to their livelihoods. Many of those who have realized this dream find it hard due to insufficient number of customers, though the little businesses they have do clearly work as a buffer when sudden expenditures arise. It is, however, obvious that the purchasing power in the area is not so great. A useful project or an approach of a government support system would be NOT aiming at developing a single sector (e.g. poultry or milk markets), but focus on what supports enterprise development (credit, business skills training, business ideas, technical skills etc.) and what hinders the sector (e.g. licenses, transport).

Another dream problematic under current circumstances is acquiring more animals. Lack of enough fodder has already been mentioned as a serious problem and space would be another limit. Some of the suggestions, however are worth considering and expanding, i.e. dairy cows

together with further processing of dairy products, further expansion of poultry, irrigation especially by rainwater harvesting, and horticulture by a bigger variety of products. Further, cash and subsistence crop possibilities include growing a wider selection of fruit trees, e.g. temperate fruit trees, higher value timber trees, and more drought resistant crops instead of maize in the lowlands. All the agricultural development should go hand in hand with market development and be planned according to marketing opportunities. Mombasa must be behind Nairobi but following in development of a 'middleclass' and supermarket shopping culture, with the requirements for consistent supply of high quality fruit and vegetables. Taita is ideally placed to meet the demand – the coastal environment being not so suitable for much of what is in demand. If Taita horticulture farmers could get together to guarantee consistent quality and supply they could do very well in this sector.

Consequences of the diversity and continued switching between farm enterprises require a dynamic support from the district agricultural officers and projects operating in the Taita hills. They would need to continually expand the range of information and support they give, rather than promoting *the* solution, be it dairy goats, improved maize, fertilizer application, grafted mangos or what ever. The useful approach for the extension service or projects will be to continually increase the options.

More effort would need to be put to solve the serious problems of pests (especially 'Scania' destroying stored maize), animal destruction on cultivations on the lower slopes and compensation schemes to pay for the losses, livestock and poultry diseases, and insufficient fodder supplies farmers have for their livestock especially during prolonged droughts. Monkey and baboon destruction is harder to cope with, but fencing of the National Park boundary immediately bordering villages and homesteads is the only alternative to protect people and crops. Drought was mentioned by half of the farmers as a serious problem and rainwater harvesting should be encouraged and facilitated, and drip irrigation facilitated for increased water productivity. An increasing number of farmers are permanently settled in the dry lowlands and require developed technologies and a larger selection of drought tolerant crop varieties.

One of the main research questions of this survey was to answer the question on the relationship of livelihood capital/assets and desired livelihood outcomes. What livelihood capital or assets are needed in achieving the desired livelihood outcomes?

The linear multivariate regression analysis shows that only Financial capital has clear positive relation (significant at $p=0.01$) with the outcome. But one should notice that the variance

accounted for is very little, 11.0. That means that most of the variation in the outcome index is simply not linearly accounted for by the four livelihood assets.

By analysing each of the six components of the livelihood outcome index separately with the four capitals by the logistic model (1) some associations showed. Those who have introduced animals (usually dairy cows) are more richly endowed with Natural and Financial capital. Association with Natural capital is explained by the correlation of Improved cow (in Natural capital) and Introduced animals (in the outcome index). Introduction of a dairy animal is, however, negatively associated with Social capital, i.e. farmers who have invested in dairy cows are not as likely to be in groups as those who have not introduced animals. Groups – usually considered as the drivers or means of achieving desired livelihood goals – cannot be shown to play a role as social capital feeding to the improved livelihood outcomes, on the contrary membership in groups has a negative association with desired livelihood outcomes. However, one can further speculate whether these farmers were even less well off if they were not in groups. Established business and Financial capital are naturally associated. This is due to the fact the in some cases an established business in the same as off-farm job which is a component in Financial capital. Financial capital is negatively associated with Introduced crops, i.e. those with high scores of Financial capital have not been as often introducing new crops. One explanation to this may be that Financial capital often means having a job which leaves limited time for labour intensive activities like new crop enterprises.

When the analysis was repeated using each separate outcome component with each of the capital components, one could find the following additional associations. Farmers with plots in two ecological zones score higher with number of children in secondary schools. This is explained by the fact that farmers with plots in two ecological zones are often highland farmers. This group of farmers have more children in secondary schools, i.e. there is an indication they may in general educate their children further. As most of the plots bought are in the lowlands and half of the highland farmers have a plot in the lowlands, Bought land is associated with Plots in two ecological zones. Established business correlates with father's off-farm job. Negative correlation of Established business with farmers schooling is odd and may not be real.

The general lack of clear associations between the livelihood capital and the livelihood outcomes can be explained simply that there are many individual livelihood strategies, and (at least in a sample of 51) it is not possible to pull out many general patterns. Some households were found to be far off what could be expected. There are households with no livelihood outcome scores yet they can be reasonably endowed with some of the capitals. There are also some farms with high scores in outcomes yet some of the capitals as 0. Each family has a

unique and changing set of assets and incentives. Even though most of the people living in rural areas consider themselves as farmers, today's rural dwellers livelihoods are increasingly multi-occupational.

One should not disregard the indication given by the analysis that Financial capital may be the most crucial of the different types of capital. The increasing need of cash for farm inputs, school fees, health care, added to the decreasing farm produce is forcing farmers to look for off-farm jobs. Half of the fathers and one fifth of the mothers have an off-farm income source, either permanent or casual. In 37% of the interviewed households either mother or a father has an off-farm job. The shift from agriculture to non-agriculture earning is happening and is going to be more significant in the future. Even if the differences between regions can be significant, survey reviews show that roughly 40% of African rural household income on average is derived from non-farm sources (Livingstone, 1991; Haggblade *et al.*, 1989; Reardon, 1997; Bryceson, 1999; Soini, 2005 b). But the present options for off-farm income are seriously limited. Simply, there are too many businesses of the same type, too much competition in the same field. Recent studies conclude that households that escape poverty over years do so

because they diversify their income sources when a household member obtains a job in the urban formal or informal sector. Other ways out of poverty typically include diversification of on-farm income through cash crop production or livestock, ranging from poultry to dairy animals (Barret *et al.*, 2001a,b; Kristjanson *et al.*, 2004). Increased efforts are needed in the Taita hills to look for an integrated way to create more income generating agricultural options together with providing the rural human potential with marketable skills and a variety alternative and dynamic non-agricultural livelihood options.

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Who we are

The World Agroforestry Centre is the international leader in the science and practice of integrating 'working trees' on small farms and in rural landscapes. We have invigorated the ancient practice of growing trees on farms, using innovative science for development to transform lives and landscapes.

Our vision

Our Vision is an 'Agroforestry Transformation' in the developing world resulting in a massive increase in the use of working trees on working landscapes by smallholder rural households that helps ensure security in food, nutrition, income, health, shelter and energy and a regenerated environment.

Our mission

Our mission is to advance the science and practice of agroforestry to help realize an 'Agroforestry Transformation' throughout the developing world.

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