

Baseline Study of Smallholder Farmers in *Striga* Infested Maize Growing Areas of Eastern Tanzania

AFRICAN AGRICULTURAL TECHNOLOGY FOUNDATION
FONDATION AFRICAINE POUR LES TECHNOLOGIES AGRICOLES

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- Field Extension Workers (FEWs) who conducted the interviews
- Local leaders and farmers who spared their precious time to respond to the interviews

Acronyms and abbreviations

AATF	African Agricultural Technology Foundation
BMI	Body Mass Index
CIMMYT	The International Maize and Wheat Improvement Center
CLA	Composite Liquidity Asset
DALDOs	District Agriculture and Livestock Officers
DEDs	District Executive Directors
DFID	Department for International Development
FAO	Food and Agriculture Organisation
FEWs	Field Extension Workers
FSD	Food Security Department
GPS	Global Positioning System
HIV/AIDS	Human Immuno-deficiency Virus/ Acquired Immune Deficiency Syndrome
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IDRC	International Development Research Centre
IHI	Ill Health Index
IITA	International Institute of Tropical Agriculture
IR	Imazapyr Resistant
ITDG	Information Technology, Transnational Democracy and Gender
NGOs	Non-Governmental Organisations
OPV	Open Pollinated Variety
PAI	Productive Assets Index
SACCAR	Southern Africa Centre for Cooperation in Agricultural Research
SSA	Sub-Saharan Africa
SLF	Sustainable Livelihood Framework
UNDP	United Nations Development Programme

Summary

This report presents findings from a livelihood study of smallholder farmers in *Striga*-infested, maize growing areas of eastern Tanzania using the Sustainable Livelihood Framework (SLF). The report provides baseline indicators against which the progress of future interventions to control *Striga* can be objectively measured.

The study was conducted in five districts, namely Morogoro, Mvomero, Muheza, Mkinga and Handeni. Muheza and Mkinga were merged and considered as one district in this report because secondary agricultural data are still available on the basis of the old Muheza District, which was split into two in 2006. The selection of districts was based on two criteria; maize being among the major crops and *Striga* being a major constraint to maize production. The villages within the districts were then listed based on the importance of maize and high ranking of *Striga* as a major constraint to maize production. This was in collaboration with the District Agricultural Extension Officers. Five villages from each district were then randomly selected and within each sampled village, a census of households was taken and 15 households selected using a table of random numbers for interviews by enumerators. In summary, the study was conducted in five districts involving a total of 20 villages covering a sample size of 301 households.

Data was collected using a structured questionnaire that was administered by trained enumerators who were Field Extension Workers (FEWs) from local District Agricultural Development Department offices. The management of data prior to the analysis was facilitated by the use of CSpro (**C**ensus and **S**urvey **Pro**cessing system) v2.4 software, which ensures that quality is checked. A second quality check was performed using SPSS v11.5. The analysis involved three levels. At the first level, computations which generated secondary variables such as indices and yields were done. At the second level, descriptive analysis offered a general picture of the livelihood situation such as ownership and distribution of livelihood assets, contexts and strategies. At the third level, explorative analysis was conducted to determine the driving factors behind a certain livelihood situation of interest such as wealth status, yield of maize and extent of adoption of improved maize varieties. STATA v9.0, LIMDEP v8.0, SPSS v11.5 and EpiInfo v3.3.2 were the software used for data analysis.

Household characteristics, livelihood assets ownership and distribution

The sample was dominated by male-headed households. This situation is expected in most African societies where men inherit basic resources such as land and livestock. Most land is owned through customary usufruct entitlement, while sharecropped land comprises the smallest proportion. Households in Handeni District had the largest land holdings and those in Morogoro the least. About half of the respondents had an improved toilet, sources of drinking water and roofing material of the main house.

Predominantly, households used firewood as their major source of energy for cooking and, to some extent for lighting, implying poor living standards.

The provision of extension services is dominated by the public sector over private agents and Non-Governmental Organisations (NGOs). About half of the sampled households received extension information related to improved maize varieties compared to other technologies. This finding underscores the intention of the government to promote the use of improved maize varieties to increase productivity.

Very few households kept savings at a bank, an indication of poor accessibility to banks and other micro-finance institutions. Cash remittances formed an important liquidity source, second to cash savings at home. Morogoro households had the highest average liquidity per capita while Muheza/Mkinga had the lowest. Households kept poultry and ruminants, although the average incomes from these stocks were low compared to that from cattle. The overall income per capita was low from marketed products (crops, livestock and natural resources such as wood, charcoal, fish and minerals), and services (business, salaried or professional employment, wage work and traditional healing). Most products and services are produced and consumed at home or given as gifts. Households in Handeni District had the highest overall enterprise income from market participation. Across districts most respondents were involved in religious groups followed by credit and savings associations.

Livelihood contexts and strategies

Context forms the external environment in which livelihoods are obtained. In this study, contexts considered trends in livelihood elements in the past five years, prominent shocks and the incidence of *Striga*. Increased incomes and crop production are two trends that impacted positively the livelihoods of most households compared to other factors. On the other hand, an ageing rural population, illness of household members, low income and low crop production were reported as having negative impacts on household livelihoods

In all districts, food deficits were the main shock which affected almost half of the sampled households in the five years preceding the survey. Morogoro District had the most households which experienced a food deficit while Handeni District had the least proportion of households which experienced this shock. Half of the respondents reported *Striga* infestation in maize plots at different levels of severity. Morogoro rural had the highest percentage of households with *Striga* in their farm plots. Improved maize varieties were reported to have high *Striga* incidence in farmers' fields probably because they are not resistant or tolerant to *Striga*. Crop production was the major occupation upon which the livelihood of the majority depended. Although hybrid maize varieties are cultivated in larger farm plots, most farming households cultivated local maize varieties.

Livelihood outcomes

Households in Mvomero District had more wealth in the form of improved main houses and possession of consumer durables than other districts. As the wealth increased, respondents tended to improve floors, roofing and walls in the main house. These housing attributes differentiated apparently between rich and poor clusters, and were good indicators of wealth status. Contrary to the poor who used primitive sources of energy for cooking and lighting, mostly firewood, the rich used improved sources such as kerosene, gas, solar and electricity. Comparing the gap between the rich and poor groups based on the average wealth index, households in Handeni and Mvomero districts were richer than households in other districts. Most Handeni households in the rich group had a high rate of participation in marketing of their products and services.

The physical productivity of maize was low compared to potential yield hence contributing to food insufficiency probably because local maize was cultivated by the majority of farming households. Stunting (height for age) affected about half of the children under five years old particularly in Mvomero District. Wasting (low weight for age) was more rampant in Mvomero than in other districts surveyed.

Micro-level determinants of livelihoods, maize yield and improved maize cultivation

Econometric estimation indicated that the Productive Assets Index, years of schooling of household head, household size (adjusted to size and composition), number of extension visits, current financial assets (savings at bank, home or pocket, claim on debtors and jewellery), overall income and membership in social groups had a significant positive impact on the livelihood status measured in terms of wealth index. The better position households were with regard to these attributes, the wealthier they tended to be. Correlation analysis indicated that an increase in the number of extension visits and productive assets translated into higher productivity of maize. Seasonality (weather), Ill Health Index and *Striga* infestation in maize plots had a significant negative relationship with maize yield. The extent of adoption of improved maize varieties in terms of allocated area was positively influenced by the number of extension visits, current financial assets, social transfers, overall income and overall maize yield. Increased liquidity from access to current and social transfer financial assets, and farm income would enable farmers to afford farm implements and inputs. Access to extension services would enhance adoption of novel technologies including improved maize varieties.

Chapter 1

Introduction

Background

Striga, commonly known as witchweed, is a genus of 28 species of parasitic plants that occur naturally in parts of Africa and Asia (Kamal et al, 2001). Although most species of *Striga* are not pathogens that affect human agriculture, some species have devastating effects upon crops, particularly those planted by subsistence farmers (Nickrent and Musselman, 2004). Three species cause the most damage: *Striga asiatica, Striga gesnerioides* and *Striga hermonthica. Striga asiatica* has a very wide geographic distribution, from Africa through southern and eastern Asia to Australia. *Striga hermonthica* (purple witchweed) is also a parasite that affects grasses, particularly sorghum and millet, in Sub-Saharan Africa (Wikipedia, 2007).

African farmers today are fighting a losing battle against *Striga*. *Striga* is more than just a weed growing in fields meant to produce food. In addition to draining photosynthate, minerals and water, *Striga* does most of its damage to its host through phytotoxins before the weed emerges from the soil. *Striga* is a parasitic plant that survives by literally sucking nutrients out of the crops that African farmers use to feed their families. *Striga* exacts its toll on crops by inserting a sort of underground hypodermic into the roots of growing plants and siphoning off water and nutrients for its own growth. Above ground, the crop withers, and grain production is reduced (CIMMYT, 2004).

Striga flowers and sheds seed within the life cycle of its host. Seeds are tiny (<0.3mm) and one plant can produce 50,000 – 200,000 of them in a season. At typical infestation densities of 20 plants/m^2, annual increases in the size of the *Striga* seed bank in soil are tremendous. Moreover, unless stimulated to germinate, seeds may remain dormant and viable in the soil for up to 20 years. *Striga* cause most damage to the crop before the weed emerges from the soil. Attachment may occur as early as two weeks after germination of maize, depending on the size of the *Striga* seed bank in the soil and the exudation of germination stimulant by maize roots in the vicinity of *Striga* seeds (Kanampiu et al, 2001).

Extent of *Striga* distribution

Striga in Africa is found from the high plateau of east Africa where peasant farmers struggle to survive on tiny fields of maize, to the arid savannahs of northern Nigeria where they rely on sorghum (Koyama, 2000). Tanzania is ranked by AATF (2006), as one of the most highly infested countries with totals of about 179,000ha of land with *Striga*. The eastern part of Tanzania (Tanga, Morogoro, Coast, Lindi, Mtwara, Ruvuma, Singida and Dodoma) has *S. asiatica* and *S. forbesii* predominating, both of which

parasitise maize (Mbwaga and Massawe 2002). *S. hermonthica* has specialised in the north western Lake Victoria zone (Mara, Kagera, Tabora and Shinyanga) (Mbwaga and Massawe, 2002; AATF, 2006) (Figure 1).

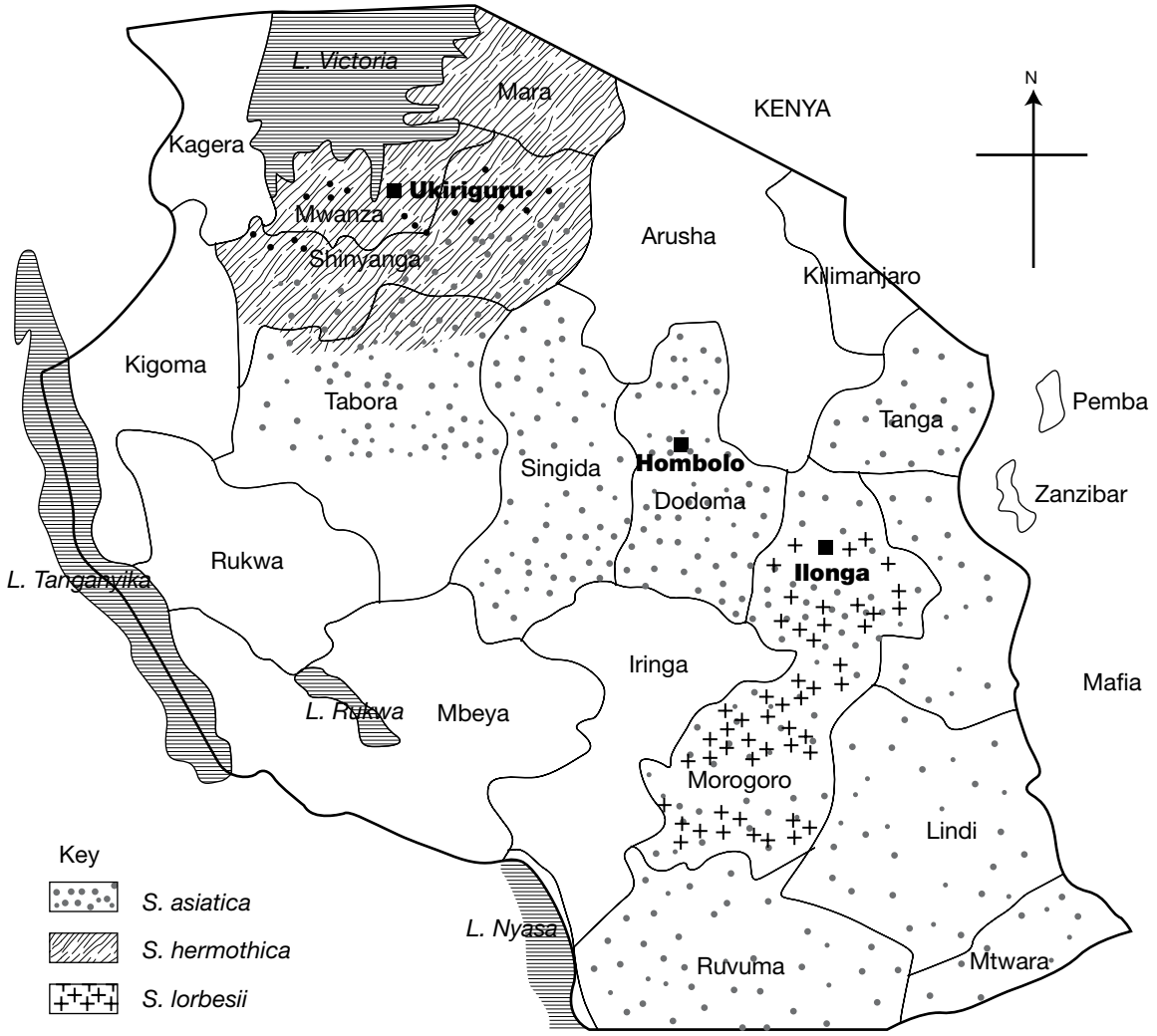

Figure 1: Distribution of Striga *in Tanzania*
Source: Mbwaga et al (2006)

Importance of maize and *Striga*

Maize is the major cereal grown and consumed in all 21 regions of mainland Tanzania. The crop is cultivated on an average of two million hectares (about 45% of the cultivated area), mostly in the Southern Highlands (46%), the Lake Zone, and the Northern Zone (Mafuru et al, 1999). It is estimated that the annual per capita consumption of maize in Tanzania is 112.5kg; national maize consumption is estimated to be three million metric tonnes per year and maize contributes 60% of dietary calories to Tanzanian consumers (FSD, 1992, 1996). The cereal also contributes more than 50% of utilisable protein and is a very important staple food for both the urban and rural citizens (Mafuru et al, 1999).

Despite the importance of the crop, maize yields on farmer fields are only 1.2 metric tonnes per hectare compared to the estimated potential of 4 – 5 metric tonnes per hectare (Mbwaga and Masawe, 2002). It is clear that the relatively poor yield of maize is due to a range of factors; the major ones include declining soil fertility, lack of high yielding maize cultivars, diseases and the *Striga* problem (Mbwaga and Masawe, 2002).

The impacts of *Striga*

Globally, *Striga spp* have a greater negative impact on human welfare than any other parasitic angiosperms because their hosts are subsistence crops in marginal agricultural areas. In general, low soil fertility, nitrogen deficiency, well drained soils and water stress accentuate the severity of *Striga* damage to the hosts. These are the typical environmental conditions for *Striga* hosts in the semi-arid to sub-humid tropics. *Striga* is considered as the greatest single biotic constraint to food production in Africa, where yield losses associated with *Striga* damage often range from 40 – 100% (Bebawi and Farah, 1981; Lagoke et al, 1991; Ejeta et al, 1992).

It is predicted that the grain yield in Africa will increasingly get reduced, especially with the adaptation of *Striga* to crops and to a wider ecological amplitude, allied to a drop in soil fertility in tropical soils (Kroschel, 1998). The significant yield reductions result in little or no food at all for millions of subsistence farmers and consequently aggravate hunger and poverty (Frambach et al, 2002). The witchweeds, *S. hermonthica* and *S. asiatica,* decimate maize and other cereals affecting over 100 million people in Sub-Saharan Africa (SSA) who lose half of their crop to *Striga* infestation (Berner et al, 1995 cited by Kanampiu et al, 2001). As an immediate response to these instant economic effects, farmers take actions that are damaging to the environment and their future well being by migrating from severe to less infested land, abandonment of fields and changing of cropping patterns (Mbwaga et al, 2006).

Each season, infestation by *Striga* becomes worse contributing to the downward spiral of poverty. Yield loss due to *Striga* damage ranges from 20 – 80%; complete yield loss is not uncommon. *Striga* infests an estimated 20 to 40 million hectares of farmland cultivated by poor farmers throughout Sub-Saharan Africa. The tiny seeds are carried in run off water and eroded soil, and contaminate traded seed to infest an ever increasing area (Kanampiu et al, 2001). Every year *Striga* damage to crops accounts for an estimated US$ 7 billion in yield loss in Sub-Saharan Africa and negatively affects the welfare and livelihood of over 100 million people (CIMMYT, 2004).

The objective of this study was to assess the livelihood status, contexts, strategies and outcomes of smallholder farmers in maize growing areas of eastern Tanzania where *Striga* infestation is high. The findings will constitute benchmark indicators that will be used in future to measure progress of any newly introduced *Striga* control technology.

Data generation

Conceptual framework

This study applied the Sustainable Livelihood Framework (SLF) (Figure 2), which has been developed to help understand and analyse the livelihoods of the poor. In addition to improving the understanding of livelihoods, the framework can be used in planning new development activities and assessing the contribution to livelihood sustainability made by existing activities (DFID, 2000). Sustainable livelihoods offer a conceptual framework for understanding causes of poverty, analysing relationships between relevant factors at micro, intermediate and macro levels, and prioritising interventions. The approach explicitly requires going beyond sectoral barriers, to look at more of the context in which people live (DFID, 1997; Carney et al, 1999). There are variations on the SLF, emphasising different aspects. However, there are many common elements. The SLF considers five assets or types of capital namely natural, human, financial, physical and social. It also integrates vulnerability contexts and livelihood strategies.

