The Value of Uganda's Forests: A livelihoods and ecosystems approach

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Glossary

ANOVA – a shortened form of the parametric test known as 'analysis of variance' to test of variance between more than two sample means in comparison of a single factor.

Chi squared test – Parametric test used in the analysis of data on a nominal scale to understand if the data fits a specified theoretical distribution

Consumer surplus - the difference between the total value a consumer places on all units of a good or service consumed and the payment that they must actually make to purchase a given amount of that good or service.

Contingent valuation – an exercise to ascertain the value that individuals place on a non-marketed good or service. The exercise is 'contingent' on establishing a hypothetical market scenario in which to conduct the exercise.

Dichotomous choice – where a respondent makes a choice between two options answering yes or no to the choice

Economic welfare – the level of consumption of good and services by consumers measured by consumer surplus

Empirical data –collected evidence based on or guided by the results of observation or experiment only

Externalities – costs of a transaction that are incurred by members of the society, or benefits that are received by them, but not considered by parties in the transaction.

Kruskal-Wallace test – non-parametric approach to measuring variance amongst more than two sample means in comparison of a single factor

Non parametric test – a statistical test where the underlying pattern of observations are known to not conform to a normal distribution

Normal Distribution – data observations that conform to a known pattern or an underlying trend.

Parametric test – a statistical test on data where the underlying pattern of observations is based on a normal distribution.

Spearman rank correlation – non-parametric test to assess the relatedness between two variables according to a nominal scale or rank of the variables.

Total economic value (TEV)– the summation of values from all of the direct, indirect and non-use values associated with a resource

Tukey HSD – a parametric test that extends ANOVA analysis to assess multiple factors.

Executive Summary

Uganda continues to rely on woody biomass for its domestic energy consumption. Apart from energy other products such as timber, poles and non-timber forest products are also collected from forests. The majority of products consumed derive from the natural forests that remain in protected areas and on private lands rather than from farm or plantation forests. Worryingly the ability of Uganda's forests to continually provide such forest products is diminishing as they become degraded under the pressure of current demands (National Biomass Study, 2003). Importantly Uganda is beginning to enter a national fuel wood deficit.

A significant body of knowledge is being developed world wide on the importance of forests to local people and importantly the role that forests play in livelihood security and poverty alleviation. In addition the broader economic benefits provided by forests in terms of stabilising the environment both locally, nationally and internationally are being realised. In Uganda a good qualitative understanding of these issues has been developed. However to date quantitative work has focused mainly on macro level estimates and there has been a lack of quantitative disaggregated data on livelihoods issues pertaining to forests, upon which macro level estimates can be more accurately made.

The purpose of this study was therefore to develop a quantitative economic understanding of the value of forests to the local economy and its importance in local livelihoods as well as to the national and global economy. The European Union Forest Resource Management and Conservation Program and the Uganda Forest Department commissioned this study, as a result of a growing awareness about the broader values that forests provide to the national economy. This was due to a growing concern that such environmental economic values are currently under or not valued at all in national budgetary and planning processes. The study is also timely in that the national budget process in Uganda has become more participatory and inclusive with the advent of the Poverty Eradication Action Plan. The Wildlife Conservation Society conducted the management of the study, analysis and writing of the final report.

A series of field surveys around four focal areas representing the four main forest types (Tropical High Forest (THF) in protected areas, THF on private land, Protected Savannah Woodland and Protected Afromontane Forest) were conducted between October 2003 and January 2004. Using these data, data from the National Biomass Study (2003) as well as other secondary sources, estimates of the value of forests to local livelihoods, the national and global economy were made.

Several important findings were made in relation to forests livelihoods and poverty. Forests provide an important backstop of resources for a household during times when stocks of food and resources are running low ('hungry gap'). Average annual incomes from the different forest types varied by forest but ranged between 8-35% of annual incomes to the households (Table a).

Table A. The Total annual income per household, income from the forest and the percentage of income derived from the forest.

Forest (n)	Mean Adjusted income USh p.a.	Mean total Income USh p.a.	Mean income from the forest USh p.a.	Mean % income from the forest
Budongo (154)	394,287	1,411,655	118,672	8.4
Bugoma (175)	562,589	1,963,407	320,049	16.3
Kasagala (151)	528,302	1,714,746	182,512	10.6
Rwenzori (159)	492,357	2,040,622	727,104	35.6
All forests (639)	**496,457**	**1,790,495**	**339,696**	**19.0**

When these values are scaled up for the total amount of forest cover of each forest type in Uganda the total contribution of forests to local peoples livelihoods at the national level is calculated to be 332.3 billion USh or $190 million USD at current exchange rates.

Interesting dynamics between wealth and forest use were observed. Although poorer households derived proportionally more of their income from forests, in absolute terms, wealthy households captured more of the financial value available. Thus there was a large income disparity between wealthy and poor households.

Uganda's forests contribute significantly to the protection and stabilisation of the environment. Indirect use values were calculated for the contribution of forests to soil and water management, as well as in the sequestration of carbon and future uses for Uganda's biodiversity.

The combined value of all of these services and option values was calculated as 222.2 billion USh or $127 million USD. A break down of these values and where they accrue to in the policy hierarchy show that much of these are relevant at the local and national level (Table b).

Table B. The indirect use values of ecosystem benefits and at what level they benefit society.

Ecosystem and Option Values	USH (billion)	Level of benefit in society
Watershed benefits	60.8	Household, Local Community, National
Carbon sequestration	56.4	Global Community
Biodiversity value	5.8	National, Global Community
Soil Conservation	99.2	Household, Local Community, National

The study calculated that the total economic value (**TEV**) including all marketable and non-marketable values of Uganda's forests is approximately 593.24 billion shillings, roughly equivalent to 5.2% in GDP terms.

Forests fall under three broad categories of ownership or land management structures, those under control of the forestry authorities, those under the Uganda Wildlife Authority and those on private land. The break down of the **TEV** between forests on the different lands is shown on Table C.

Table C Proportion of **TEV** under different land management arrangements

Forest Type	Forest Authorities	Uganda Wildlife Authority	Private	Total
Total forest cover (Ha)	773,255	676,659	3,448,378	4898,292
% of total forest cover	15.8	13.8	70.4	100
Value (Billion USh)	**93.65**	**81.95**	**417.64**	**593.24**

Importantly a large proportion of the values derived from Uganda's forests come from forests on private land. Currently there are few incentives or regulations to promote sustainable forest management on private land. Thus there is an urgent need to develop an appropriate combination of incentives and disincentives to regulate the management of forests on private land.