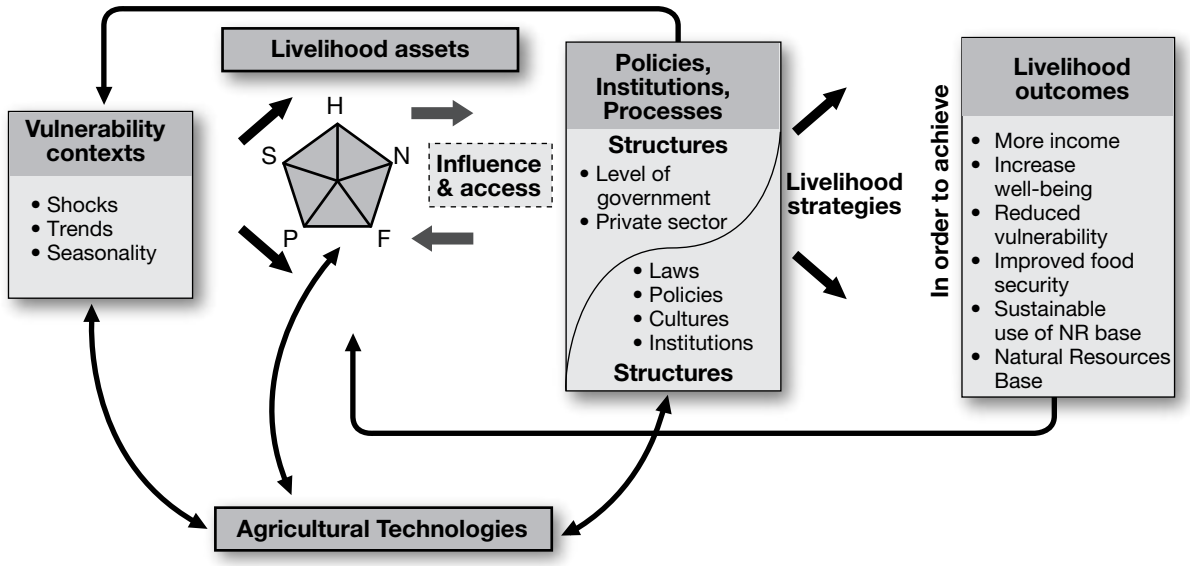

Figure 2: Sustainable Livelihood Framework
Source: Adapted from DFID (2000)

Study area

The baseline study was conducted in four districts of mainland Tanzania where: (1) maize is an important crop, (2) *Striga* is a top ranking constraint, and (3) where plans are underway to deploy a new *Striga* control technology in collaboration with TANSEED, a private seed company contracted by AATF. The districts were Morogoro, Mvomero, Muheza/Mkinga and Handeni (Figure 3). These districts belong to two administrative regions (Morogoro and Tanga). Morogoro District has six divisions and 25 wards which cover an area of about 11,925km^2, of which 8,805km^2 is potentially arable land. Total human population is about 263,920. The district has three agro-ecological zones namely, highland and mountains, miombo woodland, and Savannah River basin line zones.

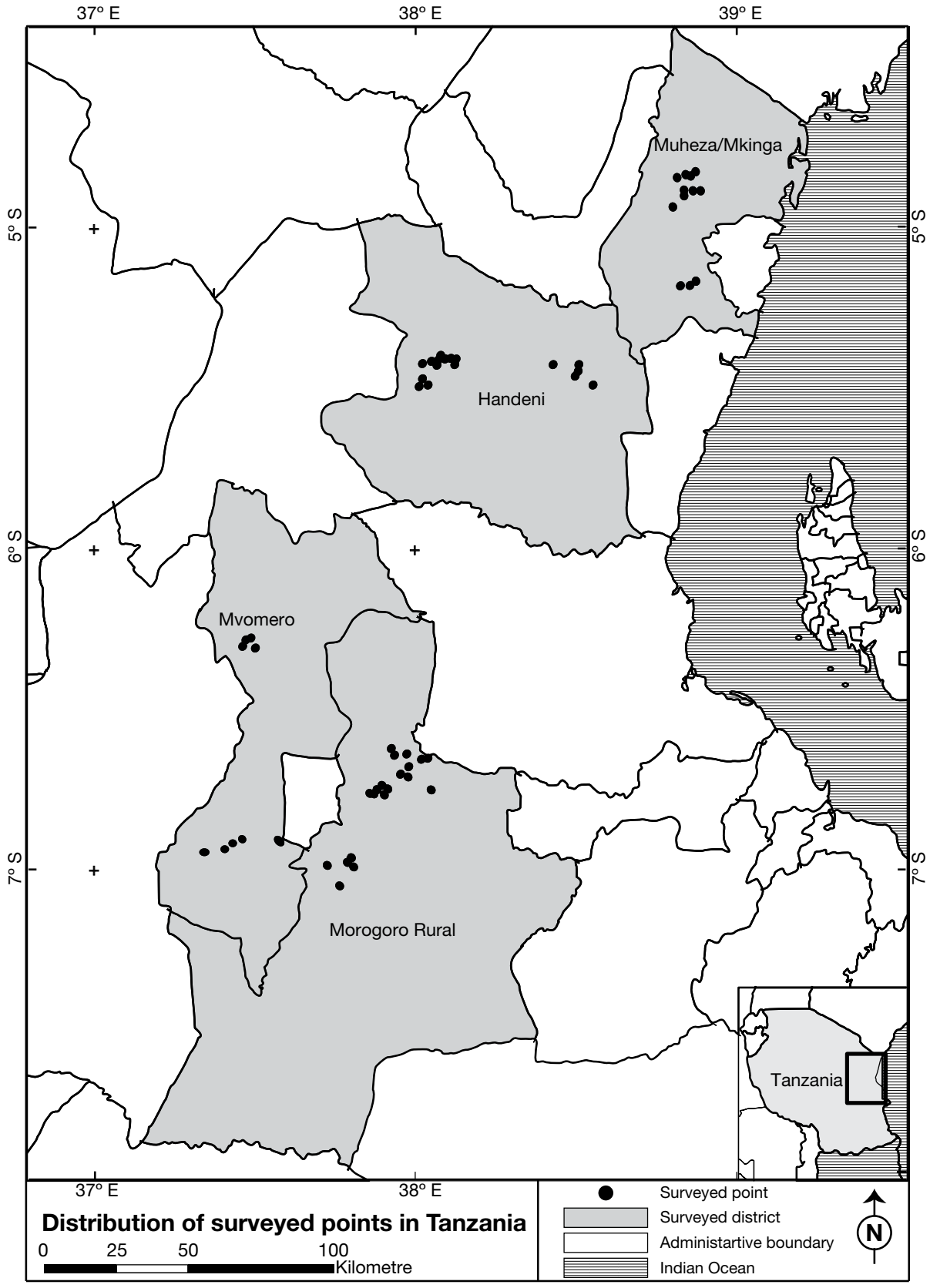

Figure 3: Tanzania: Districts surveyed

Mvomero District has four divisions, 17 wards and 101 villages which cover an area of about 7,325km^2 of which 5,493.75km^2 is potentially arable land with a total human population of about 260,525 (URT, 2002). There are also three agro-ecological zones namely, highland and mountains, miombo woodland, and Savannah River basin line zones (MAFS & C, 2003).

Muheza District comprises four divisions with a total of 23 wards and 100 villages. The total area of the district is 1,974km^2 of which 85% is arable with a total human population of 172,190 people at a population density of 87 people per km^2. Major landscapes in the district are pen plains, mountains and a small area of coastal plains. The landscapes differ markedly in terms of slope gradients, relief intensity and altitude.

Mkinga District comprises two divisions with a total of 12 wards and 75 villages. The total area of the district is 2,947km^2 of which 85% is arable land. It has a total population of 107,232 people at a population density of 36 people per km^2. Major landscapes in the district are pen plains, mountains and a small area of coastal plains. The district has a marked difference within it in rainfall amount and pattern, landform soil types and cultural practice land uses.

In this study, Muheza and Mkinga districts were merged and considered as one single district because they both belong to the single old Muheza District before it was split into two in 2006. By the time this study was conducted, Mkinga District had not become fully operational.

Handeni District has seven divisions and 19 wards, with a population of about 249,572. Geographically it is found south west of the Tanga region covering an area of 7,080km^2 and has around 340,470ha of arable land. However, land which is currently under crop production is estimated to be only 102,530ha (about 30% of arable land). It has a population density of about 35 people per km^2. Major agro-ecological zones found in Handeni are four, undulating plains, medium altitude plains, low altitude plains and Maasai plains. These zones are based on variations in topography climate, soils, vegetation and crop production.

Sampling strategy

Among all the districts in Tanzania which have maize ranked as an important crop and which are also regarded as *Striga* hot spots were purposely selected through consideration of the literature (Mbwaga et al, 2006; Mbwaga and Massawe, 2002) and contact with various key informants who included, but were not exclusive to, *Striga* specialists (Prof P Sibuga, personal communication), District Agriculture and Livestock Development Officers (DALDOs) and a local private seed company, TANSEED (Mr Mashauri, personal communication). The villages within districts were listed based on the importance of maize and high ranking of *Striga* as a major constraint to maize production. This was done with the help of, and in collaboration with, the respective District Agricultural Extension Officers during pre-survey visits and the methodology workshop held between 11 and 14 June 2007 (see section 1.2.4).

Five villages from each district were randomly selected using an inbuilt '*sample [%]*' command in STATA software. Within each sampled village, the village register from the village government office was used to list all the households. In two villages (Misufini-Mvomero and Taula-Handeni) where the information was missing, the trained enumerators developed the household list in collaboration with Village Executive Officers, Trained enumerators used random number tables to select 15 households for interview and another five households for replacement in the case of any household unable to take part in this survey. In summary, the study covered 301 households who belonged to 20 villages, 14 wards, 8 divisions, 4 districts and 2 regions. The decision to use this sample size was due to the limited resources (time and money) available for the study.

Data collection and management

Data was collected by means of structured questionnaires (Annex 1) that were administered with the assistance of Field Extension Workers (FEWs) from local District Agricultural Development Offices trained in a five day methodology workshop organised by IITA before data collection. Training modules included main subjects contained in the questionnaires (demographics, productive resources endowment, productivity costs, family labour and marketing, *Striga* extent, severity and control technologies and vulnerability, capital assets and livelihoods), use of random number tables to select households, anthropometric data collection techniques and use of GPS receivers to collect household coordinates and for measurement of field areas. Data was collected over a period of six weeks starting from late June to early August 2007.

Management of data prior to analysis started by designing data entry forms in CSpro (**C**ensus and **S**urvey **Pro**cessing system) v2.4 software, followed by data entry and quality checks within CSpro. The database was exported to SPSS v11.5 where another quality check was conducted. Five data entry clerks were orientated to the questionnaire and trained on the basic navigations in CSpro preceding data entry.

Data analysis

Sustainable livelihood assessment is intended to generate an understanding of the role and impact of a project in enhancing and securing local people's livelihoods. As such, it relies on a range of data collection methods, a combination of qualitative and quantitative indicators and, to varying degrees, application of a sustainable livelihoods model or framework.

The analysis involved three levels:

- Computations which generated secondary data such as indices and yields. Adjustment of household size to composition and scale economies was done for smooth comparison of wealth-related livelihood variables across households in the study area. The composition and scale effects were widely used for welfare measuring indicators such as income and accumulation of assets. Table 1 shows equivalents that were used to adjust household sizes.

Table 1: Equivalent scales for adjusting aggregate household size

Age category (years)	Sex based adult equivalent scales		Household size*	Economies of scale
	Male	Female		
0 to 2	0.40	0.40	0 to 2	1.000
3 to 4	0.48	0.48	2 to 3	0.946
5 to 6	0.56	0.56	3 to 4	0.897
7 to 8	0.64	0.64	4 to 5	0.851
9 to 10	0.76	0.76	5 to 6	0.807
11 to 12	0.80	0.88	6 to 7	0.778
13 to 14	1.00	1.00	7 to 8	0.757
15 to 18	1.20	1.00	8 to 9	0.741
19 to 59	1.00	0.88	9 to 10	0.729
60+	0.88	0.72	10+	0.719

* Measured in number of age and gender weighted adult equivalent units

Source: Richards et al (2003)

- Descriptive analysis offered a general picture of the livelihood situation in the study area, for example livelihood asset ownership and distribution, contexts and strategies available.
- Explorative analysis was conducted to determine the driving factors behind the current livelihood situation in the study area. Factors affecting wealth at the household level and factors related to yields were determined and their intensity explored. Microsoft Excel and SPSS v11.5 statistical packages were used in computation of the secondary data and descriptive analysis generating result tables and graphs. Stata v9.0 software was employed for Tobit modelling, generation of comparative scatter plots and correlation coefficient analysis. LIMDEP v8.0 and SPSS v11.5 were used for linear regression analysis.

Analysis of livelihood assets

Scoones (1998), identified five assets or types of capital namely natural, human, financial, physical and social. These five forms of capital have different characteristics. People, according to the livelihoods approach, rely for their success on the value of services flowing from the total capital stock. Different households with different access to livelihood assets are affected by the diversity of assets, quantity of assets and balance between assets. It is therefore, worth investigating accessibility, quantity and balance of assets as benchmark information against which progress in the future can be measured from the changes brought about by the deployment of new innovations such as IR maize to control *Striga*.

(a) Natural capital

Natural capital refers to the biophysical elements such as water, air, soil, sunshine, woodlands and minerals. These are naturally occurring assets that are largely renewable. In this study, mean land area size and tenure were analysed and descriptive statistics acquired. These descriptive results were also used to explore other livelihood contexts and outcomes.

(b) Human capital

Human capital is perhaps the most important factor (Chivaura and Mararike, 1998). It is the people who are both the object and subject of development. Since this study was on smallholder farmers, their know-how about agriculture, technology available, sources and levels of accessibility was investigated. Also, the quality of labour was evaluated using Ill Health Index (IHI). Health as an indicator of human capital was conceptualised through a morbidity composite Ill Health Index (IHI). IHI constructs include ten diseases (fever/malaria, dysentery/diarrhoea, respiratory system related disease, measles, typhoid fever, under nutrition, tuberculosis, HIV/AIDS, injurious accident and lifetime disease/disorder). For each disease, a disease intensity index was calculated as follows.

$$IHI_j = \sum_{k=1}^{m}\left[\sum_{i=1}^{n}\left(\frac{d_{ij}}{N_j}\right)\bullet\theta\right]$$

Where:

IHI_j = Ill Health Index of the j^{th} household for diseases $k^{th} = 1 \ldots m$
d_{ij} = number of days the i^{th} member of the j^{th} household suffered from disease k^{th}
N_j = unadjusted size of the j^{th} household
$1 \ldots n$ = members of the j^{th} household suffered from disease k^{th}
$k \ldots m$ = portfolio of diseases inflicted on the j^{th} household
θ = annualisation factor = 1/365.

IHI increases in magnitude with increasing intensity of incidence of diseases among members during a reference period. Therefore, IHI explains the level of ill health or morbidity in the household.

(c) Financial capital

Financial capital is the medium of exchange and, therefore, central to the functioning of a market economy. Its availability is critical to the successful utilisation of the other factors or assets. The main analyses in this section were Composite Liquidity Asset (CLA) index, valuation of non working animals and overall income per capita per annum from marketed products and services. The CLA index consolidates access to a variety of liquid assets, ordinal ranks of their magnitude, and their easiness to raise or realise and spend. These are the most important factors underlying any form of financial or liquid capital in the context of livelihood security. The easiness to realise

and spend explains a situation where not only the amount of money matters but how easily and quickly that money can be raised and spent in case of a financial obligation. The CLA index was further grouped into three categories of financial capital sources, namely current assets (CURFASS), conditional credits (CONDFASS) and social transfers (SOCITRAN). The current assets included cash at bank, cash at home, claim on good debtors and jewels owned. Conditional credit comprised formal and informal sources of credit. Social transfers consisted of remittances in cash and in kind from relatives and friends.

The ordinal ranks by weights in the index, that is not easy, moderate and very easy to raise, were recorded as 1, 2 and 3, respectively. These ranks were averaged to get a source specific rank (r_{ij}). CURFASS, CONDFASS and SOCITRAN share the same mathematical expression of the CLA index as given in the equation below.

$$CLA_{ij} = \sum I_{ij}\left(\frac{R_i}{r_{ij}}\right)$$

Where:

CLA_{ij} = liquidity index for respondents i = 1 ... n and financial capital source j = 1 ... m

I_{ij} = an indicator variable equal to '1' if the respondent i cites to have access to financial source j and '0' otherwise

r_{ij} = the average cardinal rank given to source j among sources cited by respondent i computed by averaging the ranks of the easiness to realise and spend attributes

R_i = number of sources of finance ranked (also equal to accessible sources).

The CLA index assumes a range of numbers from zero to infinity loading both the access to different sources of financial capital and easiness of such access. CLA index increases in line with the number of financial capital sources which the respondent has access to and the easiness of access and spending. Based on the CLA index, descriptive analyses and cross tabulations were produced.

(d) Physical capital

Physical capital refers to man made assets such as productive assets, housing quality and consumer durables. A composite Productive Assets Index (PAI) was developed by combining the number and working status of productive assets. Mathematical expression of PAI is as in the following equation.

$$PAI_i = \sum_{j=1}^{m} n_{ij} W_{ij}$$

Where:

PAI_i = Productive Assets Index of the i^{th} farm

n_{ij} = number of productive asset j^{th} for the i^{th} farmer

j.m = a portfolio of productive assets from j = 1 to j = m
W_{ij} = working status of the j^{th} productive asset for the i^{th} farmer.

PAI is directly related to the stock of productive assets and the working status recorded, 1, 2 and 3 for items not working, working improperly, and working properly respectively. The larger the PAI, the better off the household is in terms of productive assets capability.