Key Policy Issues that emerged from the study include:

- Making rural households wealthier will not reduce the exploitation of forest resources; in the short term there is every indication that forest exploitation would increase
- Current use of Uganda's forests is by and large unsustainable, the long term impact of such a trend will be a vastly reduced output of goods and services coupled with rising costs of mitigating environmental damage
- Reducing the current use of Uganda's Forests to sustainable levels, all other things remaining unchanged, will increase poverty in the short term.
- Sustainable forest management requires a coordinated effort between forest management and rural development activities to mitigate the short term effects of reducing local peoples forest incomes.
- Local people need to be integrated as much as possible into forest management in both protected forests and on private land
- There are significant concerns over the balance of benefits derived from plantation activities (private investor vs. local communities) the right balance needs to be struck.
- Uganda needs to capture more global financing to maintain Uganda's forests and grants from the Global Environment facility as well as the World Bank Bio Carbon fund should be sought to finance forest management activities. In addition finances from carbon offset schemes and debt for nature swaps could also be investigated.
- The MWLE needs to develop a sector investment plan in order to promote the economic contribution and investment needs of the environment and natural resource sector into the GOU budgetary process.
- The forestry sub-sector should receive continued support from treasury funds to deliver on the public goods aspects of its work. Its importance must be highlighted in the budget PRSP and budget planning process through the MLWE sector wide strategy and investment plan.

In order to fully realise the values of Uganda's forests in management plans and policy several points of further research and action are recommended:

- As a priority, valuation should be developed within routine systems for monitoring and evaluating non-timber benefits on a national and local scale i.e. UBOS household survey or part of a NFA monitoring program;
- Uganda seems to suffer from a lack of comprehensive data on land use management. As a priority a systematic survey of the relative profitability (gross margin analysis) should be undertaken to understand the economic performance of crops, livestock and trees on different soils in different agro ecological and climatic zones. Future valuation exercises should help to assess the change in the economic importance of forest benefits at the level of the forest site, region or nation under different land use and management schemes;
- A comprehensive survey of market prices, performance and integration for forest products should be conducted in order to give insights into how the trade could be regulated;
- Valuations should be used to make informed trade offs between the marketed and non marketed benefits from forests;
- Valuations should be used to devise a balanced combination of regulations and incentives that lead forest managers to account more fully for the non-use benefits from forests in their decision-making. Further studies should be undertaken to examine the qualitative and quantitative impacts of different combinations of policy options
- A thorough assessment of current and future demands for forest products needs to be made as a framework for plans to promote the use of natural forests and the development of on farm forestry.

1 Introduction

1.1 The role of forests in poverty alleviation

Forests provide a wealth of indirect environmental benefits as well as direct use benefits for many of the people surrounding them. The loss of forested areas upsets soil-water relations, creates erosion, and lowers water quality that, in turn has an associated effect on human health. In addition people may gather medicinal plants, fuel wood or derive food from the forests to support their livelihoods and the loss of these habitats leads to a lower quality of life. The importance of these ecosystems in the conservation of biodiversity also has an international dimension; many species are of global value and their habitats of importance in the provision of global public goods such as carbon sequestration.

Uganda has established a comprehensive network of protected areas to ensure a sustainable supply of these social and environmental values, but a proportion of Uganda's forests are on private land. If these protected areas provide such public goods then there is a good rationale for public financing to maintain them. As forests protect watersheds they have an impact on the livelihoods of local communities that live downstream. Therefore protecting forests contributes to securing peoples livelihoods. Unless monetary values are measured and quantified it is difficult for policy makers to mainstream environmental considerations within their economic decision making frameworks. As a result it is difficult to influence the framework conditions that make forest management and conservation efforts sustainable within a national economy.

1.2 Forest degradation and clearance

Tropical High Forests (THF) are particularly important as they provide disproportionately high values of natural products environmental services and support high levels of biodiversity. In Uganda, the quality of the Tropical High Forest has declined over time. A recent study by MUIENR (2000) indicates that the overall biodiversity of the country is declining. This is supported by recent censuses in a range of western forest reserves that show a loss of primate and other mammal biodiversity due to forest fragmentation (Plumptre *et al*, 1999). Well over 30% of the THF in Uganda is now degraded, with private forests shrinking more rapidly than forests managed by the government (Forest Department Map of Uganda's Land Cover).

Two key factors may be seen as the major causes of deforestation in the last century in Uganda:

- Conversion of forest into agricultural and grazing land, due to population expansion and extensive pastoral systems
- Over harvesting (mining of the resource) for fuel wood, timber, NTFP and charcoal due to high dependence by predominantly rural populations to maintain their livelihoods.

Even in the recent past, forest continues to be lost at an alarming rate. It is estimated that around 800 km^2 of forest has been lost in western Uganda since the mid 1980s. This loss has occurred primarily outside the forest reserves and national parks but will lead to increased pressure on the reserves in future (Plumptre, 2002).

1.3 Need for Economic Valuation

These facts underline the urgent need to better manage and protect Uganda's natural forest areas and provide some insight into approaches that might mitigate the threats to deforestation. In order to more fully appreciate the value of forests, and thereby influence the economic planning process and attract financial support for conserving these forests, it is vital that realistic values about the net stream of benefits are developed.

There is therefore a need for economic data to justify spending on management and protection of forest reserves / parks, and publicly funded incentives to private forest owners to manage

forest resources for the national interest. Broader valuation of forest benefits assist in developing strong arguments about the need to finance forest protection and management.

1.4 Study objectives

Due to a growing awareness about the broader values that forests provide to the national economy, the European Union Forest Resource Management and Conservation Program and the Uganda Forest Department commissioned this study. Such values are currently under, or not valued at all in national budgetary and planning processes. The study is also timely in that the national budget process in Uganda has become more participatory and inclusive with the advent of the Poverty Eradication Action Plan.

The **objectives** of this study were to:

1. Generate forest monetary values that are acceptable to Ministry of Finance, Planning and Economic Development (MoFPED), and therefore which can be included in the Medium Term Expenditure Framework (MTEF) of the District and Central Governments, especially the strategies for the PEAP.
2. Show where these monetary values are flowing within the economy and where possible disaggregate them in terms of the beneficiaries to illustrate the potential ability of forestry to eradicate poverty.
3. Adapt existing economic valuation methods to make it possible for staff of the NFA and the District Forest Service to collect the information needed for inclusion in the Government Statistical Abstracts and the Background to the Budget.
4. Illustrate the economic value of forests as a sustainable land use, compared with existing estimates for commonly competing agricultural crops; and identify areas in which the values of forestry can be enhanced by better rent capture, and efficiency of forest product use.

These objectives will contribute to the achievement of the FRMCP **purpose** to improve forest management for conservation of biodiversity and increased sustainable production with a focus on the poor, and the **goal** of increased and equitably distributed sustainable supply of environmental, social and economic benefits from Uganda's forests resources.

2. Understanding the economic value of forests

2.1 Economics and sustainable development

The debate about sustainable development has grown in recent years. There is firm consensus on sustainable development having to take account of three key factors, environment, society and economy. These are widely considered to be the 'three legs' of sustainability all of which must be considered and developed in synchrony (Brundtland, 1987; Barbier 1989; Daly, 1989; Pearce, 1990). The theory and practice of environmental economics has developed dramatically in recent years to meet the challenge of putting the case forward for environmental protection as the third leg of sustainability. However the traditional neo classical assumptions regarding substitution and technological advancement to correct environmental losses have continued to drive economic practice, resulting in a corresponding decline in environmental resources. An economy also reflects the choices of society over the way in which it uses its resources. The choice in resource use is laden with social values that have no market dimension and are difficult to quantify economically. Attention must be drawn to the role of the environment and society in a sustainable economy and the non-use values associated with their existence. Only by finding a common language with which to argue for the benefits and importance of conservation areas can their longevity be maintained. Therefore, putting economic values to environmental benefits helps to mainstream environmental considerations in the economic decision making frameworks of policy makers.

Campbell and Luckert (2002) state that valuing non market goods and services from natural resources is of critical importance to Less Developed Countries' (LDC) economies due to the dependence of the rural livelihoods on natural resources in general, and trees and forests in particular. This means that a great deal of goods and services from natural resources are effectively 'un-priced'. Poor price information means that policy makers have little information available to make decisions about resource allocation. Providing this information is key to setting development priorities. As forest conservation areas are invariably major natural resources in LDC economies, enabling governments to make informed decisions about economically efficient strategies towards their conservation and management is crucial for their long-term preservation.

The entry point to understanding the economics of forests is to recognize and define the broad range of goods and services that can be obtained from forests. Broadly these benefits can be broken down into two types, direct and indirect benefits. It is the sum of all these values that accrue at local, national and international levels that generates the ***total economic value (TEV)*** of a forest.

2.1 Direct benefits

The benefits of forest resources have historically been valued in terms of their direct benefits. Timber, tourism and other non-timber forest products are the visible focus of the economic activities of people. However there are also a multitude of indirect benefits as well (Table 1).

The measurement of direct benefits is reasonably clear. Surveys of the use of forests by local people, estimates of the value of goods traded on markets, gate receipts and permits from tourists visiting forest parks can all be used to calculate financial values derived from the forests. Where goods are not marketed but consumed in the home, estimates of consumption can be made and appropriate market prices prescribed to value consumption.

Table 1. **Direct and indirect benefits that together provide the total economic value of forests**

Direct economic benefits:	**Indirect economic benefits:**
Timber: Fuel wood Construction materials Charcoal Non Timber Forest Products: Medicinal plants Wild honey Bark cloth Wild food (flora and fauna) Craft / Thatching materials Recreational use: Park entry fees Guiding fees Gorilla permits Earnings by tour companies/hospitality industry Grazing – Forage values Crops/swidden cultivation	Soil protection: Erosion control, fertility Water conservation: Percolation into aquifer – stable release rather than flash flooding Climate control Carbon sequestration Water related issues (extra household expenditure on treatment, longer distance travelled to clean water source) Option Values – future use and bequest to future generations

However, the socio-economic and environmental data necessary to derive monetary values of the use values of forests is difficult to obtain and what exists is often incomplete and unreliable. This project seeks to take a comprehensive approach to valuing forest resources to more fully realize their value in the local and national economy and effect rational changes in public expenditure towards environmental protection.

2.2 Indirect benefits

There is a hidden dimension to forests in that they have a wider role in the maintenance of environmental quality such as soil/ water conservation and carbon sequestration. Such hidden benefits are public goods that benefit many people at a local, national and international level. The loss of forests in many areas often result in terrible environmental consequences in terms of soil erosion, flash floods and not least of all the depletion of a global carbon sink.

The consequences of environmental degradation and the loss of forests are varied in magnitude and the economic and social cost. In Mali for example soil erosion causes losses in agricultural production of about 0.2% of GDP (Pearce, 1993). Yaron and Moyini (2003) also report on the cost of soil erosion in that the value of soil nutrient loss caused by soil erosion itself (largely the result of poor farming practices) is calculated to be approximately US$625 million each year (in 2001/2 prices) in Uganda. This is a truly enormous loss to the country – more than the entire value of manufacturing. It corresponds to an 11% share of GDP[1]. Not only are there direct losses to productivity to consider. Ameliorating the effects of natural resource degradation costs the public money that may otherwise have been better invested.

In addition to the livelihoods values are the significant non-use values attributable to forest ecosystems. People throughout the world put a value on the existence of these ecosystems, and there are values held about the bequest value for future generations. The social value of forests is reflected in a willingness to pay to ensure their maintenance.

[1] Using a 2001/2 GDP figure of $5.7 Bn.

2.3. Poverty Reduction Strategy and Forestry

2.3.1 PRSP and PEAP process

The World Bank and the International Monetary Fund developed an approach to enhance the poverty impact of their concessional assistance in low-income countries. Those countries receiving debt relief under the Highly Indebted Poor Countries (HIPC) initiative were the first to benefit, including Uganda. The focus of the approach is to help recipient countries build more effective poverty reduction strategies through a participatory and inclusive process. These strategies are then expected to form the basis for a joint Poverty Reduction Strategy Paper (PRSP), which brings together the country's own strategy and Bank-Fund assistance to the country. In brief, the PRSP is an effort to help mainstream poverty reduction in the recipient country's public policy. As such, PRSP should start from existing government strategies and build on them.

In the case of Uganda such a strategy had existed for several years. Uganda was one of the first low-income countries to prepare a comprehensive and participatory national strategy for poverty reduction. The formulation of Poverty Eradication Action Plan (PEAP) in 1996-97 was an effort by the executive branch of the government to make this commitment and vision operational.

The PEAP has guided the formulation of government policy since its inception in 1997, and is currently being revised. Under this plan, Uganda is being transformed into a modern economy in which people in all sectors can participate in economic growth. This implies a number of conditions:

- The economy requires structural transformation, including the modernisation of agriculture, the development of industries that build on demand and supply linkages from agriculture, and continued institutional development in the legal and financial sectors.
- Poor people must be able to participate in this growth, both by expanding smallholder agriculture and by increasing employment in industry and services.
- Economic growth must be sustainable, high quality and broadly based.
- The non-material aspects of poverty must be addressed. Participatory studies have shown that insecurity, illness, isolation, and disempowerment are as important to the poor as low incomes.

Uganda's Poverty Eradication Action Plan (PEAP) is established on four major pillars:

- Creating a framework for economic growth and transformation
- Ensuring good governance and security
- Directly increasing the ability of the poor to raise their incomes
- Directly increasing the quality of the life of the poor.

The revision of the PEAP in 2000 drew on the progress made since 1997, including the development of sector-wide approaches, the participatory research carried out by the Uganda Participatory Poverty Assessment Project (UPPAP), the constraints identified in the Poverty Status Report, and the development of costing of public actions and indicators for monitoring in key, poverty-oriented sectors.

2.3.2 Omission of the Forest Sector in PEAP Process

In the 1997 PEAP development and in the 2000 revision, forests and the forestry sub-sector were not fully considered in the planning framework. This was partly because the value of the environment and its role in people's livelihoods was poorly understood.

The current revision (2004) process has been a much more inclusive process including forests and fisheries as specific sub sectors. However evidence of the importance of forests within the revision process is mainly qualitative and points towards a lack of wealth disaggregated data on which to base quantitative judgements about the role of forests in poverty alleviation.