The housing quality and other consumer durables were computed to derive the wealth index as described later in this chapter.

(e) Social capital

Social capital according to Coleman (1990), is the productive capital making possible the achievement of certain ends that would not be attained in its absence. In the SLF, social capital entails the social networks and associations to which people belong. In this context, social capital is taken to mean the social resources upon which people draw in seeking to achieve their livelihood outcomes, such as networks and connectedness that increase people's trust and ability to cooperate, or membership of groups and their systems of rules, norms and sanctions. Social capital attributes were analysed descriptively through simple statistics such as means, frequencies and cross tabulations with other variables. Attributes that were analysed descriptively include group belonging in terms of group typology and the level at which sampled populations are involved.

Analysis of vulnerability contexts and livelihood strategies

Under the SLF, people's livelihoods and the wider availability of assets are fundamentally affected by critical trends (such as population trends, resource trends, technology trends, national and international economic trends, shocks (such as human health shocks, natural shocks, economic shocks, conflicts and crop/livestock health shocks), and seasonality (of prices, of production, of health and of employment opportunities). In general, people tend to have limited or no control on the vulnerability contexts. The factors (trends, shocks and seasonality) that make up the vulnerability contexts impact directly on people's asset status and the options open to them in pursuit of beneficial livelihood outcomes. Trends of livelihood and prominent shock incidence in the past five years, *Striga* incidence and extent in maize plots and strategies to mitigate shocks were all analysed and descriptive means and frequencies established.

Analysis of livelihood outcomes

Utilisation of livelihood capital results in livelihood outcomes such as income, food and nutrition security, and reduced vulnerability. From this perspective, income, maize yield per hectare and food and nutrition security (indicated indirectly through women's Body Mass Index and Z-scores for children) and their frequencies and means were calculated. A wealth index was also computed.

Wealth index

The methodology for calculating wealth indices is by aggregating the various asset ownership and housing characteristic variables based on the method of principal components. According to Filmer and Pritchett (1998), household long run wealth is what causes the most common variation in asset variables. The statistical procedure of principal components was used to determine the weights (scoring factors) for an index of the asset variables and household main building characteristics. Principal components is a technique for extracting those few orthogonal linear combinations of the variables that best capture the common information from a large number of variables. The asset variables considered in the analysis were related to main building quality (roofing, wall, floor, toilet and extra house), consumer durables (iron/wooden bed, iron box, sofa, spongy mattress and watch/wall clock), communication means (TV set, cell phone, landline and radio), energy and water source (energy for cooking, energy for lighting and source of water), and transport means (car, motorbike and bicycle) making a total of 20 variables. The assets take the value 1 if the main building quality or energy water sources are improved and the value 0 if otherwise. The consumer durables, communication and transport means also take the value 1 if they are owned and 0 if otherwise.

The result of principal component analysis is an asset index for each household (*Aj*) based on the formula below.

$$Aj = f_1(a_{j1} - a_1)/(s_1) + \ldots + f_N(a_{jN} - a_{jn})/(s_N)$$

Where: f_1 is the eigenvector (scoring factor) for the first asset as determined by the procedure, a_{j1} is the j^{th} household's value (1 or 0) for the first asset, a_1 and s_1 are the mean and standard deviation of value on the first asset variable over all households.

The underlying assumption is that the household long run wealth is what causes the most common variation in asset variables (Filmer and Pritchet, 2001). This seem to be a better approach to assessing wealth compared to existing procedures based on expenditure and consumption data, and hence a better and more convenient indicator of wealth. Filmer and Pritchett (2001), assigned 40% of households to the bottom, 40% to the middle and 20% to the top of the wealth indices. They referred to these clusters as poor, middle and rich respectively. This study had a variation on Filmer and Pritchett's approach as it considered the components that make up at least 50% of variance from the principal components analysis. The sum of all 20 variable asset indices in the given household represented its wealth index.

Body Mass Index

The Body Mass Index (BMI) of mothers and female guardians were computed in EPi Info v3.3.2 software. The BMI is a measure of the nutritional status of adults expressing

health effects of body weight relative to height. A BMI score of between 22 and 24 is considered normal. Below the lower limit, an individual is underweight and possibly malnourished, and above the upper limit, an individual is overweight or obese. In case of being underweight and overweight, individuals have increased relative risk for morbidity and mortality compared to those of 'normal' weight. Mathematically BMI is expressed in the following formula.

$$BMI_i = W_i / H_i^2$$

Where:

BMI_i = Body Mass Index of the i^{th} mother or female guardian
W_i = weight of the i^{th} mother or female guardian
H_i = height of the i^{th} mother or female guardian.

Z-scores

The Z-scores of children under five years were computed directly in EPi Info v3.3.2 software. The Z-score is defined as the difference between the value (weight) for a child and the median value (weight) of the healthy reference population (children of the same age or height), divided by the standard deviation of the reference population. The Z-scores are the most commonly used anthropometric indicator for assessing child nutrition status. It is expressed by the following formula.

$$Z_i = \frac{V_i - M}{S}$$

Where:

Z_i = Z-score value of the i^{th} child
V_i = value (weight) of the i^{th} child
M = median value (weight) of the reference population of the same age or height
S = standard deviation value of the reference population of the same age or height

The Z-scores are on weight for height (wasting), weight for age (underweight), and height for age (stunting). Anthropometric data in SPSS were saved in *dbf* format then transferred into EPI info (Version 3.3.2) for computing the Z-scores. The Z-scores cut-off ranges used for measuring children were: Z>-1.00 for normal, -1.00>Z>-2.00 for mild malnutrition, -2>Z>-3.00 for moderate malnutrition and Z<-3.00 for severe malnutrition. These categories of cut offs were cross tabulated with other household variables.

Determinants of Livelihoods

The livelihood status of households was analysed in two ways. The first was through evaluation of the current status of livelihood assets and the second was through the

establishment of wealth indices for individual households. Wealth indices considered physical characteristics of household dwellings such as walls, floors and roofing materials (improved or not improved), and ownership of consumer durables such as clock/watch, bicycle, radio, television, bicycle and car which depicts accumulation of wealth over time. The Tobit model was applied to studying the factors affecting wealth status. Other analyses included correlation analysis between yields and other socio-economic factors.

Micro-level determinants of wealth

In terms of socio-economic status, wealth is defined in terms of assets; this can be used as an alternative to income or consumption methods (Gwatkin et al, 2000). Asset information was gathered using the questionnaire about the household. The Tobit model was used to analyse the factors affecting wealth indices because of its flexibility allowing it to handle continuous dependent variables. It can be specified as follows.

$$\begin{aligned} Y_t &= X_t\beta + U_t && \text{if } X_t\beta + U_t > 0 \\ &= 0 && \text{if } X_t\beta + U_t \le 0 \\ & && t = 1,2,L\ ,N \end{aligned}$$

Where:

Y_t = wealth index of a given household
X_t = vector of independent variables
β = vector of unknown coefficients
U_t = independently distributed error term assumed to be normal with zero mean and constant variance -2
N = number of observations.

The empirical model to assess the wealth indices was as follows.

$-^0$ = constant
X_1 = AGEHEAD (Household head age in years)
X_2 = PAI (Index aggregating ownership and importance of productive assets)
X_3 = OVATLU (Tropical Livestock Units)
X_4 = NYRESCHED (Education level of household head, in years)
X_5 = HHSZCSE (Adjusted household size)
X_6 = NUMEXVIS (Total number of extension visits in the preceding year)
X_7 = CLA (Composite Asset Liquidity, that is cash at home and bank, claim on debtors and jewellery)
X_8 = BMIMOGUA (Body Mass Index for mothers)
X_9 = OVINCOPC (Overall income per capita from marketed products and services)
X_{10}= SCGRANYM (If at least one household member is involved in social groups)
– = Error term

Hypotheses about underlying factors influencing household wealth (sign for expected relationship with the dependent variable are in brackets) were as follows.

Household head age (+): Aged heads are expected to have accumulated wealth from experience, works, farms managed over years and accumulation of other capital such as social and physical.

Productive Assets Index (+): Ownership of important farm level production assets and their working status should have influence on crop productivity. Fewer assets per household or hectare and in comparatively poor working condition will have negative effects and vice versa.

Total Tropical Livestock Units (+): Ownership of livestock is hypothesised to be positively related to the increase in wealth as they may act as productive assets (that is oxen and manure) and can also serve as sources of household income. The conversion factors for livestock are 0.7, 0.2, 0.1 and 0.01 Tropical Livestock Units (TLU) for each cattle, pig, shot (goat/sheep) and poultry respectively.

Years of schooling (+): Exposure to education should increase a farmer's ability to obtain, process and use information relevant to the adoption of improved technologies and, hence, increase yields and influence wealth.

Adjusted household size (+/–): This adjusts the effect of size and composition of a household. Its effects can be positive or negative.

Number of extension visits (+): Extension visits are expected to introduce more know how to farmers and bring more productivity and market information. More extension visits should make people wealthier.

Composite asset liquidity (+): This is primarily an intermediate form in which income is gained or stored, that is cash at home, cash at bank, claim on good debtors and jewellry. The more assets the person has, the greater the probability of being wealthier.

Body Mass Index (+): The healthier the adult women in the household are, the more quality farm labour is available; therefore, greater farm productivity which can result in greater surpluses translating into more income.

Overall income per capita from marketed goods and services (+): This is a direct contribution to increased wealth. Higher income from market participation is expected to improve wealth status.

At least one member involved in social groups (+): The household with this respondent is likely to earn benefits from social groups which are hypothesised to have an ultimate goal of greater well being.

Relationship between maize yield and socio-economic factors

Factors influencing household maize yield were subjected to non parametric correlation coefficient analysis against factors that were hypothesised to be related to household maize production to see if there were any significant relationships. Assumptions underlying the selection were hypothesised to be influencing maize yields as described hereunder.

Household head age (+/–): Aged heads are expected to have accumulated experience. A farmer's experience can generate or erode confidence (Mafuru et al, 1999). With more experience a farmer can become more or less averse to the risk implied by adopting new technologies and improved agricultural practices. Thus, this variable can have a positive or negative effect on a farmer's decision to adopt yield enhancing technologies.

Years of schooling (+): Exposure to education should increase a farmer's ability to obtain, process, and use information relevant to the adoption of technologies that increase maize yield. Education is thus thought to increase the probability that a farmer will produce high maize yields.

Contact with extension workers (that is number of visits) (+): It is hypothesised that contact with extension workers will increase a farmer's likelihood of adopting improved maize technologies, and thus increase maize yield.

Person days per ha (+): More labour per hectare is hypothesised to be positively related with maize yield because of better care of crops in the fields.

Ill Health Index of household (+): The Ill Health Index (IHI) depicts the effect of each disease incident by capturing the effect of different diseases on the volume and quality of labour available in the household. More ill health is expected to negatively influence maize yield as it weakens the production capacity or deflects it away from farm activities to patient care.

Productive Assets Index (+): Ownership of important farm level production assets and their working status should influence maize yields.

Striga incidence (–): Maize yield is drastically affected by *Striga.* Its presence means little or no maize yields at all.

Overall season quality (+): Better season quality in rain fed agriculture is expected to improve maize yields

Factors determining adoption of improved maize varieties

The Tobit regression model was used to identify important determinants for the likelihood of a farmer cultivating improved maize varieties. The ratio of land with improved maize varieties to total land was considered as a dependent variable. The Tobit model was estimated against a set of micro-level variables hypothesised to increase the probability of a farmer being an improved maize cultivator. The Tobit model used is specified in the equation below.

$$\begin{aligned} Y_t &= X_t\beta + U_t \qquad \text{if } X_t\beta + U_t > 0 \\ &= 0 \qquad\qquad\quad \text{if } X_t\beta + U_t \le 0 \\ & \qquad\qquad\quad t = 1,2,L\ ,N \end{aligned}$$

Where:

Y_t = wealth index of given household
X_t = vector of independent variables
β = vector of unknown coefficients
U_t = independently distributed error term assumed to be normal with zero mean and constant variance –2
N = number of observations.

And:

$-^0$ = constant
X_1 = HHSZCSE
X_2 = NUMEXVIS (Number of extension services received per year)
X_3 = CURRFASS (Current financial assets)
X_4 = CONDFASS (Conditional financial assets)
X_5 = SOCITRAN (Dummy variable for whether farmer is involved in social groups or not)
X_6 = BMIMOGUA (BMI of mothers and guardians)
X_7 = OVINCOPC (Overall income from marketed products and services)
X_8 = OVERMZYD (Overall maize yield)
X_{10}= SCGRANYM (Membership of social groups)
– = Error term

This model was influenced by a number of working hypotheses. It was hypothesised that a farmer's allocation of arable land to an improved maize variety at any time is influenced by the combined (simultaneous) effects of the above variables. These variables were hypothesised to influence the adoption of improved maize varieties as follows.

Household size (+/–): Can be an incentive to produce more to meet the greater needs and hence look for more productive varieties and, also, supply of more labour. On the other hand it can be prohibitive as it may lead to a more impoverished household which is unable to buy improved seeds.

Number of extension visits (+): It is hypothesised that more contact with extension workers will increase a farmer's likelihood of cultivating improved maize varieties.

Current financial assets (+): More assets are expected to be positively associated with the decision to cultivate improved maize varieties since a farmer endowed with these assets can procure seeds and other associated inputs.

Conditional financial assets (+): Possession of more assets is expected to be positively associated with decisions to cultivate improved maize varieties since a farmer endowed with these assets can procure seeds and other associated inputs.

Social transfers (+): More socially transferred assets are expected to be positively associated with the decisions to cultivate improved maize varieties since a farmer endowed with these assets can procure seeds and other associated inputs.

BMI of mothers and guardians (+): This signifies that supply and quality of labour enhances the adoption of improved varieties that are expected to be labour intensive.

Overall income from marketed products and services (+): Market participation is expected to raise farmers income information base and hence accessibility to improved variety information and products.

Overall maize yield (+/–): General high yield from an enterprise can show how dedicated a farmer is to it (hence look for variety and market information). High yield from local varieties can hinder a farmer's need for superior varieties while low yield from local varieties can stimulate a farmer to look for superior varieties.

Membership of social groups (+): Social groups may influence adoption of improved technologies as they are a source of information sharing. Also social groups are targeted by most extension services.

Chapter 2

Characteristics of households and livelihood capital

Characteristics of sampled households

Generally, the whole Tanzanian sample was dominated by male headed households (79%). Handeni District had the most male headed households while Morogoro rural had the most female headed households, this can be due to its proximity to Morogoro municipal where men move to the town for non farm activities. The average age of the household head is quite high (about 50 years) showing that many young people do not practice farming. About 87% of household heads had attended formal schooling before, with Morogoro having the lowest rate of household heads with formal education. (Any reason?) About 15% had vocational training. A large share (84%) of household heads have their major livelihood occupation as crop production while about 5% are also employed or involved in business (Table 2).

The household sizes, in aggregate, were comparatively equal across all districts surveyed (five people), with Handeni District having slightly higher (six people) per household. Economically important components of household size were adjusted to composition and scale effect (gender, age and total number of people) where distribution was comparatively equal at an average of three. The latter is widely used for economic analysis of household size influence on major household dynamics as an individual socio-economic unit.

Livelihood capital

The poor people's capacity to access and manage assets affects their ability to access research outcomes and technologies and convert them into livelihood outcomes. The five livelihood assets that were assessed in the four districts are physical, human, financial and social capital.

Natural capital (land)

This study involved investigation of land in terms of holding size and tenure types. Generally, analysis of total land in acres per household regardless of type of land tenure revealed that Handeni District leads with households possessing on average about nine acres each and those from Morogoro District owning the least, that is about three acres (Table 3). Large land holdings per household explain the availability of one of the main factors of agricultural production; it offers the probability that those having more land are more prone to the adoption of more exotic and novel technologies as compared to those with less land. Land productivity is affected by technology involved in farming and soil fertility (Mafuru, 1999).

Table 2: Characteristics of sampled households

Household characteristics	Name of district				All districts (301)
N (Number of respondents)	Mvomero (75)	Morogoro (74)	Muheza/ Mkinga (77)	Handeni (75)	
Household head					
Male (%)	80.0	74.3	79.2	82.7	79.1
Age of head (years)	47.4 (14.8)	50.6 (16.0)	51.4 (15.29)	51.5 (12.64)	50.2 (14.76)
Years of schooling of head (years)	5.9 (3.12)	5.1 (3.04)	5.27 (2.74)	5.95 (2.61)	5.6 (2.89)
Formal schooling of head (%)					
Attended before	86.7	82.4	85.7	93.3	87.0
Off school training of head (%)					
None	69.3	90.5	67.5	82.7	77.4
Vocational training	17.3	2.7	26.0	12.0	14.6
Short term training	13.3	6.8	6.5	5.3	8.0
Landlessness across districts (%)	17.3	24.3	18.2	5.3	16.3
Major occupation of household head (%)					
Crop production (include others)	86.7	89.2	76.6	82.7	83.7
Household size (number)					
Unadjusted	5.1 (2.28)	5.32 (2.92)	4.91 (2.46)	6.19 (2.84)	5.4 (2.67)
Adjusted	3.2 (0.94)	3.24 (1.10)	3.23 (1.05)	3.65 (1.03)	3.3 (1.04)

All percentages are in respect of row N, presented in brackets is the standard deviation.

Table 3: Mean land holding ownership by district in eastern Tanzania

	Name of district				
	Mvomero	Morogoro	Muheza/Mkinga	Handeni	All
N	75	74	77	75	301
Mean land sizes (acres)	4.1	2.6	4.3	8.9	4.9
Standard deviation	4.2	3.1	5.1	8.6	6.1

Most land is held under usufruct customary tenure (average of 3.96 acres per owner) while sharecropped land is the least form of land holding (average of 0.02 acres) (Table 4). In terms of the most common land ownership type (usufruct customary tenure), Handeni District farmers have the largest land holdings (about 7.91 acres) while Morogoro District farmers have the smallest sized plots (about 1.73 acres).