2.3.3 The Uganda Forest Department Restructuring

In 1998 a National Forest Plan was produced which identified the need to reform the Forest Department, and to give the new National Forestry Authority (NFA) the autonomy and management freedoms required to achieve clearly defined objectives. The management of the Forest Department had not been able to meet the public's expectations. By its own assessment, the Department lacked transport, working funds, motivation and a clear mission. As a consequence, the Central Forest and District Forest Reserves had insufficient protection, investments and private sector and local community involvement. Outside the reserves, the Department, for the same reasons, was carrying out little forest extension work.

The new Forestry Policy passed by the Cabinet in March 2001 reflected this situation, stating that the institutional framework for the forest sector will be strengthened and that the Government is committed to the transformation of the present Forestry Department into an autonomous authority. The approval to prepare the legislation to create the NFA was given by Cabinet in October 2001. A National Forestry and Tree Planting Act gazetted in August 2003 provided the enabling clauses for the National Forest Authority.

The new NFA is organised as a parastatal, which will supervise the portfolio of central forest reserves and the District Forest Services will manage local forest reserves and provide support to private forest owners.

It is assumed that the delivery of public goods, such as environmental services and community benefits, will be improved under the NFA management, which will operate with freedoms and planning horizons that the Forestry Department did not have. As a government-owned organisation, the NFA Performance Contract will specify the balance it must achieve between income generation and the delivery of public goods and services.

However a new dynamic will be established. Unless political will to finance public goods activities is present from the government and international community there may be a tendency to develop a profit making focus for the authority with an increasing focus on revenue generation. The appropriate incentive for the government to maintain the focus on poverty alleviation may not be evident unless the full economic benefits of public goods services from forests are properly quantified.

2.3.4 Market failure and the role of the state in forest management

Market failure is the less than optimal functioning of a market to provide goods or services over a given period. Two such sources of market failure occur in the provision of public goods and in externalities.

Public goods have two attributes that discourage private markets because profits and benefits cannot be appropriated by the supplier:

- Public goods are non excludable, in that once produced, non paying consumers cannot be prevented from benefiting from using the goods.
- Public goods are non sub-tractable in that the consumption of the public good by one individual does not diminish its supply to another

The ecosystem services provided by forests are a classic example of a public good. If an individual or group have ownership or control of a forest to exploit it, they are not easily able to realise in financial terms a return from the public goods that are provided by it. Hence there is no financial incentive to conserve natural forests to ensure the provision of the public goods.

Externalities exist when the production or consumption of a good or service has a spill over effect on other individuals that are not fully reflected in the market price so that a good may be under or over provided on the market. Externalities can be ***positive*** i.e. reduced risk of infection to other members of the community after receiving a vaccination, or ***negative*** i.e. where the costs of soil and water degradation from timber extraction are not included in the price for timber products.

Uganda has recently moved into a national fuel wood deficit and the geographical distribution of fuel wood scarcity is very uneven (National Biomass Study, 2003). In some districts there is an acute shortage, and this has stimulated a market response. Deforestation causes increased fuel wood costs, both in terms of money and time spent in collection. When wood becomes scarce, prices typically increase and this can trigger more investments in tree growing. Wood supply can thus to a large extent be ensured by allowing markets to develop for wood from plantations and trees on-farm. Alternatively other unregulated or illegal natural timber harvesting may be a course of action to meet supply

However, markets typically fail to respond to loss of environmental values. Deforestation also causes reduced supply of non-wood products, reduced environmental services such as watershed protection and soil protection, and reduced biodiversity. Market mechanisms are unlikely to save natural forests and the important social and environmental services they provide. Clearance of forest for agricultural development is currently more profitable than sustainable forest management. An underlying issue is the difference between financial and economic values attributed to forests and the need for individual forest users to maximize profit in the short term. Many economic values such as the ecosystem values of forests do not realise a tangible stream of financial benefits in the short term to individual forest users.

Such circumstances require the intervention of the state to develop and implement policies to avert market failure. In doing so they have two main options open:

- ***Productive policies*** that correct for market failures to improve efficiency and bring about increases in social welfare

- ***Redistributive policies*** that alter the distribution of income or wealth, so that some gain at the expense of others

The state possesses three broad types of policy instrument to intervene in the supply of goods and services:

1. Direct government provision through a state agency i.e. NFA
2. The use of taxes and subsidy to influence private behaviour i.e. sales tax on forest products
3. Regulation of private service providers i.e. licensing of timber concessions

The appropriate choice or combination of responses will depend on the exact nature of the market failure and the prevailing institutional framework and capacity. It is clear that in order for the NFA as a state agency to be able to manage the supply of public goods and mitigate negative externalities it will not be possible for them to raise finances for this from market based activities; the NFA will continue be reliant on state and international sources of revenue to ensure that market failures can be rectified.

2.3.5 Environmental Economics to inform processes

In the NFA Business Plan an explicit assumption is that the biodiversity of the natural forests in some of the Central Forest Reserves (CFR) is of national and international importance. The revenue potential from some of these reserves is far less than the cost of proper protection and restoration, although some do have eco-tourism potential. All reserves designated under the Forestry Nature Conservation Master Plan are under prescriptions whereby 50% of the area of the natural forest estate is designated for productive activities. A further 30% is designated as buffer zone where extraction activities are limited to fuel wood and non-timber forest products and a further 20% is designated as strict nature reserve (Forest Department, 2002).

It is clear that the NFA will need long-term financial assistance with the management of some of these natural forests. This public good element has been conservatively factored into the financial projections of the NFA Business Plan as an annual stream of USh 0.3 billion in year 2, and increasing steadily up to USh 1.5 billion by year 5. It has been proposed that the NFA will solicit funding from the Government of Uganda and international community to help finance public goods and environmental services. Work has already started on accessing carbon financing for tree planting in the CFR, and the expansion of this type of innovative financing and the international marketing of environmental services provided by Uganda's forests, will form part of the NFA management mandate. It is assumed that the level of investment to finance public goods and services will correspond with the NFA's overall reputation as a service provider and capable custodian of Uganda's CFR.

The assumptions and considerations described above give rise to some important questions:

1. Is the money estimated in the NFA business plan enough and does it represent a rational level of expenditure on public goods activities?

2. What are the types of policies by which the government and the NFA can raise the revenue needed to fully engage in the conservation of public goods from forests?

3. How can the success of the management of the stream of public goods from the forests by the NFA be measured?

Restructuring is a significant step in providing forestry services that are responsive to market demands. The new dynamics between government and NFA requires the NFA to lobby hard to ensure that sufficient finances will continue to be made available for the management of public goods activities. However ensuring the delivery of public goods requires a thorough understanding and detailed quantification of the economic benefits for forests beyond the marketable goods and services.

2.4. Valuing Uganda's Forests

2.4.1 Historical valuations in Uganda

This study builds upon extensive work of Howard (1995) "The Economics of Protected Areas in Uganda; Costs Benefits and Policy Issues" and Falkenberg and Sepp (1999) "Economic Evaluation of the Forest Sector in Uganda". These studies made clear that there was a need to concentrate on valuation issues where there was little reliable quantitative data in order to make specific recommendations about forests on a case by case basis and support policy and decision-making.

In addition broader studies by Yaron et al (2003) "The role of the environment in increasing growth and reducing poverty in Uganda" and Emerton & Muramira 1999, " Uganda Biodiversity: An economic assessment", indicate that there are few quantitative data on the role the forestry sub-sector plays in enhancing food security and the role they play in rural livelihoods. Anecdotal evidence suggests that particularly during dry seasons, rural households obtain a significant amount of their nutritional requirements from forest resources, be they fruits, vegetables, mushrooms, honey or herbs. The extent to which the poorest segments of society depend on forests is presented in Figure 1.

The forestry sub-sector makes important contributions, both formally and informally, to the economy of Uganda. The rural location of most forests means that any economic activities in the sub-sector are ideally suited for the attainment of poverty eradication goals. Unfortunately, the sub-sector is more difficult to characterise than most other productive and commercial modern sectors. In Uganda, the value of the sub-sector in terms of its contribution to national welfare or even contribution to gross domestic product (GDP) is very difficult to measure due to: unrecorded outputs that go into subsistence consumption, meeting basic needs of rural populations (energy, food); informal trading, illegal trading to evade taxes and fees; and difficulties associated with valuing ecological services (Falkenberg and Sepp, 1999).

The current officially reported figure for the contribution of forests to Uganda's GDP is about 1.9%. When compared to the figure of 6% for the contribution of the worlds forests to global GDP this seems low. The official figure in Uganda only takes into account the value of timber at the forest gate and not the added value activities post harvest. Falkenberg and Sepp (1999) recalculated the GDP figure to include processing and value added activities and came up with a revised amount of 6.1% of GDP. However even the revised figure does not fully take into account informal consumption of forest products and the value of ecosystem services. A forest department estimate calculates that about 70% of wood consumption in Uganda is in the informal sector. This indicates that the true value of forests to the national economy may be much higher.

2.4.2 Livelihoods and Ecosystems Perspectives

The studies mentioned in the previous section are an important step forward in realising the value of Uganda's forests and have helped to develop a good qualitative understanding of forest values and framework for analysis. However they have been very macro in scope and have not collected any primary data on forest resource use. As has been stated in several of the studies a significant shortcoming in their estimates has been the lack of any wealth disaggregated economic data on people's use of forests.

The main effort of this study was therefore to collect primary economic data on peoples use of selected forest types and the trade in selected forest products to develop a detailed understanding of the financial and economic value of forests in local peoples livelihoods as well as data that would contribute to the development of better national measures of the worth of forests.

- The **landless** use forests for food production, firewood, wild food, employment and income.
- Poor **women**, especially widows and female headed families, use forest resource as alternative or supplementary land for food production, for firewood, income generation and for food, water and herbal medicine. For example in Moyo District, poor women engage in fish smoking, rope-making, basket weaving, baking, beer brewing, and selling firewood or charcoal, in other to supplement their income.
- Poor **smallholder farmers** use forest resources for fodder, green manure, firewood, building materials, wild food and medicine, seasonal employment and income during lean seasons.
- **Cattle keepers** in drought – prone areas use forest resources especially during the dry season when they experience shortages in fodder and water. Cattle keepers seasonally use forest and game reserves in Karamoja, Masindi and Kabarole.
- **Minority ethnic groups, forest dwellers** (such as the Batwa) and **communities living adjacent to the forests** are usually isolated, with poor access to social services. Forests provide sanctuary, food, recreation and cultural and spiritual sustenance.
- **Fishermen and women** use forest and trees for constructing canoes and as fuel for fish smoking.
- The formerly **unemployed youth** use forests as sources of employment and income from e.g. charcoal, brick and lime production.
- For the **internally displaced** (400,000 in 1998), **refugees** (180,000 in 1998) and those living in areas prone to natural disasters, forests offer shelter, firewood, food security from wild foods and the possibility of transitional employment.
- Only 20% of urban households have access to electricity and, coupled with the high cost of living in cities, this creates a high demand for charcoal and firewood, especially among the **urban poor**, for cooking, heating, lighting and beer brewing.

Source: MWLE (2001)

Figure 1. Key features of the importance of the forestry sub-sector to sustainable rural livelihoods (MWLE, 2001).

2.4.3 Methods

In order to achieve the objectives three methods were employed:

1 Household Survey

A household survey of local people's use of the forest was made. Data from the household survey were used to understand financial benefits of forests to households as well as to understand some aspects of the role of forests in reducing vulnerability.

2 Market Survey

Using focus groups and key informants a financial estimate of the values of selected forest products (bamboo, rattan, charcoal) were made at markets.

3 Evaluation of Secondary Data

Secondary data were collected and analysed to estimate the economic and financial values of forest ecosystem services and the role they play in the economy as well as financial revenues from timber harvesting. Information from the national biomass study, forest inventories and forest timber production figures were used, as well as other applicable international data.

A detailed description of the methods is in **Appendix 1**. For ease of access to the main findings it was not included as a section in the main body of the report.

2.4.4 Selection of study sites

Four forest sites were surveyed representing the four predominant forest types in Uganda described in the table below.

Table 2. **Sites and description of survey areas**

Forest Site	Classification	Area (ha)	Status
Budongo	Medium Altitude THF	79,300*	Forest Reserve
South of Bugoma	Riverine/Gallery forest	128,804**	Private Forest
Kasagala	Savannah Woodland	10,105	Forest Reserve
Rwenzori	Afromontane Forest	97,380	National Park

*Total area of CFR but only 42,800ha is THF; Area of THF in **Area of surrounding forest – not the area of Bugoma CFR itself; THF=Tropical High Forest

Understanding the values associated with different forest types will assist in developing a more accurate estimate about the value of Uganda's forests to the economy. From recent forest biomass studies conducted by the Forest Department, an accurate estimate of the area under each forest type was available. This allowed measures of economic values to be scaled up to make an estimate of the value of the total value of Uganda's protected forest areas to the national economy.

The methods were used to create a matrix of economic and financial, values derived from the forests in order to create an understanding of the Total Economic Value (TEV) of the selected forest types. The different data collected and associated valuation method that was used in their subsequent analysis at different policy levels are given in table 3.