Table 4: Land holding (in acres) per household and tenure by district in eastern Tanzania

	Type of land tenure						
District	Private titled land	Customary tenure	Rented in land	Sharecropped land	Borrowed land	Gifted land	Rented out land
Mvomero (75)							
Mean	0.45	2.77	0.56	0.04	0.22	0.52	0.31
Std Dev	1.45	3.38	1.86	0.22	0.87	2.00	1.07
Max	6	15	15	1.5	4.5	16	6
Morogoro (74)							
Mean	0.83	1.73	0.27	0.03	0.27	0.01	0
Std Dev	2.56	2.36	0.84	0.14	0.70	0.12	–
Max	15	12	6	1	4	1	–
Muheza/Mkinga (77)							
Mean	0.85	3.44	0	0	0.52	0	0
Std Dev	2.71	4.96	–	–	1.01	–	–
Max	16	30	–	–	4.5	–	–
Handeni (75)							
Mean	0.88	7.91	0.04	0	0.26	0.06	0
Std Dev	3.51	8.15	0.26	–	1.33	0.52	–
Max	25	40	2	–	10	4.5	–
All (301)							
Mean	0.75	3.96	0.22	0.02	0.32	0.15	0.08
Std Dev	2.65	5.69	1.04	0.13	1.01	1.05	0.55
Max	25	40	15	1.5	10	16	6

NB: Number of respondents is presented in brackets in location names

Physical capital

Physical capital comprises the basic infrastructure and producer goods needed to support livelihoods. One of the critical elements of physical capital in agrarian societies is a portfolio of physical tools used in the production process. Such tools were analysed in terms of a Productive Assets Index (PAI). Table 5 shows that Mvomero District had the largest PAI while Morogoro District had the least on the same index. This implies that households in Mvomero had more and better productive farming assets such as hoes, ploughs, axes and machetes. Increase in PAI increases the capacity of farmers to prepare and transform primary factors into potential outputs.

Table 5: Descriptive statistics of Productive Assets Index

Statistics	Name of district				All
	Mvomero	Morogoro	Muheza/Mkinga	Handeni	
N	75	74	77	75	301
Mean	18.6	13.9	15.8	18.4	16.7
Standard Deviation	11.3	7.1	7.7	8.8	9.0
Min	3	2	6	4	2
Max	78	42	42	45	78

N = Number of respondents

Variables describing characteristics of the household dwelling and ownership of certain consumer durables such as clock/watch, bicycle, radio, television and car were used to assess the household physical capital endowment. Table 6 shows the type and quality of dwelling characteristics. It was found that 50% and above of respondents had an improved toilet, source of drinking water and roofing material of the main house only. Other characteristics of the main dwelling such as improved source of light were very low (as low as 7%) meaning most respondents (about 93%) still use unimproved sources of energy for light such as firewood (Table 7).

Table 6: Description of household dwelling characteristics and utility sources

Household dwelling characteristics	Traditional	Improved
Roofing material	Mud/cow dung, leaves/grass	Timber/wood, corrugated iron sheets, cement concrete, tiles, asbestos sheets
Wall material	Mud/cow dung/raw bricks, stones	Burnt bricks, cement blocks, iron/ metal sheets
Floor material	Earth	Cement
Kind of toilet	No toilet (bush), pan/bucket, pit latrine uncovered	Pit latrine covered, own flush toilet, shared flush toilet
Main source of energy for:		
Cooking	Fuel wood, charcoal, crop residues, animal dung	Kerosene, gas, electricity
Lighting	Kerosene, candles, firewood	Gas, electricity, generator, battery
Major source of drinking water	River/lake/stream, unprotected well/spring, borehole, protected well/spring, rain water	Piped in dwelling, piped outside dwelling, vendor/tanker truck, public tap

Table 7: Distribution (%) of improved main house qualities and ownership of durables

Assets and amenities	Name of district				
	Mvomero	Morogoro	Muheza/ Mkinga	Handeni	All
N (Number of respondents)	75	74	77	75	301
Improved housing qualities and durables roofing material–main house	66.7	59.5	28.6	65.3	54.8
Wall material–main house	66.7	31.1	11.7	16.0	31.2
Floor material–main house	36.0	24.3	29.9	32.0	30.6
Toilet mostly used	72.0	73.0	75.3	73.3	73.4
Source of energy for cooking	10.7	17.6	2.6	25.3	14.0
Source of energy for lighting	6.7	0.0	13.0	9.3	7.3
Source of water for drinking	85.3	41.9	59.7	38.7	56.5
Households with:					
Car	1.3	0.0	0.0	0.0	0.3
Motorbike	0.0	1.4	0.0	2.7	1.0
Television set	2.7	0.0	6.5	4.0	3.3
Bicycle	86.7	50.0	64.9	73.3	68.8
Radio	86.7	79.7	76.6	81.3	81.1
Wooden/iron bed	68.0	55.4	66.2	72.0	65.4
Iron box	25.3	21.6	23.4	42.7	28.2
Mobile phone	36.0	24.3	31.2	45.3	34.2
Landline	0.0	0.0	0.0	5.3	1.3
Sofa set	6.7	5.4	13.0	26.7	13.0
Sponge mattress	77.3	39.2	67.5	77.3	65.4
Wall clock/wrist watch	41.3	13.5	24.7	32.0	27.9
More than one house	37.3	28.4	20.8	45.3	32.9

N = Number of respondents

Human capital

Human capital represents the skills, knowledge, ability to labour and good health that together enable people to pursue different livelihood strategies and achieve their livelihood objectives (DFID, 2000). At the household level, it varies according to variables such as household size, skill levels, leadership potential and health status. Human capital appears to be a decisive factor in making use of other types of assets. Therefore, changes in human capital have to be seen not only as isolated effects, but as a supportive factor of the other assets. This study (which was concerned with smallholder farmers) specifically focussed on human capital accrued from agricultural technology. From a broad perspective, public agents were the premier providers of extension services followed by NGOs and private agents respectively (Figure 4). The

percentage of respondents accessing extension services from NGOs and private agents in Muheza/Mkinga District were the same, although few. Only in Handeni District did the private sector extension surpass NGOs in service provision. About half of the total sampled households had received information concerning improved maize varieties. This is due to the fact that maize is the main food and cash crop for the major part of the population (Figure 5).

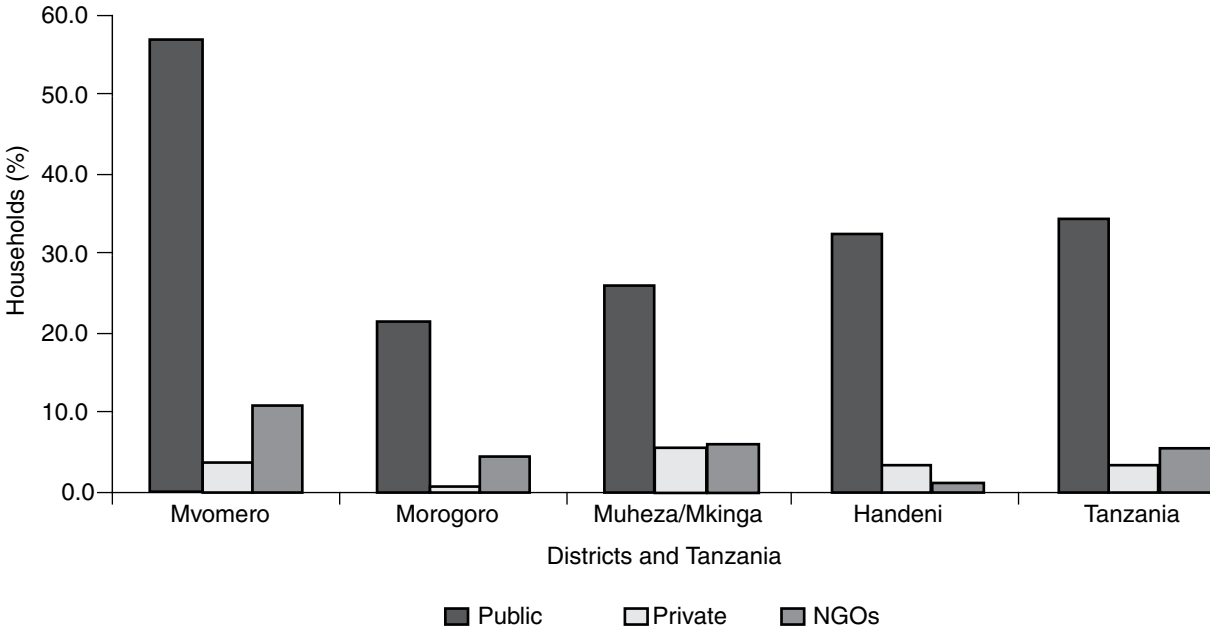

Figure 4: Access to sources of extension services

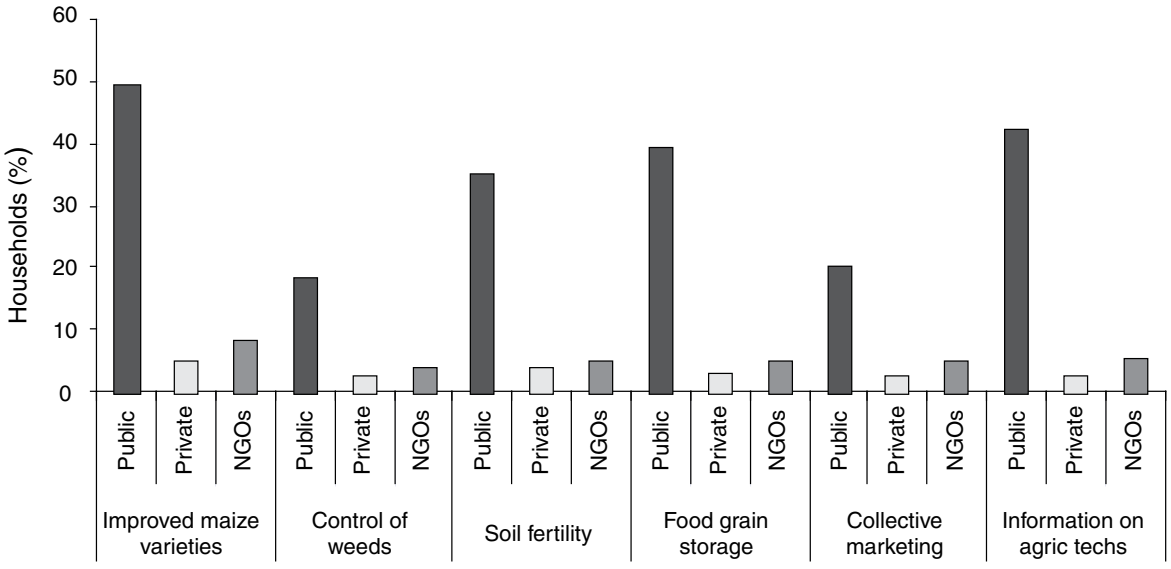

Figure 5: Type of information provided by extension service agents

Financial capital

This denotes the financial resources that people use to achieve their livelihood objectives and comprises the availability of cash or its equivalent that enables people to adopt different livelihood strategies. Among the five categories of livelihood assets, financial capital is probably the most versatile as it can be converted into other types of capital or it can be used for direct achievement of livelihood outcomes (for example purchasing of food to reduce food insecurity). However, it tends to be the asset that is least available to the poor, which makes other capital types important as substitutes. This study included cash from various sources and non working livestock that could be converted quickly into cash.

Most households (66%) had their cash savings at home (Table 8). Most households save their cash in nearby household points probably because of poor accessibility to banks and high volatility of money in a poor country like Tanzania and with only small amounts found in farmers' possession. The second most frequently found type of financial capital was represented by cash remittances. Most farmers rely on their relatives who have other sources of income and can afford to send some cash back to the rural areas.

Table 8: Type of financial capital (% of households)

Financial capital type	Name of district				
	Mvomero (N = 75)	Morogoro (N = 74)	Muheza/Mkinga (N = 77)	Handeni (N = 75)	Total (N = 301)
Cash savings at bank	24.0	4.1	6.5	10.7	11.3
Cash savings at home	89.3	48.6	63.6	61.3	65.8
Claim on good debtors	14.7	8.1	11.7	30.7	16.3
Jewellery	0.0	1.4	2.6	0.0	1.0
Formal credit	13.3	6.8	0.0	4.0	6.0
Informal credit	16.0	33.8	6.5	24.0	19.9
Cash remittances	29.3	21.6	24.7	9.3	21.3
In-kind remittances	29.3	9.5	6.5	1.3	11.6

NB: N represents the sample size for each location and multiple responses make the column total % to exceed 100

In regard to non working livestock, most households keep poultry followed by small ruminants, although the mean value of these stock is small (Table 9). Cattle were the most valuable adult non working animals, contributing to financial assets amounting to an average of TSh 1.0 million per household that owns it. Again, the number of households that own cattle is quite small so very few have access to this form of financial capital.

Table 9: Type, number and mean value (TSh '000) of non working livestock per household

Non working animals	Name of district								All	
	Mvomero		Morogoro		Muheza/Mkinga		Handeni			
	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean
Cattle	2	2,730 (3635)	1	400	9	818 (917)	8	930 (821)	20	1,033 (1284)
Goats	9	212 (235)	5	65(52)	19	167 (204)	39	143 (129)	72	152 (164)
Sheep	1	40	0		0		3	1,190 (85)	4	99 (80)
Pigs	2	287.5 (300)	2	80 (85)	6	458 (384)	4	130 (83)	14	286 (306)
Poultry	62	80 (129)	57	66 (72)	48	42 (52)	48	54 (48)	215	62 (86)
Pets	1	8	0		2	42 (46)	0		3	31 (38)

NB: N are valid cases for corresponding means; the standard deviation is presented in brackets

The other method used to evaluate financial assets was income from marketed products and services from a given household, per capita (Table 10). Besides showing turnover of financial capital, that indicator also shows the level of participation in the market of a given household. This was about US$ 90 per capita per year. This means respondents from the study area are marketing about US$ 0.25 a day per capita of their services and produce. From a district perspective, households in Handeni earned more from market participation, with their services and produce reaching market value add up to about US$ 134 per capita per year. This may be due to greater land accessibility and healthy women (it is assumed that healthy household members means more labour). Morogoro District ranked the least (US$ 31).

Liquidity refers to assets or proceeds that can be turned into cash or serve the same purpose as cash would have done. Liquidity shows the level of vulnerability of a household and its flexibility upon an immediate need for cash. Average liquidity per capita per year in the sample was US$ 100. Morogoro District had the highest liquidity of about US$ 149 followed by Mvomero District (US$ 119). Muheza/Mkinga had the lowest liquidity per household per year (Table 10).

Table 10: Marketed produce income and liquidity per household per capita per year

Marketed income and liquidity (US$)		
(N = 294)	Mean	Std Dev
Overall income per capita	90	133
Overall liquidity per capita per year	100	353
Mvomero District (N = 73)		
Income per capita	103	139
Liquidity per capita per year	119	177
Morogoro District (N = 70)		
Income per capita	31	49
Liquidity per capita per year	149	679
Muheza/Mkinga District (N = 76)		
Income per capita	86	153
Liquidity per capita per year	54	91
Handeni District (N=75)		
Income/capita	134	140
Liquidity per capita per year	84	141

NB: N = Number of respondents; US$ 1= TSh 1,250 in June 2007

Social capital

This is shared knowledge, understandings, norms and expectations about patterns of interactions that groups of individuals bring to a recurrent activity. Relations of trust, reciprocity and exchanges, common rules, norms and sanctions, connectedness, networks and groups are often indicated as important mechanisms for building social capital assets. About 11.3% of respondents where involved in religious social groups marking the highest level, with most coming from Handeni District (Table 11). This was followed by credit and savings social groups. The groups that had lowest respondents were those concerned with informal insurance and HIV/AIDS. Religious groups were likely to be bigger and stronger due to the fact that the glue between their members is faith based and almost everybody, regardless of condition or status, can join by believing what others do. The participation in credit and savings groups was probably because of an intense campaign by government, donors and NGOs since 2001 when the national micro–finance policy was approved in which smallholder farmers and youth are encouraged to join forces and form their own capital bases (Randhawa and Gallardo, 2003). In the case of HIV/AIDS, lower levels of incidence and worries of being outcast from other people may be the reason for extremely low responses for this group (about 1.7%).

Table 11: Households (%) involved in social groups

	Name of district				
Social group type	Mvomero (N = 75)	Morogoro (N = 74)	Muheza/Mkinga (N = 77)	Handeni (N = 75)	Total (N = 301)
Community development	6.7	4.1	1.3	10.4	5.6
Cooperative	5.3	0.0	13.0	2.6	5.3
Religious	8.0	5.4	5.2	26.0	11.3
Credit and savings	17.3	2.7	10.4	10.4	10.3
Informal insurance	0.0	0.0	2.6	3.9	1.7
Women	10.7	6.8	1.3	2.6	5.3
HIV/AIDS	1.3	4.1	1.3	0.0	1.7
Irrigation groups	1.3	0.0	0.0	0.0	0.3

NB: Number in brackets represents sample size for each district

Chapter 3

Livelihood contexts and strategies

Context is the external environment in which people exist and gain importance through direct impacts upon the status of their assets (Devereux, 2001). It comprises trends (that is demographic trends, resource trends and trends in governance), shocks (that is human, livestock or crop health shocks, natural hazards like floods or earthquakes, economic shocks and conflicts in form of national or international wars), and seasonality (of prices, products or employment opportunities) and represents the part of the framework that lies furthest outside stakeholder control. Not all trends and seasonality can be considered as negative; they can move in favourable directions, too. For example trends in new technologies or seasonality of prices could be used as opportunities to secure livelihoods. This study only considered trends in livelihoods in the past five years, prominent shocks and the incidence of *Striga*.

Livelihood contexts

Trends in livelihoods in the past five years

Increase in crop production was the prominent feature of livelihood trends in the past five years in the study area (Table 12). Increase in income was second. Morogoro had most households (27%) with improved livelihoods due to increased crop production. Muheza/Mkinga was the most stricken district with income falling (26%) despite crop production increasing by 14.3%. Trends in *Striga* infestation seem to have impacted negatively on the livelihoods of respondents mostly from Mvomero and Handeni districts. Increases in crop production may, or may not, translate into an income increment. In this regard, trends in income (increase or decrease) translate into the livelihood status of the individuals in question and, hence, it is an important factor affecting livelihood status.

Prominent shocks in the past five years

Shocks like changes in human or animal health, natural disasters, sudden economic changes or conflicts were investigated. The most common shock was food deficit which almost half of the households had experienced in the past five years (Table 13). Illness and famine (17% each) were also recorded. Morogoro District had the most respondents reporting food deficit. Handeni District reported the least incidence of food deficit which is reflected in the BMI evaluation (most women had normal or overweight indices) despite a higher incidence of illness.

Table 12: Trends that lead to given livelihood status at the time of data collection

Trends leading to ill/improved livelihood status (for past five years)	Name of district				All
	Mvome-ro	Morogoro	Muheza/Mkinga	Handeni	
N	75	74	77	75	301
Ill status (% of households)					
Old age/illness	2.7	8.1	16.9	4.0	8.0
Low income	4.0	4.1	26.0	9.3	11.0
Decreased crop production	9.3	12.2	6.5	5.3	8.3
Pests	6.7	0.0	0.0	0.0	2.0
Insufficient rain/drought	2.7	1.4	0.0	5.3	2.3
Lack of capital/poor farm implements	5.3	1.4	1.3	6.7	3.7
Striga infestation	4.0	0.0	3.9	0.0	2.0
Poor farming techniques, eg inferior seed varieties	1.3	1.4	1.3	4.0	2.0
Improved status (% of households)					
Increased income	17.3	16.2	5.2	13.3	13.0
Increased crop production	6.7	27.0	14.3	8.0	14.0
Enough rainfall	4.0	6.8	1.3	2.7	3.3
Good health/hardworking	6.7	9.5	0.0	6.7	5.6
Adoption of agricultural novel technology, eg improved seed	4.0	0.0	2.6	1.3	2.0
Food sufficiency	1.3	0.0	0.0	6.7	2.0
Enterprise diversification, eg business, food, water selling	5.3	1.4	1.3	10.7	4.7

N = Number of respondents

Striga incidence and extent in different maize plots

Generally, about 40% of respondents reported *Striga* infestation in local maize (monocrop) plots at different levels of severity (Table 14). In overall terms, the range was between mild and severe infestation. Morogoro had the highest percentage of respondents (64%) reporting mild to severe *Striga* in their monocropped local maize farm plots. *Striga* infestation was perceived high in OPV monocrop maize probably because existing improved varieties are not resistant or tolerant to *Striga*. Also, *Striga* infestation was found to be high in intercropped local maize. Only hybrid maize showed low *Striga* infestation although the number of observations was small.

Table 13: Nature of shocks (% of households)

Nature of shocks	Name of district				
	Mvomero (75)	Morogoro (74)	Muheza/Mkinga (77)	Handeni (75)	All (301)
Food deficit	52.0	60.8	50.6	18.7	45.5
Famine	21.3	23.0	9.1	13.3	16.6
Loss of property	0.0	2.7	6.5	5.3	3.7
Illness	17.3	6.8	18.2	26.7	17.3
Death of important member	6.7	4.1	6.5	16.0	8.3
Loss of animals	2.7	0.0	0.0	6.7	2.3

NB: Numbers in brackets represent sample size for each district

Table 14: *Striga* extent and perceived incidences in different maize plots (% of plots)

Maize enterprise	Extent of *Striga*	Name of district				Total
		Mvomero	Morogoro	Muheza/Mkinga	Handeni	
Local maize, sole N		14	36	66	55	171
	Not infested	64.3	36.1	51.5	87.3	60.8
	Mild	7.1	22.2	27.3	10.9	19.3
	Severe	28.6	41.7	21.2	1.8	19.9
Hybrid maize, sole N			1		6	7
	Not infested		0		100	85.7
	Severe		100		0	14.3
OPV maize, sole N		51	9	3	17	80
	Not infested	33.3	22.2	100.0	100.0	48.8
	Mild	51.0	33.3			36.3
	Severe	15.7	44.4			15.0
Local maize, intercropped N		5	26	9		40
	Not infested	80.0	23.1	33.3		32.5
	Mild	20.0	50.0	44.4		45.0
	Severe	0.0	26.9	22.2		22.5

NB: N is the valid number of plots

Livelihood strategies

These are choices that respondents employ in their pursuit of income, security, well being, and other productive and reproductive goals. In the livelihood strategies approach, it is recognised that households and even individuals may pursue multiple strategies, either sequentially or often simultaneously. In this analysis only the major strategy was considered. Crop production remains the dominant livelihood strategy of most households (85%) followed by livestock keeping (Table 15).

Table 15: Livelihood strategies (% of households)

Livelihood strategy/enterprise	Name of district				
	Mvomero (75)	Morogoro (74)	Muheza/Mkinga (77)	Handeni (75)	All (301)
Crop production	86.7	89.2	80.5	85.3	85.4
Livestock	2.7		1.3	1.3	1.3
Business	2.7	4.1	7.8	8.0	5.6
Employment	2.7	1.4	5.2	1.3	2.7
Wage work	1.3	1.4	3.9	1.3	2.0
Technician	1.3	2.7			0.3
Artisan/handcraft	2.7		1.3		1.7
Natural resources		1.4		2.7	1.0

NB: Numbers in brackets refer to number of respondents

Area under maize production

Because the major livelihood strategy was crop production and maize the major crop, the area cultivated to maize was determined. About 60% of households monocrop local maize and a plot has an average size of about 2.94 acres (Table 16). Monocropped hybrid maize occupied the largest share of land (3.57 acres per cultivator) although cultivated by few households. Local maize intercropped had the least area under maize production (1.8 acres).

Table 16: Area (acres) with maize and sample involved

Maize enterprise	Name of district								All	
	Mvomero		Morogoro		Muheza/Mkinga		Handeni			
	N	Mean (Std)	N	Mean (Std)	N	Mean (Std)	N	Mean (Std)	N	Mean (Std)
Local maize, sole	14	2.10(2.56)	36	1.84(1.39)	68	2.24(1.15)	55	4.73(2.93)	173	2.94(2.37)
Hybrid maize, sole	0	–	1	1.5	0	-	6	3.92(2.73)	7	3.57(2.65)
OPV maize, sole	51	2.31(1.05)	9	2.83(1.70)	3	3.33(1.15)	17	3.69(2.05)	80	2.7(1.48)
Local maize, intercropped	5	2.60(1.47)	25	1.55(1.18)	10	2.03(0.95)	0	–	40	1.8(1.19)
OPV maize, intercropped	7	1.79(1.29)	1	2	1	2	0	–	9	1.83(1.12)

Standard deviation is presented in brackets and N refers to the number of valid cases

Chapter 4

Livelihood outcomes

Livelihood outcomes encompass many types of livelihood strategies or agricultural technologies which impact differently on poverty. Potential outcomes include conventional indicators such as income, food security and sustainable use of natural resources. Outcomes can also include strengthening of the asset base, reduced vulnerability, and other aspects of well being such as health, self esteem, sense of control, and even maintenance of cultural assets and, thus, have a feedback effect on the vulnerability status and asset base. Three indicators were investigated under this study wealth status, maize yield and food security.

Wealth status

The principal components of the analysis on the 20 asset variables resulted in the retention of six components that explain more than 50% of variation (Annex 2). The wealth index for each household was calculated from the summation of the loading scores of the retained components. The overall average index was 4.5. Mvomero District had the highest among the surveyed districts while Morogoro scored the least (Figure 6).

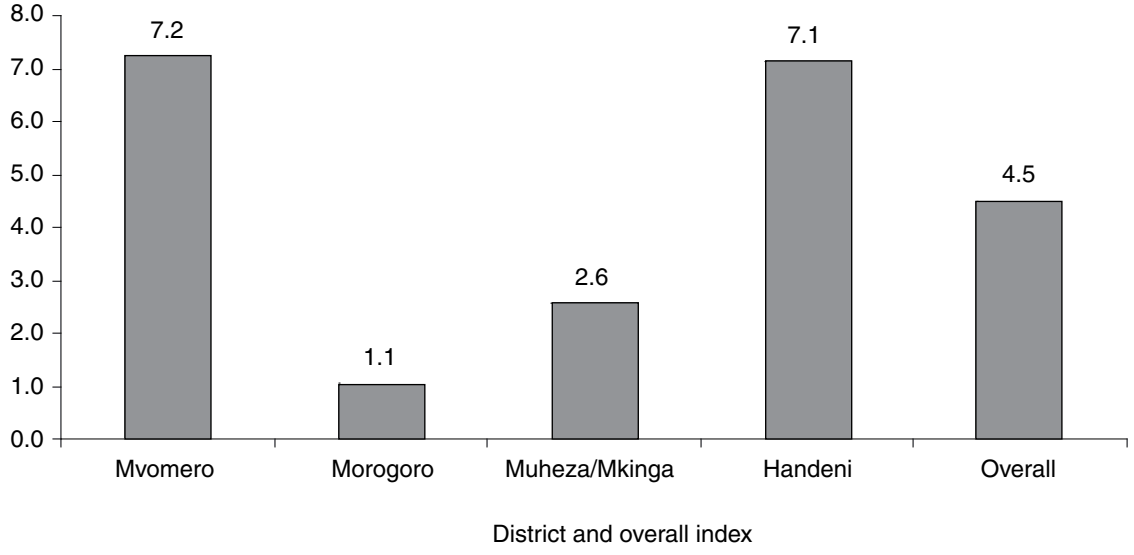

Figure 6: Average wealth indices for each cluster in districts

This information means that, all other things being equal, households in Mvomero District had improved main buildings and possessed more consumer durables which explain their accumulated long run household wealth compared to other district households. Following the Filmer and Pritchett (2001), clustering of households in descending order, ranking of the wealth indices, first 20% are comparatively rich, the next 40% are middle and those at the bottom are regarded as poor. Figure 7 shows

how wealth indices are distributed within these clusters for each district and among them all. Handeni District had the widest gap between the rich and poor groups (29.7), while Morogoro had the narrowest gap (20.3).

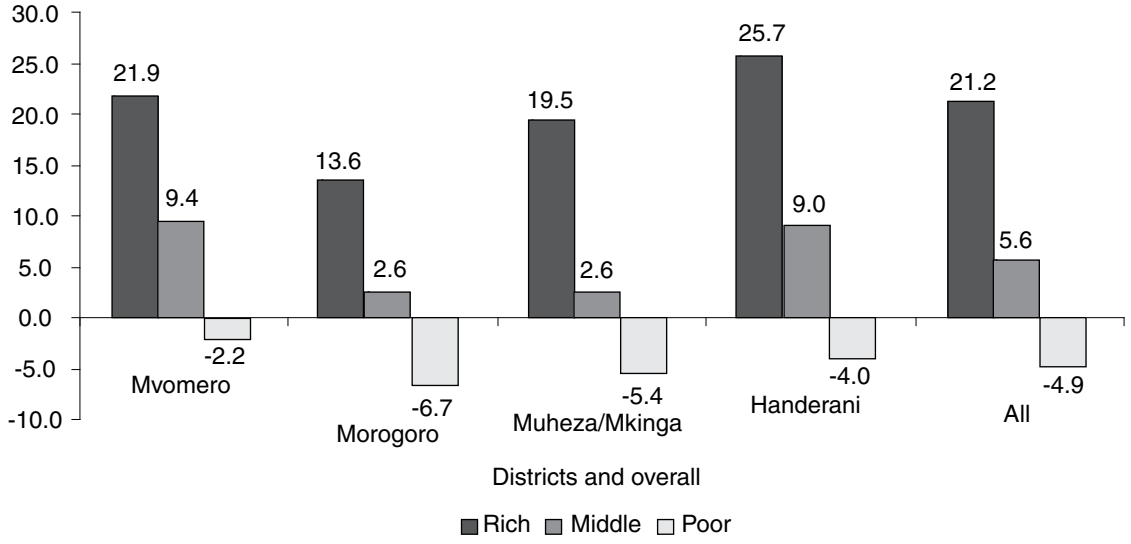

Figure 7: Wealth indices for different classes in surveyed area

The possession of assets and characteristics of differentiation between the rich and poor classes appears in Figure 8. The interpretation of bars in Figure 8 is as follows. For a given asset, there are three bars. The larger the bar at the top on the y axis (on a scale of 0 to 1), the more the household possesses of that asset and the larger the bar beneath the y axis, the less the household possesses the asset. The third bar between the two above gives their average. Its size and location along the y axis are influenced by the first two bars. The assets that were used to compute the wealth indices (improved or not) were subjected to graphical cluster analysis. Five asset groups were used for the purpose of comparison between the rich and the poor: housing quality (roofing, wall, number of houses, floor and toilet type), consumer durables (bed, iron box, sofa, mattress and watch), communication assets (TV set, cell phone, landline and radio), source of energy (lighting and cooking) and drinking water source. Possession of improved floor, roofing and walls in the main house was a notable difference between the rich and poor clusters (Figure 8a). This means that in the study area, floor and roofing materials (improved or not) are a good indicator of wealth status. Possession of a toilet is not such a distinguishing feature between the poor and rich, probably because of the heavy government campaigns on promoting a toilet per house in Tanzania which was made a legal requirement. Ownership of utility assets was very important in distinguishing between the poor and the rich: possession of an iron box, bed, sofa set, mattress and TV set were characteristic of the majority in the rich cluster and conversely in the impoverished cluster (Figures 8b, 8c). Basic utilities like the source of energy for cooking and light also distinguish these two clusters. The rich have improved sources of energy for lighting while the poor do not (Figure 8d). Water sources were almost the same for these clusters and hence cannot be used to distinguish them. Also the means of transportation cannot differentiate between the two clusters because both groups use bicycles, have no car and have no motorcycle (Figure 8e).

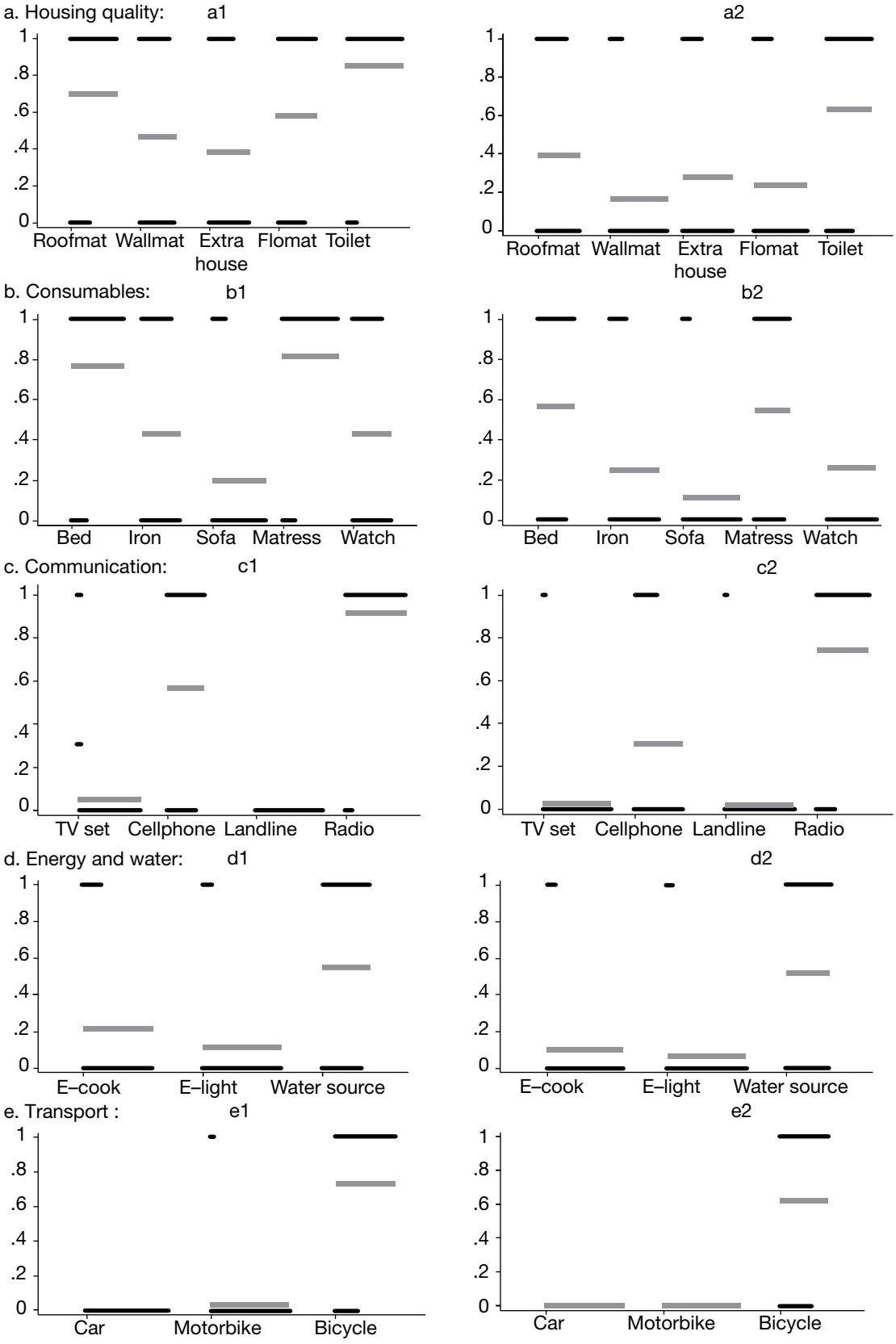

Figure 8: Housing and asset ownership between the poor (left graphs, 1s) and the rich (right graphs, 2s)

Anthropometric indices of vulnerable groups

Z-scores for children

Z-scores and associated standard deviation units are commonly used anthropometric indicators for assessing the status of child nutrition. This has a direct correlation with immediate and long term food insecurity in the household. To assess food and nutrition status, this study collected data on children of age five years and below. Results of the analysis showed that stunting (height for age) was a problem in about 40% of children involved in the survey (Table 17). Mvomero recorded the largest proportion (50%) of severely stunted children. Wasting (weight for age) was also more rampant in Mvomero than in other districts surveyed. Despite registering the highest maize yield per hectare and highest income per capita, Mvomero seems not to have been able to fight long term malnutrition. It can be assumed that since this study was cross sectional, the stunting status of children could be a consequence of droughts and erratic rainfall that were recorded as a major cause of poor livelihoods in the past five years in that district.