Table 3. **Data requirements for Valuations**

Type of Forest good or service	Type of value	Valuation technique	Data source/approach/policy level
NTFP: Handicrafts, Rattan, Bamboo Bushmeat	Direct Use	Market Prices	House hold survey – proportion of income from forest products – Local Household survey - Economic Value – Local Market surveys Secondary data/market survey– use of NTFP in the production of handicrafts - Local, National Market surveys
Charcoal,	Direct Use	Market prices	House hold survey – proportion of income from forest products – Local Secondary data/market survey– use of NTFP in the production of handicrafts - Local, National Market surveys
Recreation	Direct Use	Market prices	Secondary data – Recreational revenue derived from forest areas - Local and National
Watershed protection	Direct Use	Damage Cost Avoided	Household – Local, National Secondary/ manufactures data - Cost of borehole provision – local, district, national
Social/existence Value	Indirect Use	Contingent Valuation	Household survey – Economic value - Local
Carbon Sequestration	Indirect Use	Damage Cost Avoided	Secondary Data – National, Global
Grazing (in woodlands)	Direct Use	Market prices	Household Survey – Local
Timber	Direct Use	Market Prices	Household Survey – Local Secondary data – Timber revenues

3.0 Results

3.1 Layout of results

This section presents the results of the analysis of household survey, contingent valuation and market survey data collected. Data were analysed using SPSS™ and LIMDEP™. It was not possible to analyse and present all of the data collected during the survey in this technical report. Where elements of data collected using the survey sheets (Appendix 2 and 3) are not presented in the report it is because it was felt that that their presentation in this report would not add significantly to the policy level discussion. It is anticipated that further analysis will be conducted and more detailed technical reports produced about specific issues such as medicinal plant use and bushmeat harvesting.

Section 3.2 reports on the household survey and is structured to build a picture of the basic social and economic characteristics of the households interviewed and the economic role of forests in supporting forest users livelihoods.

Section 3.3 reports on the calculation and significance of the contingent valuation exercise.

Section 3.4 uses the data derived from this survey along with secondary data to estimate ecosystem and other direct use values.

Section 3.5 deals with the market survey results

S**ection 3.6** presents the total economic value of Uganda's forests and a revision of the contribution of this value to Uganda's GDP

The questionnaires used respondent's recall and own reported values regarding quantity and use of various resources. Interpretation of results must take into account the potential sources of bias, inaccuracy and imprecision which might cloud the truth. Typical sources of error in such a survey are poor recall of the facts regarding resource use or consumption, withholding information for fear of taxation, because it is illegal or cultural reasons, and second-guessing the purpose of the survey especially if it were perceived that some project benefits in a locality might occur.

Many of these sources of error can be planned for in the structure and delivery of questions in the survey, triangulation on households responses by observing their actual situation in the home, clear statements of purpose regarding the survey, proper introductions to community leaders and local authorities and participatory exercises as an entry point to the survey. The two main sources of error in this survey were probably from poor recall of income and consumption in the previous year, and understatement of consumption of forest resources, especially where they were illegal. The effects of such error will be to systematically undervalue the forests and in the authors' opinion the magnitude could be up to a 10% to 30% under estimation for certain respondents.

3.2 Household Survey

A total of 696 households (table 4) were interviewed amongst the four survey sites in 70 LC1s. An LC1 is equivalent to a village. The number of LC1s sampled around each area varied slightly because of time constraints and access issues. It was especially problematic around the Rwenzori massif where communities were often extremely remote requiring a lengthy drive to a drop off point with the team continuing for several hours on foot to the LC1 centre. The number of households interviewed in each LC1 also varied slightly because of time and distance constraints, especially where households in an LC1 were diffuse over a wide area.

Table 4. **Households and individuals sampled**

Forest	Number of LC1 Sampled	Observations/households (n)	Total no of individuals represented
Budongo	18	180	1043
Bugoma	19	179	1098
Kasagala	17	176	1020
Rwenzori	16	161	1277
All Forests	**70**	**696**	**4438**

3.2.1 Household composition

Households on average varied between 6-8 people per household with slightly more women to men (Table 5). A high percentage of households were headed by women apart from around the Rwenzori mountains.

Table 5. **Household composition by forest and for all forests combined (all forests)**

Forest	Observations (n)	Mean Nº Individuals	Mean Nº Females	Mean % females	% female headed
Budongo	180	5.79	2.93	49.62	11.11
Bugoma	178	6.14	3.15	49.41	13.41
Kasagala	176	5.80	2.77	45.62	21.59
Rwenzori	162	7.91	3.83	48.08	3.11
All Forests	**696**	**6.38**	**3.15**	**48.20**	**12.50**

Households in the Rwenzori had a significantly higher mean number of individuals (*ANOVA*: F=16.705, d.f.=3,651 p<0.001 – *Tukey HSD Test*) and mean number of female members in the household than other survey sites (ANOVA: F=9.629, d.f.=3,651 p<0.001 – Tukey HSD Test). There was no significant difference between mean percentage numbers of female members by forest site.

3.2.2 Livestock

Ownership of livestock may be considered to be an indicator of wealth, although the significance and capacity of households to accumulate wealth through livestock may vary according to agro ecological zones (Table 6).

Table 6**. Mean household livestock numbers and for all households combined (All forests)**

Forest (n)	Mean NO Goats	Mean NO Sheep	Mean NO Pigs	Mean NO Poultry	Mean NO Cows
Budongo (154)	2.02	0.19	0.70	8.15	0.72
Bugoma (175)	1.78	0.40	1.18	6.60	0.91
Kasagala(151)	2.72	0.01	1.67	6.87	9.46
Rwenzori (159)	1.46	0.38	0.60	2.54	0.22
All Forests (639)	**1.98**	**0.27**	**1.04**	**6.03**	**2.71**

There was no significant difference in the mean numbers of goats, sheep or pigs kept by households between forest areas. However the numbers of chickens kept in the Rwenzori were significantly lower than in the other forest sites (ANOVA: F=11.570, d.f.=3, 634, p<0.001 – Tukey HSD Test). Overall Kasagala had a significantly higher number of cows (ANOVA: F=30.131, d.f. = 3, 634, p<0.001 – Tukey HSD Test).

Table 7. **Number of households without livestock**

Forest (n)	Number Observations	Nº without livestock	% without livestock
Budongo	154	16	10.4
Bugoma	175	17	9.7
Kasagala	151	20	13.2
Rwenzori	159	77	48.4
All forests	**639**	**130**	**20.3**

A Chi Square analysis of the frequency of households without livestock showed that households in the Rwenzori were significantly less likely to have livestock (table 7) than households in the other survey sites (X^2= 103.697, d.f. = 6, p<0.001).

In relative terms this may point toward the accumulation of wealth through the acquisition of livestock being more difficult in places that do not favour animal husbandry for agro ecological and demographic reasons. For example in the Rwenzori the mountainous terrain and high population density may make keeping large numbers of grazing animals difficult. Not being able to accumulate livestock as a form of livelihoods security or capital may lead to the need to greater dependence on other resources such as forests.

3.2.3 Material Possessions

Another indicator of wealth, which may be more comparable across regions, is the quantity of material possession a household is able to accumulate (table 8), especially where those possessions are able to contribute to wealth creation (eg. bicycles and motorcycles for transport of goods to market).

Table 8. **Mean number of households owning a radio, bicycle or motorcycle**

Forest	Number Observations	Mean Nº Radio	Mean Nº Bicycle	Mean Nº Motorcycle
Budongo	154	0.82	0.68	0.120
Bugoma	175	0.82	0.63	0.009
Kasagala	151	0.75	0.74	0.005
Rwenzori	159	0.48	0.21	0.000
All forests	**639**	**0.72**	**0.56**	**0.006**

Rwenzori households were significantly less likely to own a radio (ANOVA: F=21.128, d.f.= 3, 634, p<0.001 – Tukey HSD Test) or a bicycle (ANOVA: F=35.438, d.f.=3, 634, p<0.001 – Tukey HSD Test) than households in the other survey sites. Both Rwenzori and Kasagala were significantly less likely to own a motorcycle than other survey sites (ANOVA: F=5.433, d.f. = 3, 634, p=0.001 – Tukey HSD Test).