Body Mass Index for women

The health status of mothers and female guardians was assessed using Body Mass Index (BMI). This helps in identifying the nutritional status of farm workers in the sense that women are said to provide more labour to the farm plots than men. Therefore, households with nutritionally sick women are likely to have less labour resulting in lower farm productivity. Handeni had the most overweight or obese women (45% of total women found in interviewed households) and the lowest proportion of underweight (about 5%). Muheza/Mkinga had the largest proportion of underweight women whose households were interviewed (11%). Generally, adult women found in respondents households were overweight and underweight (34% and 33% respectively). Only 32.5% had normal weight (Table 18).

Food insecurity

Food insecurity was observed as one of the main shocks in the study area, reported by about 46% of the respondents. As an outcome, the study tried to investigate its sources as presented in Table 19. Low crop production was found prominent (24%) as a source of food insecurity followed by drought/inadequate rainfall (17%). Only 2.7% of respondents reported *Striga* infestation as the major source of food insecurity in their households.

Physical productivity and economic profitability of maize enterprise

Maize seed procurement

Figure 9 shows that only a quarter or less of farming households procured local maize seed from the market. In the case of improved maize varieties, significant proportions

Table 17: Z-score categories for children under five years old

Z-score categories	Name of district				
	Mvomero	Morogoro	Muheza/Mkinga	Handeni	All
Weight for height	(N = 35)	(N = 37)	(N = 16)	(N = 43)	(N = 131)
Normal	77.1	75.7	93.8	95.3	84.7
Mild malnutrition	8.6	16.2	0.0	2.3	7.6
Moderate malnutrition	2.9	5.4	0.0	0.0	2.3
Severe malnutrition	11.4	2.7	6.3	2.3	5.3
Weight for age	(N = 42)	(N = 37)	(N = 23)	(N = 43)	(N = 145)
Normal	61.9	67.6	52.2	74.4	65.5
Mild malnutrition	19.0	8.1	30.4	18.6	17.9
Moderate malnutrition	7.1	16.2	8.7	0.0	7.6
Severe malnutrition	11.9	8.1	8.7	7.0	9.0
Height for age	(N = 34)	(N = 37)	(N = 16)	(N = 43)	(N = 130)
Normal	26.5	29.7	31.3	27.9	28.5
Mild malnutrition	14.7	35.1	25.0	18.6	23.1
Moderate malnutrition	8.8	10.8	6.3	7.0	8.5
Severe malnutrition	50.0	24.3	37.5	46.5	40.0

N in brackets represents valid cases

Table 18: Women's nutritional status in surveyed households

	Name of district				
Nutritional status	Handeni	Muheza/Mkinga	Morogoro	Mvomero	All
N	75	72	68	71	286
Underweight (BMI below 22) (%)	18.7	44.4	42.6	28.2	33.2
Normal (BMI between 22 and 24) (%)	36.0	33.3	29.4	31.0	32.5
Overweight/obese (BMI above 24) (%)	45.3	22.2	27.9	40.8	34.3

N = Number of respondents

of households procured improved maize seed from the market. However, still notable proportions of farming households, particularly in Morogoro rural and Mvomero districts, recycled improved maize seed. This has many implications, for example the recycling of improved seed makes the performance of the crop to gradually decline thus leading to low yields. In addition to this, the promotion of improved seed via input markets will receive stiff competition from home based recycling of seed. It is

Table 19: Major sources of food insecurity (% of households)

Major source of food insecurity	Name of district				All
	Mvomero	Morogoro	Muheza/Mkinga	Handeni	
	(N = 75)	(N = 71)	(N = 75)	(N = 75)	(N = 296)
Soil infertility	0.0	8.5	2.7	5.3	4.1
Stalk borer	0.0	2.8	4.0	0.0	1.7
Low family income	1.3	15.5	6.7	8.0	7.8
Poor farming implements	2.7	1.4	1.3	2.7	2.0
Low crop production	20.0	32.4	32.0	12.0	24.0
Storage pests infestation	8.0	9.9	2.7	0.0	5.1
Vermin	1.3	9.9	4.0	0.0	3.7
Theft from the field	1.3	0.0	1.3	1.3	1.0
Land shortage	5.3	4.2	1.3	0.0	2.7
Poor farm management	4.0	0.0	0.0	4.0	2.0
Drought	18.7	1.4	18.7	30.7	17.6
Poor and erratic rainfall	21.3	2.8	0.0	4.0	7.1
Pest infestation	1.3	0.0	2.7	25.3	7.4
Floods	0.0	0.0	6.7	0.0	1.7
Striga infestation	4.0	5.6	1.3	0.0	2.7
Rodents	0.0	0.0	9.3	1.3	2.7
Illness	2.7	0.0	2.7	1.3	1.7
Low capital/high input cost	4.0	0.0	0.0	0.0	1.0

N = Number of respondents

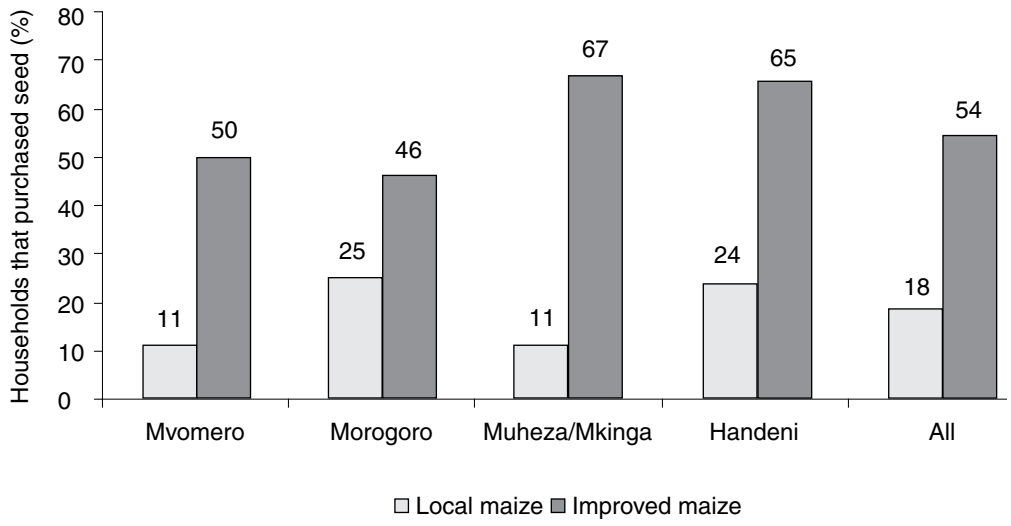

Figure 9: Procurement of maize input seed from the market by districts

therefore critical that for any new *Striga* control technology (for example IR maize technology) to be more widely adopted, it must involve coating of OPVs as they can be recycled unlike hybrid seed that a farmer needs to buy every new season. This is probably because most small scale farmers are poor and cannot afford to buy seed every other season.

Maize yields with levels of *Striga* infestation

As of now in Tanzania there are no maize cultivars available to farmers which have been bred to effectively resist the detrimental effect of *Striga* on yield. Hypothetically, improved maize varieties, in this case OPVs and hybrids, stand a better chance of offsetting enormous yield drops associated with *Striga* infestation compared to local varieties which are already low-yielding. This hypothesis holds under *ceteris paribus* for other factors like field and crop management practices. To test this hypothesis, yields obtained from local and improved maize varieties with and without differing severity of *Striga* infestation in the study areas were compared. Here the concept of infestation severity is based on farmer perceptions that were probed during interviews based on common themes. These themes included aspects like the percentage of the field infested, density of *Striga* relative to other weeds and number of *Striga* shoots per host plant. In perceiving the level of infestation severity, that is mild or severe, a reduced yield criterion was not favoured in investigating as yield is a multifactoral outcome that cannot be confidently attributed only to *Striga*.

Figure 10 shows that improved maize varieties gave higher yields compared to local maize varieties in case of no *Striga* across districts. With mild infestation of *Striga,* improved maize varieties still performed relatively better than local varieties. In Mvomero District, with severe *Striga* infestation, the yield of maize was about the same for both local and improved varieties. Mvomero District has some hot spots such as Melela where *Striga* decimates maize productivity. In Morogoro District, improved maize varieties gave higher yields compared to local varieties under severe *Striga* infestation. In Muheza/Mkinga and Handeni districts, a comparison between local and improved varieties was impossible as no household grew improved maize in *Striga* infested plots. Conclusively, adoption of improved over local maize varieties would reduce the negative impact that a farmer would suffer in terms of yield reduction as a result of *Striga* infestation. This means that a package of improved variety and effective *Striga* control technologies such as IR maize is promising.

Maize returns to land

The economic returns to land expressed as gross margins per unit of land underscore the profitability of the maize enterprise, hence the potential for income generation. The results shown in Table 20 indicate that returns to land from an improved maize variety exceeded that from local maize varieties in all districts except Mvomero. Given that in Mvomero improved maize recorded high yields compared to local maize (see Figure

10), lower returns from the former could result from differences in output prices and costs of production among farmers. Generally, increased adoption of improved maize would improve crop income given other factors such as better output prices and lower costs of inputs associated with maize.

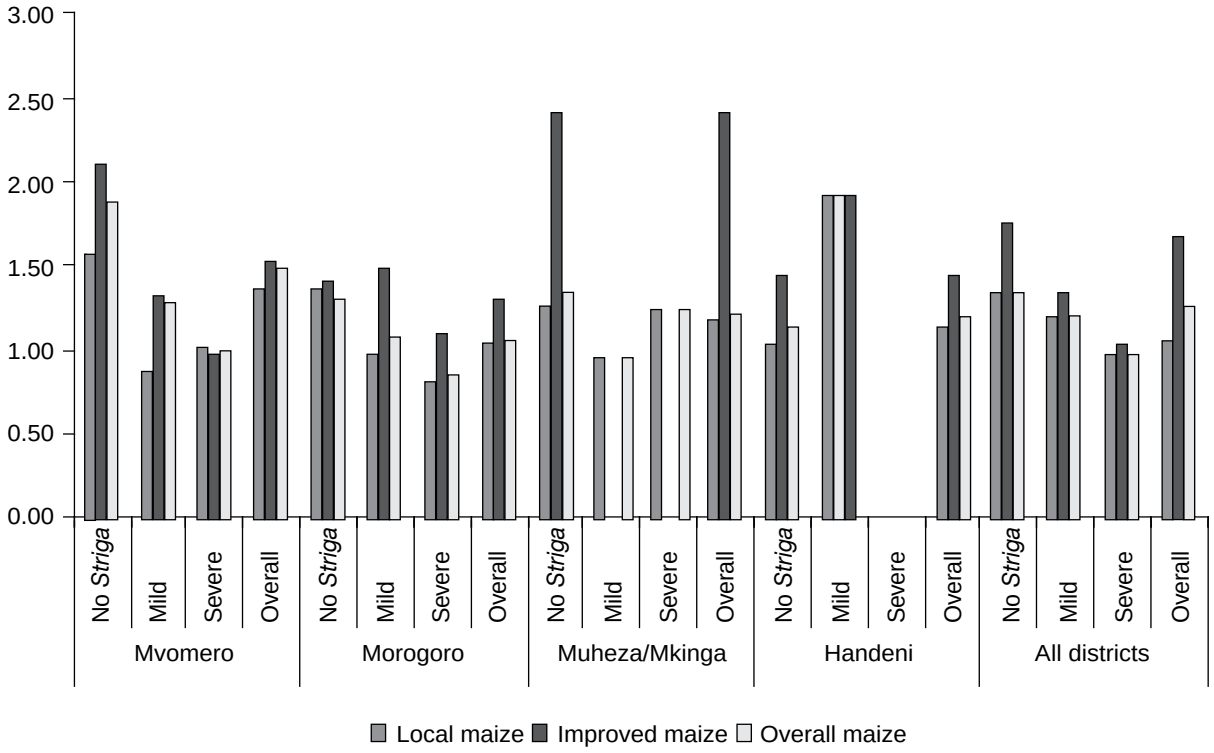

Figure 10: Yield of maize with different levels of Striga infestation by district

Table 20: Economic returns to land (gross margins in US$/ha) for local and improved maize

District/variety	N	Mean	STD	Min	Max
Mvomero					
Local	18	229.6	319.6	6.4	1,399.0
Improved	54	174.7	188.4	-62.2	800.5
Overall	71	184.5	226.1	-62.2	1,399.0
Morogoro					
Local	57	107.7	133.0	-145.2	458.3
Improved	11	204.9	237.8	-13.2	859.1
Overall	66	123.3	158.2	-145.2	859.1
Muheza/Mkinga					
Local	65	116.9	242.1	-657.3	1,202.9
Improved	3	357.4	418.9	18.1	825.6
Overall	68	127.6	252.4	-657.3	1,202.9
Handeni					
Local	53	59.9	72.9	-74.5	259.8
Improved	23	90.9	65.3	-20.3	221.5
Overall	73	67.7	70.9	-74.5	259.8
All districts					
Local	193	109.0	193.0	-657.3	1,399.0
Improved	91	163.2	187.1	-62.2	859.1
Overall	278	125.4	193.1	-657.3	1,399.0

N = Number of plots

Chapter 5

Micro-level determinants of livelihoods

Factors affecting household wealth indices

The Tobit model was used to investigate the relationship between the factors that were hypothesised to affect wealth status. The result showed that the Productive Assets Index, years of schooling, household size, number of extension visits, current assets, overall income and group networking had positive significant effects on livelihood status (P<0.1) as measured by the wealth index (Table 21). Having more productive assets, other factors being constant, increases farm productivity which, in turn, increases wealth. More years in formal schooling allow a farmer to seek the right information and digest it for decisions that concern his/her major income activities. At the extreme, more years in school may let the household head optimally utilise the available resources. Household size (adjusted to size and composition) was significant (P<0.05) having a positive influence on household wealth as it increases (if other factors are held constant). This may be due to the presence of enough labour and economies of scale of practices within the household. Also as the number of extension visits increases, wealth is increased since they increase a farmer's knowledge. Current financial assets (savings at bank, home, claim on good debtors and jewellery) showed a significant (P<0.01) influence on wealth. Having comparatively large liquid assets in the long run increases the chance of household's livelihood improving.

Table 21: Micro-level determinants of household wealth

Variable	Mean	Std Dev	Min	Max	Expected sign	Coefficients	t-ratio	dy/dx
AGEHEAD	50.24252	14.76497	20	95	–/+	0.017	0.48	0.017
PAI	16.68439	9.022013	2	78	+	0.117	1.9*	0.117
OVALTLU	0.778239	2.51026	0	31.6	+	-0.045	-0.23	-0.045
NYRSCHED	5.551495	2.891627	0	14	–/+	0.544	3.02***	0.544
HHSZCSE	3.340299	1.041369	0.72	6.64	–/+	0.083	2.29**	0.083
NUMEXVIS	7.747508	13.71894	0	109	+	1.211	2.43**	1.211
CURRFASS	0.764850	0.656177	0	3.33	+	2.139	3.01***	2.139
BMIMOGUA	23.76748	4.450187	15.5	43.7	+	0.167	1.61	0.167
OVINCOPC	89.71963	132.0254	0	1076	+	0.015	4.34***	0.015
SCGRANYM	0.378737	0.485880	0	1	+	3.045	3.08***	3.045
Constant						-18.61	-5.18	0.017

Significance levels *, ** and *** are P<0.1, P<0.05 and P<0.01, respectively

Overall income was positively and significantly (P<0.01) associated with wealth status. This is because the more the income increases the better the chances of improvement in the well being of a household (other factors held constant, in the sense that the capability of meeting basic and subsidiary needs is increased). A household having at least one member participating in social group(s) had a significantly improved wealth status (P<0.05). This may be due to reduced vulnerability provided by social safety nets that characterise social groups, also, empowerment and sharing of experience between its members.

Model summary	
Model and estimation	Tobit (censored) and Maximum Likelihood Estimation
Dependent variable	Share of land under improved maize
Number of observations	286
Software used	STATA
LR chi2(df)	94.54 (10)
Prob>chi2	0.0000
Pseudo R2	0.0457
Log likelihood function	-986.345
Censoring	Left censored = 0, Uncensored = 286, Right censored = 0

Correlations between maize yields, household and field factors

Factors that affect household maize yield were investigated by running a non parametric correlation coefficient analysis against factors that were hypothesised to be related to household maize productivity. The number of extension visits and Productive Assets Index were found to be significantly (P<0.01) and positively correlated with maize production, that is the more intense these factors, the higher the household maize yields (Table 22). On the other hand, season quality (weather), Ill Health Index (frequency and intensity) of household member(s) and *Striga* infestation in maize plots are significantly and negatively correlated with maize yield.

Factors that determine the probability of improved maize variety cultivation

It is important to understand the factors that dominate farmers willingness to adopt new technologies so that new technologies are tailored to fit those traits. In this study, the Tobit regression model was applied to investigate determining factors where the ratio of land growing improved maize varieties was used as a dependent variable. The higher the number of extension visits (NUMEXVIS), current financial assets (CURRFASS), social transfers (SOCITRAN), overall income from market participation (OVINCOPC) and overall maize yield (OVERMZYD), the more likely that a household will dedicate

Table 22: Correlation of maize yield (metric tonnes/ha) with household and farm characteristics

Factors correlated with yield	Correlation coefficient	Sig (1-tailed)
Age of head	0.0522	0.1888
Number of years of schooling of head	0.0462	0.2175
Number of extension visits (public, private, NSAs)	0.2911***	0.0000
Overall Ill Health Index (IHI)	-0.0911*	0.0616
Productive Assets Index	0.1984***	0.0004
Overall *Striga* infestation in maize plots	-0.0771*	0.0959
Overall seasonality quality	-0.1020**	0.0419
Total maize labour days per hectare	0.0433	0.2322

* Correlation is significant at the 0.1 level (1-tailed)
** Correlation is significant at the 0.05 level (1-tailed)
*** Correlation is significant at the 0.01 level (1-tailed)
NB: Kendall non parametric correlation method was applied

more land share to improved varieties (Table 23). The number of extension visits was a strongly significant determinant factor for improved maize cultivation (P<0.01). This was expected as farmers in the rural areas, like other firm managers, need information about technology and anything concerning their industry for best and optimal decisions on production. This confirms that extension agents are the major and key informants in the rural areas. It is also congruent with earlier findings that most of the extension services in the study area were focusing on improved maize varieties. Income from market participation, current and social transfer financial assets, increases household power to purchase improved maize seed and pay for other farm services which are important for better performance. Overall maize yield shows the level of importance of maize to particular households and its need to realise maximum output. This may lead the household to allocate more land to more productive varieties.

Table 23: Micro-level determinants influencing extent of adoption of improved maize

Variable	Mean	Std dev	Min	Max	Expected sign	Coefficients	t-ratio	dy/dx
HHSZCSE	3.43	1.041	0.72	6.64	–/+	0.0142	0.54	0.0142
NUMEXVIS	7.47	13.719	0	109	+	0.0128	6.63***	0.0128
CURRFASS	0.75	0.656	0	3.33	+	0.0858	2.04**	0.0858
CONDFASS	0.24	0.466	0	3	–/+	-0.0221	-0.4	-0.0221
SOCITRAN	0.30	0.528	0	2	–/+	0.1339	2.68***	0.1339
BMIMOGUA	23.78	4.450	15.5	43.7	+	0.0081	1.41	0.0081
OVINCOPC	87.70	132.025	0	1076.07	+	0.0003	1.79*	0.0003
OVERMZYD	1.44	1.881	0	17.5	+	0.0008	0.06	0.0008
SCGRANYM	0.38	0.486	0	1	+	0.0996	1.85*	0.0996
Constant						-0.1890	-1.13	

Significance levels *, ** and *** are P<0.1, P<0.05 and 0.01, respectively

Model summary	
Model and estimation	Tobit (censored) and Maximum Likelihood Estimation
Dependent variable	Share of land under improved maize
Number of observations	274
Software used	STATA
LR chi^2(df)	60.87 (9)
Prob > chi^2	0.0000
Pseudo R2	0.1723
Log likelihood function	-146.236
Censoring	Left censored = 0, Uncensored = 274, Right censored = 0

Chapter 6

Conclusions and recommendations

Characteristics of sampled households

The sample was dominated by male headed households, as expected in most of African societies where males dominate and inherit basic resources such as land and livestock. Women are not the main decision makers partly due to a lack of basic resources that are culturally endowed to men. In the study area, women provide the bulk of labour. It is recommended that farmer's knowledge base, particularly that of women, is raised through on farm training so as to capacitate them with better know how to facilitate handling and managing resources. Deliberate efforts should be made to endow women with basic resources that are culturally dominated by men; this will help in giving them more decision making power over farm production. The average age of the household head was quite high (about 50 years) revealing that younger people do not stay in farming. Increasing the productivity and profitability of the agricultural sector would make farming attractive to young, educated household members.

Livelihood capitals

Most land is owned in terms of customary usufruct entitlement. Handeni respondent households have the largest land holdings while Morogoro respondents have the least. Being further from the municipality centre seems to have advantaged Handeni District with less land competition compared to Morogoro which hosts Morogoro municipality. About half of the respondents had improved toilets, sources of drinking water and roofing material of the main house only. Other dwelling characteristics were very low such as main source of energy for light and cooking for the household were firewood dominated.

Public agents were the premier providers of extension services with about half of the total respondents having received information concerning improved maize varieties. This may show the attention which the crop is receiving regardless of the quality of the information disseminated by the extension system. Most households have their cash savings at home which demonstrates the poor accessibility to banks and other formal micro-finance institutions in the country. The establishment of smallholder farmer friendly micro-finance institutions should be advocated to broaden their accessibility. Cash remittances that constitute the bulk of liquid assets for most farmers could be channeled through formal micro-finance institutions.

Households rear poultry and small ruminants although the average incomes from these stock are comparatively small. Cattle are the most valuable adult non working animals. Household income from marketed products (such as agricultural crops, livestock,

wood, charcoal, fish and mineral selling), and services (such as business, salaried/ professional employment, wage work and traditional healing) was very low because most products and services are produced and consumed within the household. Efforts should be made to increase farmer participation in markets since marketing surplus would positively impact on the intensive and efficient cultivation of crops.

Most households were involved in religious groups, followed by credit and savings associations. Social groups are likely to be a good vehicle for innovations due to the fact that networking based on trust is very important for group sustainability. Introduction of improved technologies should be encouraged through groups as these can distribute technologies to the rest of the society. It is advised that stakeholders should take advantage of the existing groups to improve the productivity of crops, and hence the welfare of farmers.

Livelihood contexts and strategies

Increases in crop production for the improvement of livelihoods was the prominent feature in the livelihood trends in the study area. Increase in income was second. Interventions targeting increases in crop production and income would contribute to reverse the poor trend in livelihoods.

Prominent shocks

The most common shock was food deficit where almost half of the respondents experienced food shortages in the past five years. Morogoro had most households reporting food deficits while Handeni reported the least incidence. Crop production is still erratic and about half of the households are likely to suffer food shortages in the future. Therefore, interventions that increase crop (maize) productivity and income base would improve food self sufficiency and access to food markets when own production does not match the food demand of the household.

Striga incidence in maize plots

Close to half of the respondents reported *Striga* infestation in maize plots at different levels of severity. Morogoro rural had the highest percentage of households reporting *Striga* in their farm plots. Both local and improved variety maize plots were reported to have high *Striga* infestation incidence probably because of low resistance or tolerance to *Striga*. Thus, there is the need to introduce new *Striga* control technologies such as IR maize, and push and pull.

Livelihood strategies

The major livelihood strategy was crop production with maize as the major crop. Most households cultivate local maize varieties although hybrid maize varieties are cultivated in larger farm plots. Therefore, scaling up the use of improved maize varieties may contribute to reducing the widespread food deficit.

Livelihood outcomes

Wealth status

The wealth status of each household was calculated from an asset perspective. Households in Mvomero had the greatest accumulation of wealth depicted in improved main buildings and possession of more consumer durables. This shows the accrued long run household wealth compared to households in other districts. Clustering households was done into three wealth categories of rich, middle and poor following Filmer and Pritchett (2001). Comparing the gap in the wealth index between the rich and poor clusters, Handeni had the widest gap while Morogoro had the narrowest gap. Most households falling into the rich group in Handeni have a high rate of participation in marketing of their products and services compared to their counterparts. Therefore, smallholder farmers' participation in markets should be promoted. This objective can be met by increasing farmers' productivity and surplus creation. Productivity improvement can start by reducing their farm production risks through the introduction of *Striga* control technologies, superior improved varieties and better production know how.

The rich and poor groups in Morogoro had a narrow gap between them due to generally higher average liquidity, especially through remittances. Being closer to town allows descendants to secure jobs in non farming industries more easily and serve their farming parents back home. As the wealth increases, respondents tend to improve the floor, roofing and walls in the main house, which differences were notable between the rich and poor clusters. Also, the basic utilities like source of energy for cooking and light distinguishes these two, with the rich having access to improved sources. Poor households still rely on firewood as the major source of energy.

Anthropometric indices of vulnerable groups

The food deficit as a shock experienced by most households in the preceding five years has its negative effects depicted in the under five year old children. Stunting (height for age) was a problem with about half of the children involved in this survey, with Mvomero children affected the most. Also wasting (weight for age) was more rampant in Mvomero than other districts surveyed. The food deficit is devastating and requires an immediate but sustainable solution including increased productivity on the farms to realise surplus, greater market participation, and strengthened safety nets in order to reduce the vulnerability of households.

Physical and economic productivity of the system

Low crop production and drought or inadequate rainfall were identified as critical causes of food insecurity as reported by almost half of the households sampled. The physical productivity of the farming system is poor leading to a wretched economic status as an outcome. Improvement in crop production in the study area seems to be a major gateway

to escape from the shortage of food and towards the greater economic well being of rural households. This can be by introducing improved maize varieties which give higher yields than the local ones cultivated by the majority of the households. Also, irrigation systems and introduction of rain harvesting techniques may alleviate the decline and reverse the situation by reducing farming risks associated with rain fed agriculture.

Micro-level determinants of livelihoods

Factors affecting household wealth indices

The Tobit model estimates show that years of schooling of the household head, household size (adjusted to size and composition), current financial assets, overall income and membership of social groups have positive effects on the livelihood status as measured by the wealth index of households. Children's attendance at schools must be encouraged and farmers should be given regular training on best agricultural practices. The presence of more people in the household is an additional source of labour. Also it could be an incentive for a large sized household to accumulate wealth to facilitate the survival of household members.

Liquidity is an immediate way of accessing capital. Thus households with large liquid assets are less vulnerable to shocks that deplete wealth and drag families into vicious cycles of poverty. It is recommended that farmers are informed and sensitised on the importance of liquid assets so that they use them effectively. Membership of social groups seems to reduce the vulnerability to shocks by providing social safety nets. Also, empowerment and sharing of experience between members in social groups help in how to acquire and maintain wealth. Social groups also give farmers a platform from which they have power to command markets and fight shocks.

Correlation between maize yields, household characteristics and farm plot factors

Increases in the number of extension visits and productive assets are translated into higher productivity of maize. It is expected that extension visits bring in more know how on best agricultural practices. Therefore, it is recommended that in areas where maize production is low, more extension visits should be considered. Likewise, productive assets are very important in turning other primary inputs into outputs. There is a need for more extension workers and availability of agricultural inputs in villages and at affordable prices.

On the other hand, farmer perceptions of season quality (weather), the Ill Health Index of household member(s) and *Striga* infestation in maize plots are significantly and negatively correlated to maize yields. It is therefore imperative to introduce measures that reduce farmers' dependency on weather by the introduction of effective agricultural water management systems. Also, improvement of health services would improve the availability and quality of labour. This will increase maize productivity which is likely

to reduce the food deficits and improve wealth. *Striga* is another major bottleneck that seriously reduces maize yield. This is a wake up call for scientists to collaborate with farmers to fight *Striga* and its devastating effects using all available means.

Factors that determine the extent of adoption of improved maize varieties

Tobit regression results show that factors which positively influence the proportion of land allocated to improved maize varieties include the number of extension visits, current financial assets, social transfers in terms of cash, overall income and overall maize yield.

Increased liquidity through current assets, liquid social transfers and overall income would improve the capacity of households to buy seed and other inputs before the planting season. Improved maize technology often comes with a bundle of costs embedded in seed, fertiliser and labour for other crop management practices. To increase adoption of improved maize varieties requires the timely delivery of seed and other important inputs needed for these farmers to realise surpluses and to participate in markets. Increasing the number of extension visits is a determinant factor for improved maize cultivation. Farmers need technical information about new technology in their industry before deciding to adopt it. Besides confirming the importance of extension services, this study recommends that extension agents work with researchers and farmers to close the yield gap. There is a need for efficient extension services that will go hand in hand with agricultural innovations.

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Appendices

Annex 1: Questionnaire for the survey

Part A : Interview and Household Details

I-a : Interview Information

Q1 Interviewer's name	
Q2 Name of respondent	
Q3 Name of head of household	
Q4 District/province name	
Q5 Division/county	
Q6 Ward/sub-county	
Q7 Village name	
Q8 Hamlet name	

A8 date Dd mm yy	A9a time start Hr min	A9b Am or pm	A10a interview end Hr min	A10b Am or pm

	A12 Quality checking by supervisors			
		Date	Signature	Rating
A11 Interpreter 1 = Yes 2 = No	Quality check 1 District supervisor			
	Quality check 2* District supervisor			
	Quality check 3 AATF/IITA supervisor			
	* If the rating (good/poor) of quality check 1 is poor, the enumerator must correct for the mistake at his/her own cost. Then a quality check 2 by same supervisor would be required. Any final form must be rated good to pass through.			

Part B : Household Characteristics

B1. Household socio-demographics

Id code	Name of household member	Sex 1 = Male 2 = Female	Age (In years only)	Relationship to the household head 1 = Head 2 = Spouse 3 = Son/daughter 4 = Relative 5 = Unrelated	Formal schooling 1 = Attended before 2 = Attending now 3 = Never attended	Number of years of schooling completed (If attended or is attending school)	Off school training 1 = None 2 = Vocational training 3 = Short term training on best agric. practices (non extension)
01							
02							
03							
04							
05							
06							
07							
08							
09							
10							
11							
12							
13							

Part C : Productive Resources Endowment

C-1: Land Tenure and Use Structure

C1.1. Please provide information on land tenure and use

Land tenure structure	Size (Acres)	Size of land under (Acres)				
		Annual crops	Perennial crops	Grazing	Fallow	Rented out/Given out
Pr Private (titled) land						
L Land with use rights only						
R Rented land						
S Sharecropped land						
B Borrowed land						
Gi Gifted land						
T Total						

C-2: Household Workforce

C2.1. Please provide information on household workforce

Age category (years)	Total in the household		Number of who work full time on the farm		Number of who work part time on the farm		Number of who work off farm		Number of able bodied but do not do anything		Number of disabled members (too young, too old, physically impaired)	
	M	F	M	F	M	F	M	F	M	F	M	F
Up to 6 years												
7 – 12												
13 – 17												
18 – 40												
41 – 60												
Over 60 years												

C-3: Productive Assets

C3. Please provide information on the following key productive assets

Asset	Number owned	Working status 1 = Most of them working properly; 2 = Most of them working moderately; 3 = Most of them working improperly	Total value (Current value if liquidated)
Hand hoe (Jembe)			
Machete			
Axe			
Ox plough, weeder, riper, etc			
Ox cart			
Wheelbarrow			
Oxen			
Donkeys			
Horses			
Sprayer			
Irrigation pump			
Tractor			
Pickup, lorry			
Others (Specify) _____			

D1. Land allocation and inputs during the short rainy season of 2006 (the most recent and complete one)

Crop system ID	Crop enterprise	Area (Acres)	Extent of *Striga* infestation? 1 = Not infested 2 = Mild 3 = Severe	Intercropped with	Proportion of maize area (%)	Planting seed type **	Organic fertiliser (FYM)			Inorganic fertiliser			Seed (For all intercrops if so)			Pesticides (For all intercrops if so)		
							Qty	Unit*	Unit price	Qty	Unit*	Unit price	Qty	Unit*	Unit price	Qty	Unit*	Unit price
01	Local maize, sole																	
02	Hybrid maize, sole																	
03	Local maize, intercropped																	
04	Hybrid maize, intercropped																	
05	Beans																	
06	Sorghum																	
07	Millet																	
08	Soya bean																	
09	Groundnut																	
10	Cowpea																	
11	Sunflower																	
12	Cassava																	
13	Irish potatoes																	
14	Sweet potatoes																	
15	Vegetables																	
16	Banana																	
17	Tea																	

18	Coffee																	
19	Tobacco																	
20	Sugarcane																	
21	Napier																	
22	Others (Specify) _____																	

**Planted seed type codes: 1 = Purchased hybrid *Striga* resistant; 2 = Purchased hybrid non-*Striga* resistant; 3 = Retained hybrid *Striga* resistant; 4 = Retained hybrid non-*Striga* resistant; 5 = Local variety purchased; 6 = Local variety retained

*Measurement unit codes: 1 = Kilogram, 2 = Litre, 3 = Bag (Specify in kgs) _____, 4 = Others (Specify in kgs) _____

D3. Crop marketing aspects for the short rainy season in 2006 (the most recent and complete one)

Valid crop system ID (as in D2	Name of the crop	Amount sold so far	Measurement unit of sale [1]	Average unit sale price	Amount in store based on measurement unit of sale	Month most of the produce was sold	Market place where most of the produce was sold[2]	Who bought the produce[3]	What is the most limiting marketing constraint[4]	Does this market constraint limit your willingness to adopt productivity enhancing technologies? 1 = Yes 2 = No	Mention any of such technologies you have declined to adopt because of lack of market incentives

D2. Production costs and labour inputs for the short rainy season in 2006 (the most recent and complete one)

Valid crop system ID (as in D1)	How do you rate the season with regard to rainfall/soil moisture in your farms? 1 = Above average 2 = Normal 3 = Below average	How much did you harvest (IN KG PLEASE)?			Direct costs and family labour input FAMILY LABOUR: PEOPLE (AE) X EFFECTIVE DAYS X EFFECTIVE HOURS AE = Adult Equivalents (1 Adult = A person of 15 and above years of age; A child of 10–14 years of age will be equated to 0.5 of an adult equivalent)											
		Crop 1	Crop 2	Crop 3	Land rent if rented in	Land preparation		Planting		Fertiliser/ chemical application		Weeding (all)		Harvesting and transporting		Storage (shelling + storage equipment)	
					Cost	Cost	Labour	Cost	Labour	Cost	Labour	Cost	Labour	Cost	Labour	Cost	Labour

E. *Striga* Extent, Severity and Control Technologies

E1. What are the most important maize production and post–harvest constraints?

Production constraint	A constraint? Yes = 1 No = 2	If yes, what is the level of severity (Intrinsic ranking) 1 = Highly severe 2 = Severe 3 = Less severe	If yes, what is the level of severity compared relative to other constraints (Comparative ranking, 1st being most severe)	If yes, to *Striga*, when (year) did it start to be a major constraint in your farm?
Striga				
Stalk borer (eg Osama)				
Storage insects (large grain borer)				
Low and erratic rainfall				
Water logging (excessive moisture)				
Low soil fertility				
Inadequate input supply				
Others (Specify) _____				

E2. What is the extent and severity of the *Striga* problem in your farm plots usually under maize?