3.2.4 Wealth and Forest Use

An informative approach to the analysis of how forests contribute to livelihoods is through the analysis of the importance of forests to different wealth groups. The sampling was structured to ensure three different wealth groups were surveyed (poor, average wealth and relatively rich) in each LC1.

In addition wealth is a relative concept depending on unit of analysis. A household that earns a million shillings per annum and has 5 members is perhaps more wealthy on a per capita basis than a household that earns a million shillings and has 10 members. However, a larger household enjoys better economies of scale than smaller households with more labour available for different activities. In addition the composition of a household in terms of age and sex structure affects levels of production and consumption of the household as a unit of analysis. In order to make valid comparisons in absolute terms across households an adjusted household income was used in this study.

Adjusted income was calculated by dividing the total income by a factor comprised of two coefficients of adult equivalency and economy of scale derived from World Health Organisation data. Whilst not perfect this helps to account for biases other wise introduced if comparisons are made on the basis of unadjusted income. Effectively the adjusted income value gives a figure that depicts household income on the basis of a standard adult unit. Table 9 shows average values for different categories of income and adjusted income and presents average household size in order to compare the effects of using the adjusted income measure.

Table 9**. Comparison of income and adjusted income measures broken down by forest and wealth group.**

Forest	Average Number Household Occupants	Average Household Total Income USh p.a.	Average Adjusted Household income USh p.a.	Average Household Forest Income USh p.a.	Average Household Adjusted Forest Income USh p.a.
Budongo					
Poor	4.9	858,005	318,383	169,714	60,273
Average	6.4	1,250,512	337,030	65,252	18,749
Wealthy	7.0	2,284,889	552,227	112,378	29,746
Bugoma					
Poor	4.9	1,040,231	388,569	299,197	117,581
Average	6.12	1,726,783	594,192	173029	48,265
Wealthy	7.5	3,011,946	680,223	492,490	103,060
Kasagala					
Poor	4.9	773,544	348,651	85,102	60,562
Average	5.6	1,159,898	420,108	217,651	89,176
Wealthy	7.9	3,143,584	803,575	230,566	58,612
Rwenzori					
Poor	7.1	1,601,337	426,489	595,636	192,455
Average	8.2	2,465,609	500,234	1,105,160	210,249
Wealthy	8.6	2,342,881	586,338	795,937	177,010

The frequency chart (Figure 2) shows the number of observations in adjusted household income groups. The frequency table shows clearly, on an absolute scale, that the sample of households is heavily skewed to those with lower adjusted income and in wealth terms is not normally distributed. Therefore in the analyses that used wealth as a parameter, non-parametric tests were applied.

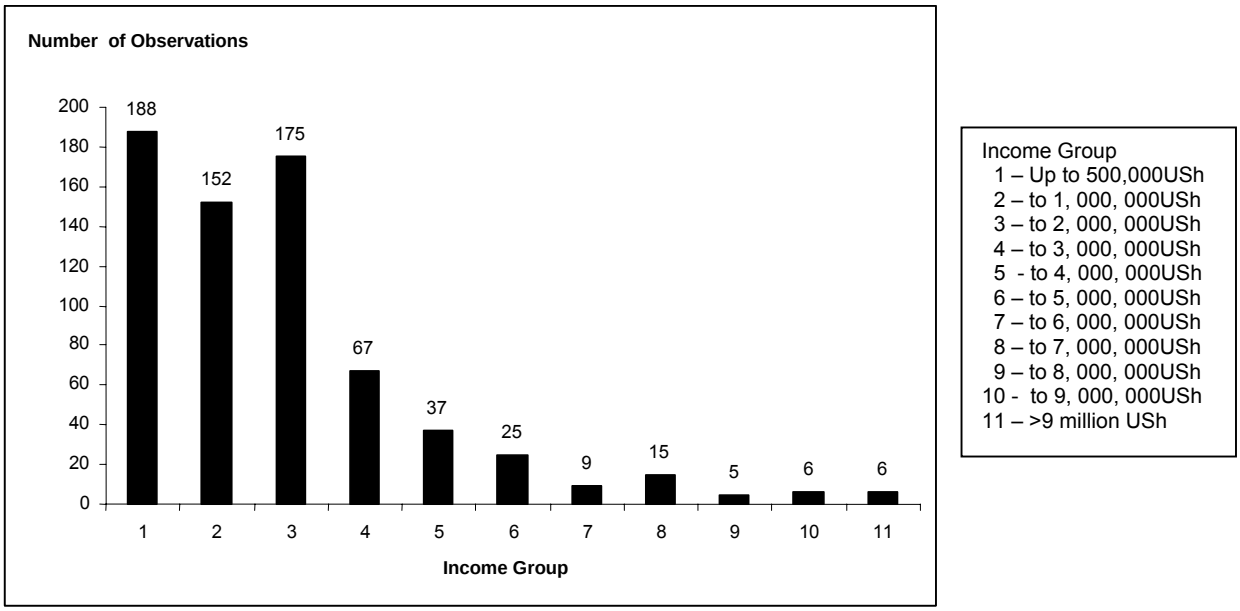

Figure 2. Frequency of observations per income group

Interestingly between category 3 and 4 there is a big difference. This may be attributed to the cut off points made between categories. In order to relate the frequency chart to our wealth categories, income groups 1 to 3 were considered to be the poor category, 4 to 8 the averagely wealthy category and 9-11 the wealthy category.

a) Household Income

As income data does not fit a normal distribution the *Kruskal-Wallace test* was used to analyse ranked sample means. Adjusted household income was calculated to adjust for the size of the household and the number of income earning members (Table 10). Adjusted household income showed no significant differences between forests. However mean total incomes were significantly different between Budongo and the Rwenzori where the Rwenzori had the highest household income (X^2= 17.347, d.f.=3, p=0.001).

Table 10. **Mean adjusted and total annual household income by forest and also mean forest income and the percentage contribution to total income from the forest.**

Forest (n)	Mean Adjusted income USh p.a.	Mean total Income USh p.a.	Mean income from the forest USh p.a.	Mean % income from the forest
Budongo (154)	394,287	1,411,655	118,672	8.4
Bugoma (175)	562,589	1,963,407	320,049	16.3
Kasagala (151)	528,302	1,714,746	182,512	10.6
Rwenzori (159)	492,357	2,040,622	727,104	35.6
All Forests (639)	**496,457**	**1,790,495**	**339,696**	**19.0**

Households in the Rwenzori had significantly higher levels of income from the forest in terms of absolute value and proportion of income than all other sites (X^2= 66.199, d.f.=3, p<0.001). In addition Rwenzori households derive a significantly higher absolute and proportion of income from the forest than in any other site (X^2= 38.192, d.f.=3, p<0.001).