Use cropping systems ID under maize in D1	Acreage (Acres)	Proportion of land infested by *Striga* (%)			Perceived level of severity (impact on maize production) Codes: 1 = More severe, 2 = Severe, 3 = Not yet a problem			
		Now	Past two years	Control measures used (multiple answer possible)*	Last season (most recent and complete)		Past two years	
					Severity	Average (kgs)	Severity	Average (kgs)

* Codes for *Striga* control measures: 1 = Uprooting, 2 = Burning, 3 = Manuring, 4 = Others (Specify)_____

E3. Which of the following *Striga* control technologies are you aware of and what is your current use status? If you are currently using a *Striga* control technology, what is the associated per acre maize yield?

Technology ID	*Striga* control technology	Aware of the technology? 1 = Yes 2 = No	If aware, current use status 1 = Currently using 2 = Abandoned 3 = Never adopted	When did you know of the existence of this technology?	Since when did you start to use it for the first time (year)?	If you are aware from whom did you receive the information?	If you are practicing it who demonstrated it for you?*
01	Traditional (uprooting)						
02	Traditional (burning)						
03	Traditional (manuring)						
04	Use of inorganic fertiliser						
05	*Striga* resistant maize grown with legumes						
06	*Striga* resistant maize without legumes						
07	Intercropping of legumes followed by cassava/Desmodium (Maize in the 3rd year)						
08	Push-Pull (Maize-Desmodium strip cropping)						
09	Others (Specify) _____						
10	Integrated ____; _____; _____; (Use technology IDs)						

*Codes for source of information and technology demonstration: 1 = Farmers in the village; 2 = Farmers in other villages; 3 = Mass media (radio, newspapers); 4 = Extension agents; 5 = Local NGOs; 6 = International research institutes (CIAT, CIMMYT); 7 = National research institute (Specify) _____ ; 8 = Others (Specify) _____

E5. If you are aware of any *Striga* control technologies but have not adopted any, what is the most important reason for non-adoption? (Multiple answers possible)

	Reason for non-adoption	Reason status (1 = Yes, 2 = No)	Ranking (1st being the most important reason)
01	Gathering more information about the technology		
02	Traditional control practice is better		
03	Too risky to adopt		
04	Cash constraint to buy seed and other inputs		
05	Lack of improved seed (*Striga* resistant varieties)		
06	Others (eg cultural factors) (Specify) _____		

E6. How would you rank the various *Striga* control technologies you have been introduced to relative to your own traditional control practice?

Technology ID	*Striga* control technology	Rank based on				
		Maize yield (Most yield enhancing to the least) 1 = Most yield enhancing 2 = Moderately yield enhancing 3 = Least yield enhancing	Technical simplicity (Simplest to most complex) 1 = Simplest 2 = Simpler 3 = Complex	Labour demand (Least demanding to the most demanding) 1 = Least demanding 2 = Moderately demanding 3 = Most demanding	*Striga* population (Most *Striga* reducing to the least) 1 = Most *Striga* reducing 2 = Moderately *Striga* reducing 3 = Least *Striga* reducing	Soil fertility (Most fertility enhancing to the least) 1 = Most fertility enhancing 2 = Moderately fertility enhancing 3 = Least fertility enhancing
01	Traditional (uprooting)					
02	Traditional (burning)					
03	Traditional (manuring)					
04	Use of inorganic fertiliser					
05	*Striga* resistant maize grown with legumes					
06	*Striga* resistant maize without legumes					
07	Intercropping of legumes followed by cassava/ Desmodium (Maize in the 3rd year)					
08	Push-Pull (Maize-Desmodium strip cropping)					
09	Others (Specify)_____					
10	Integrated ____; _____; _____; (Use technology IDs)					

F. Vulnerability, Capital Assets and Livelihoods

F: Food security and livelihood aspects

F1. Harvests, post–harvest losses, stocks of staples (roots and tubers, grains and plantain)

Crop*	Date of last harvest	Total stored last harvest		Amount of this harvest in store now	When store depleted	Loss in store? 1 = Yes 2 = No	Estimated qty lost in store?		Reasons for loss**
		Unit	Amount	Quantity	Approx. date		Unit	Amount	

*Crops: 1 = Maize, 2 = Beans, 3 = Sorghum, 4 = Millet, 5 = Soya bean, 6 = Groundnut, 7 = Cowpea, 8 = Sunflower, 9 = Cassava, 10 = Irish potatoes, 11 = Sweet potatoes, 12 = Banana, 13 = Others (Specify) _____

**Reasons for loss: 1 = Rodents, 2 = Insects, 3 = Damp/rot, 4 = Theft, 5 = Others (Specify) _____

F2. Nature, effect and response to shocks, and livelihood situation by the household in the last five years (Take note of the codes)

Nature, effect and response to shocks				Livelihood situation trend	
Event/shock[1]	When happened/ started (date)	Effect of the event/shock[2]	Response to event/shock[3]	How is your livelihood situation now compared to the past five years? 1 = Improving, 2 = Worsening, 3 = The same	What is the single most reason for such a livelihood situation?

[1]Event/shock: 1 = *Striga* infestation, 2 = Drought, 3 = Floods, 2 = Theft, 3 = Illness, 4 = Death of important family member, 5 = Crop pest/disease outbreak, 6 = Livestock disease outbreak, 7 = Strong wind/hurricane, 8 = Others (Specify) _____

[2]Effect of event/shock: 1 = Hunger, 2 = Loss of crop, 3 = Loss of animal, 4 = House damage, 5 = Others (Specify)_____

[3]Response to event/shock: 1 = Adopt *Striga* control technologies, 2 = Shift to *Striga* free/less infested land, 3 = Abandon maize production because of *Striga*, 4 = Sale of animal for cash, 5 = Received relief help (Specify source) _____, 6 = Remittances from relatives/friends, 7 = Sale of crop stock, 8 = Sale of assets (land, durables, livestock), 9 = Spend cash savings, 10 = Casual labour for work or cash, 11 = Hhd members migrated, 12 = Others (Specify) _____

F3: Financial Capital

F3.1. Please indicate the types of your financial capital and rank them in order of importance.

Financial capital	Do you have access to such a financial capital? 1 = Yes 2 = No	How much in absolute terms can you access/ command per month per year?		Rank your portfolio of financial capitals in order of importance in relation to magnitude of value, easiness to access/raise/command, and easiness to spend		
		Month	Year	Magnitude of value	Access/raise/ command (1 = Very easy, 2 = Moderate, 3 = Not easy)	Easiness to spend (1 = Very easy, 2 = Moderate, 3 = Not easy)
Cash savings at bank						
Cash savings at home/ pocket						
Claim on your good debtors						
Jewellery						
Formal credit	*					
Informal credit	*					
Cash remittances from relatives/friends						
Remittances from relatives/friends (easily transformable into cash)						
Others (Specify) _____						

* The question needs to be addressed as whether the household can get formal/informal credit when needed.

F3.2. Please indicate the type and number of non working livestock the household owns.

Type	Number		Value	
	Young animals	Adult animals	Average price per young animal	Average price per adult animal
Cattle				
Goats				
Sheep				
Pigs				
Poultry (chicken, ducks)				
Rabbits				
Doves				
Donkeys				
Others (Specify) _____				

F4: Physical capital

F4.1. Please indicate the physical infrastructure you have access to.

Physical capital	Codes for responses	Response (more than 1 response allowed)
Water supply	1 = Piped in dwelling, 2 = Piped outside dwelling, 3 = Public tap, 4 = Borehole, 5 = Protected well/ spring, 6 = Unprotected well/spring, 7 = Rain water, 8 = Vendor/tanker truck, 9 = River/lake/stream, 10 = Others (Specify) _____	
Toilet facility	1 = Own flush toilet, 2 = Shared flush toilet, 3 = Pit latrine covered, 4 = Pit latrine uncovered, 5 = Pan/ bucket, 6 = Bush, 7 = Others (Specify) _____	
Type of lighting for house	1 = Electricity, 2 = Paraffin or kerosene lantern, 3 = Candle wax, 4 = Firewood, 5 = Solar or gas, 6 = Biogas, 7 = Others (Specify) _____	
Cooking fuel	1 = Firewood, 2 = Charcoal, 3 = Electricity, 4 = Paraffin or kerosene, 5 = Gas, 6 = Solar, 7 = Biogas, 8 = Others (Specify) _____	
Health centre/hospital	Yes = 1; No = 2	
Own vehicle	Yes = 1; No = 2	
Own motor bicycle	Yes = 1; No = 2	
Own bicycle	Yes = 1; No = 2	
Telecommunication (mobile phone, others)	Yes = 1; No = 2	

House roof	1 = Thatched, 2 = Iron sheets, 3 = Asbestos, 4 = Tiles, 5 = Tin, 6 = Cement, 7 = Others (Specify) _____	
House wall	1 = Thatched, 2 = Mud and poles, 3 = Raw bricks, 4 = Burnt bricks with mud, 5 = Burnt bricks with cement, 6 = Timber, 7 = Cement blocks, 8 = Stone, 9 = Others (Specify) _____	
House floor	1 = Earth, 2 = Earth and cow dung, 3 = Cement, 4 = Mosaic of tiles, 5 = Bricks, 6 = Stone, 7 = Wood, 8 = Others (Specify) _____	

F5: Human capital

F5.1. Please provide the following information on the types of agricultural technologies introduced.

Agricultural technology	Have you ever been in contact with extension agents from different sectors? 1 = Yes 2 = No			Were you introduced to the technology? 1 = Yes 2 = No	If yes, indicate year technology was first introduced	Number of extension visits last year			Did you adopt the technology 1 = Yes 2 = No	If yes, year technology was adopted
	Public	Private	NGO/ Projects			Public	Private	NGO/ Projects		
Improved maize varieties										
Control of *Striga*/other weeds										
Soil fertility management										
Improved food grain storage										
Collective product marketing										
Livestock technologies										

G6: Social capital

G6.1. If a member of the household belongs to any local association/group, please provide the following information.

Household member ID (See Section 1)	Association/ group*	Since when?	What are three main activities of the association/group		
			1.	2.	3.
			1.	2.	3.
			1.	2.	3.
			1.	2.	3.

*Association/group: 1 = Community development, 2 = Cooperative, 3 = Religious group, 4 = Credit and savings group, 5 = Informal insurance (safety net), 6 = Women's group, 7 = AIDS group

G6.2. What is the likelihood that you will adopt/copy a novel technology from people of ...

Different wealth status	[ ]	Same wealth status	[ ]
Different ethnic/tribe	[ ]	Same ethnic/tribe	[ ]
Different age category	[ ]	Same age category	[ ]
Different occupation	[ ]	Same occupation	[ ]
Different religious faith	[ ]	Same religious faith	[ ]
Different political denomination	[ ]	Same political denomination	[ ]
Codes: 1 = Not likely, 2 = Likely, 3 = Very likely			

G6.3. In the past one year, how many people of [...] you have interacted with in exchange of information on development issues?

Different wealth status	[ ]	Same wealth status	[ ]
Different ethnic/tribe	[ ]	Same ethnic/tribe	[ ]
Different age category	[ ]	Same age category	[ ]
Different occupation	[ ]	Same occupation	[ ]
Different religious faith	[ ]	Same religious faith	[ ]
Different political denomination	[ ]	Same political denomination	[ ]
Codes: 1 = None, 2 = Around ten people, 3 = More than ten people			

H: Livelihood strategies and outcomes

H1. Please provide information on non-farm income sources, the family members involved, the average income per year, and the seasonal stability of income generated.

Income source	Was any member involved? 1 = Yes 2 = No	Household members involved			Amount per year	How stable is this source of income? 1 = Stable, 2 = Somewhat stable, 3 = Unstable
		Adult males (>15 yrs)	Adult females (>15 yrs)	Children (10–15 yrs)		
Honey production						
Agricultural wage employment						
Non-agricultural wage employment						
Food for work						
Petty trade*						
Handicrafts						
Transport service						
Grain mills						
Fishing						
Hunting and gathering of wild food						
Selling fuel wood and charcoal						
Selling prepared foods/drinks						
Professional work **						
Traditional medicine						
Rent income						
Remittances						

*Includes manufactured goods, food grains, fruits and vegetables, coffee and tea, and livestock and livestock products

** Includes teachers, health workers, vets, etc

J: Anthropometrics, morbidity and mortality

J1. Measurements on mothers and children below or equal to six years of age

Biological mother's name	Marriage order (1st, 2nd, etc)	Mother's age	Child's name	Sex Male = 1 Female = 2	Child's age	Date of birth of child (dd/mm/yy)*	Weight of mother (kg) (A)	Weight of mother + child (B)	Height of child (cm)	Height of mother (cm)

*Use MCH card to confirm the exact age of the child

J.2. Morbidity indicators (ENUMERATORS: This question, as much as possible, should be directed to mothers within the household)

ID CODE	Did, [Name] get injured or diseased in the past 4 weeks? 1 = Yes 2 = No (IF NO GO TO NEXT PERSON)	Which injury or disease and how frequent did, [Name], suffer from? (MARK MOST IMPORTANT INJURY/ DISEASE)		Did, [Name], get injured or diseased in the past 12 months? 1 = Yes 2 = No (IF NO GO TO NEXT PERSON)		What measures did the household take when, [Name], fell ill? Use codes[2] please (UP TO THREE ANSWERS ARE POSSIBLE)			[1]CODES FOR INJURY/ DISEASE 1 = Malaria 2 = Dysentery/Diarrhoea 3 = Injurious accident 4 = Toothache 5 = Skin disease 6 = Eye ache/disease 7 = Ear, nasal or throat related 8 = Lifetime disease/disorder 9 = Others (Specify)_____ [2]CODES FOR MEASURES TAKEN 1 = No any measure was taken 2 = Taken to private dispensary/hospital 3 = Taken to public dispensary/hospital 4 = Taken to traditional healer 5 = Purchased drug from a pharmaceutical shop 6 = Others (Specify) _____
		Disease[1]	Frequency	Disease[1]	Frequency	1st	2nd	3rd	
01									
02									
03									
04									
05									
06									
07									
08									
09									
10									
11									
12									

J3. Mortality indicators

J3.1. Was there any member of the household who died in the year 2007? _____ 1 = Yes, 2 = No, If yes, provide information in the following table

S/ no	Gender of the deceased 1 = Male 2 = Female	Age at death (Years)	Cause of death
01			
02			
03			

Annex 2: Factor analysis results for wealth index construct variables for Tanzania

Components	Eigen values	Cum. variance explained (%)	Wealth index construct housing amenities and consumer durables	Selected components						Total loadings (Weight)
				1	2	3	4	5	6	
1	4.289	21.4	Roofing material of main house*	0.12	0.77	0.10	0.00	0.09	0.08	1.17
2	1.689	29.9	Wall material of main house*	0.11	0.73	0.05	0.26	0.16	0.08	1.39
3	1.314	36.5	Ownership of more than one house	-0.05	0.30	-0.04	0.03	-0.09	0.44	0.58
4	1.212	42.5	Floor material of main house*	0.29	0.60	0.34	-0.04	0.13	-0.06	1.25
5	1.104	48.0	Type of toilet*	0.22	0.22	-0.03	-0.25	0.64	0.06	0.87
6	1.063	53.3	Source of energy for cooking*	0.31	0.51	0.11	-0.17	-0.06	-0.29	0.41
7	0.983	58.3	Source of energy for lighting*	0.17	0.13	0.79	-0.04	0.09	-0.04	1.10
8	0.955	63.0	Source of water for drinking*	0.07	0.02	0.02	0.70	0.08	-0.14	0.75
9	0.888	67.5	Ownership of a car	0.09	0.19	-0.15	0.12	-0.04	-0.72	-0.52
10	0.817	71.6	Ownership of a motorbike	0.37	0.04	-0.20	-0.23	-0.56	0.12	-0.46
11	0.790	75.5	Ownership of a television set	0.09	0.13	0.78	0.08	-0.06	0.09	1.11
12	0.719	79.1	Ownership of a bicycle	0.26	0.07	0.02	0.59	0.04	0.41	1.39
13	0.677	82.5	Ownership of a radio	0.23	0.09	-0.01	0.20	0.58	0.03	1.12

14	0.647	85.7	Ownership of a wooden/ iron bed	0.46	0.08	-0.24	0.09	0.15	0.44	0.98
15	0.587	88.7	Ownership of an iron box	0.64	0.22	0.25	0.10	0.01	-0.03	1.18
16	0.544	91.4	Ownership of a mobile phone	0.60	0.23	0.12	0.14	0.11	0.02	1.22
17	0.510	93.9	Ownership of a landline	0.40	-0.19	0.27	-0.27	0.19	0.00	0.41
18	0.449	96.2	Ownership of a sofa set	0.66	0.11	0.39	-0.13	0.07	-0.06	1.04
19	0.410	98.2	Ownership of a spongy mattress	0.42	0.36	-0.11	0.05	0.31	0.01	1.05
20	0.353	100.0	Ownership of a wall clock/wrist	0.61	0.13	-0.03	0.32	0.05	-0.06	1.03

*Refers to household amenities coded '1' for improved and '0' for otherwise; the remaining consumer durables are coded '1' owning/possessing a durable item and '0' otherwise.

(Footnotes)

1 Measurement unit of sale: 1 = kg, 2 = 50kg bag, 3 = 90kg bag, 4 = Others (Specify in its kg equivalent) _____

2 Market place: 1 = Village, 2 = Neighbouring village/location/road/junction, 3 = Nearby township, 4 = Distant township, 5 = Regional market, 6 = Others (Specify) _____

3 Trader typology: 1 = Local consumer, 2 = Small trader/broker (bicycle/on foot), 3 = Large trader (vehicle), 4 = Institution (school, prisons, etc), 5 = Others (Specify) _____

4 Constraint: 1 = Low producer price, 2 = Poor road to the market, 3 = Poor access to information, 4 = Lack of reliable transport, 5 = Others (Specify) _____



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