Households around Budongo showed lowest forest incomes in absolute and proportional terms. This is most likely because it is the most heavily "policed" forest rather than it being less "rich" than the other forests, in terms of available forest resources. The data also suggests that living near a forest can actually boost household income substantially. Without the current access that households currently have to forests it is likely that they would become significantly poorer should there be no change in other aspects of their livelihood.

It is also of interest to understand how the use of forest products is broken down between cash income and consumption (table 11).

Table 11. **Household income from forests separated into goods sold and goods consumed**

Forest (n)	Mean value of goods sold USh p.a.	Mean value goods consumed USh p.a.	Mean income from the forest USh p.a.	Value of goods consumed as % of total forest income
Budongo (154)	39,134	79,538	118,672	67.0
Bugoma (175)	56,919	263,130	320,049	82.2
Kasagala (151)	82,266	100,246	182,512	54.9
Rwenzori (159)	153,334	573,770	727,104	78.9
All forests (639)	**82,913**	**254,170**	**337,083**	**75.4**

In absolute terms there was a significant difference (ANOVA – F=4.212, d.f. = 3, 634, p=0.006) between the mean values of forest goods sold between forests with Rwenzori and Kasagala showing the highest averages. In terms of the value of forest goods consumed in the household Rwenzori was significantly higher than all other forests surveyed (ANOVA – F=18.966, d.f. =3, 634, p<0.001).

When considering the value of forest goods consumed as a proportion of the total income from the forest households it can be seen that households in Kasagala consume proportionately less of the value of forest products in the home (ANOVA – F=38.588, d.f. =15.496, p<0.001). This demonstrates that households around these forests are much less reliant on the forest in securing their basic livelihood. Alternatively it may also illustrate that because Kasagala is a woodland, there is substantially less woody biomass generally, and less diversity of species (wildlife, foods and craft materials) as compared with a Tropical Forest, that can be consumed in the household. Typically from woodland the most important product is charcoal and in the villages, people may sell it rather than use it, preferring to use firewood instead.

A break down of mean value of household income from non-timber forest products (NTFP) and timber products was also made (table 12).

Table 12. **Sources of forest revenue by type**

Forest (n)	Observations (n)	Annual NTFP Income Value USh p.a.	Annual Timber income Value USh p.a.*	Timber value as a % of mean forest income
Budongo	180	55346	48595	46.75
Bugoma	179	117215	197007	62.69
Kasagala	176	47182	110605	70.00
Rwenzori	161	518348	303025	36.00
Total	**696**	**176296**	**161300**	

* Firewood and charcoal included under timber income

Analysis of the mean NTFP incomes showed that households in the Rwenzori had the highest income from the forest derived from NTFP compared with the other forests and this difference was significant (ANOVA – F= 15.306, d.f. = 3, 695, p<0.001 – Tukey HSD test). In terms of timber values, households around Rwenzori also derived the highest mean incomes, with Rwenzori being significantly different from other forests (ANOVA - F= 8.741, d.f. = 3, 695, p<0.001 – Tukey HSD test). It might have been expected that Budongo Forest, the main timber forest in Uganda, would have had high income values for local communities from timber, but the results show the lowest income values for this forest from timber. This may be due to reasons such as:

- Good enforcement of regulations to halt illegal timber harvesting in the forest
- Pitsawyers are often employed from outside the region because they work harder and then return home having completed the job. The local community is usually used as porters only. As such pitsawyers are transient members of local communities and income derived from this activity do not accrue locally. Therefore values derived from pitsawying may be largely under reported.
- A reluctance to admit to illegal harvesting of timber given the law enforcement efforts

b) Household income by wealth group

An analysis of household income by wealth group was conducted where group 1 was the poorest and group 3 was the wealthiest as classified by the members of each community (Table 13). The Kruskal Wallace p value and its significance refer to the difference between wealth groups in a forest area, not between forests. Kruskal Wallace p value was the measure of the probability that the values between wealth groups were significantly different. In table 15 wealth groups are presented according to the relative measure of wealth by the wealth ranking exercise.

In Budongo, Kasagala and Rwenzori there was no significant difference found between wealth groups in absolute forest income. In Bugoma total forest income was not significantly higher for wealthier households. However, in percentage terms the poorest households derived significantly more income from forests than the wealthier categories.

Table 13. **Mean household incomes from the forest separated by wealth group & forest**

Income Type	Budongo	Bugoma	Kasagala	Rwenzori
Forest Income USh				
Wealth Group 1 = Poor	169,715	299,197	85,102	595,637
Wealth Group 2 = Average	65,252	173,029	217,652	1,105,161
Wealth Group 3 = Wealthy	112,378	492,490	230,567	795,974
All Groups	108,782	320,049	182,512	727,104
Kruskal Wallace p	0.554 NS	0.29NS	0.084NS	0.457 NS
% Income from forest				
Wealth Group 1 = Poor	16.60	24.28	17.57	28.90
Wealth Group 2 = Average	8.83	12.79	20.90	30.32
Wealth Group 3 = Wealthy	8.72	15.89	12.36	24.10
All Groups	10.75	17.27	17.02	27.27
Kruskal Wallace p value	0.131 NS	**0.007**	0.571 NS	0.705 NS

NS = Not Significant (between wealth groups)

An alternative way of analysing wealth is to order the sample and divide it into three groups based on total adjusted income combining all forests. Each wealth group is made up of the first third in terms of total adjusted income then the next and so on. Group 1 is the poorest and group 3 is the wealthiest. A Kruskal Wallace test was made of the mean ranked forest income comparing between wealth groups calculated from total adjusted income. The test statistic showed that there was no significant difference in household income from the forest between quintile groups. However there was a significant difference between quintile groups in terms of percentage income derived from forests (X^2= 66.199, d.f. = 3, p=0.000).

In absolute terms there is no significant difference between rich and poor in the amount of income derived from forests. However as a proportion of total income, poor households derive a significantly higher level of income from forests than rich. This is a strong indicator of the economic reliance that poor people have on forests.

c) Wealth and forest use

A multivariate analysis (principal components) was performed to understand the relationships between variables that reflect some measure of wealth and forest use. The variables used in this analysis were:

1. Household total occupants
2. Income from the forest
3. Adjusted household income
4. Ownership of a radio
5. Ownership of a bicycle
6. Ownership of a motorcycle
7. The total value of material assets
8. Number of goats
9. Number of pigs
10. Number of cows
11. Total value of livestock assets

The analysis takes the eleven variables and tries to explain the maximum variation between households as a factor of the variables themselves. A line (PCA Axis 1) is fitted equating to the maximum variation through a cloud of points in an eleven dimensional space. A second line (PCA Axis 2) is then fitted to explain the next greatest variation in the points while constraining it to be unrelated to axis 1. The result is two uncorrelated axes that maximise the variation between households (figure 3). Points depict levels of variance between factors. Therefore points that lie against an axis and higher up the scale along them have the greater level of variation between them than those closer to the zero point on the axis.

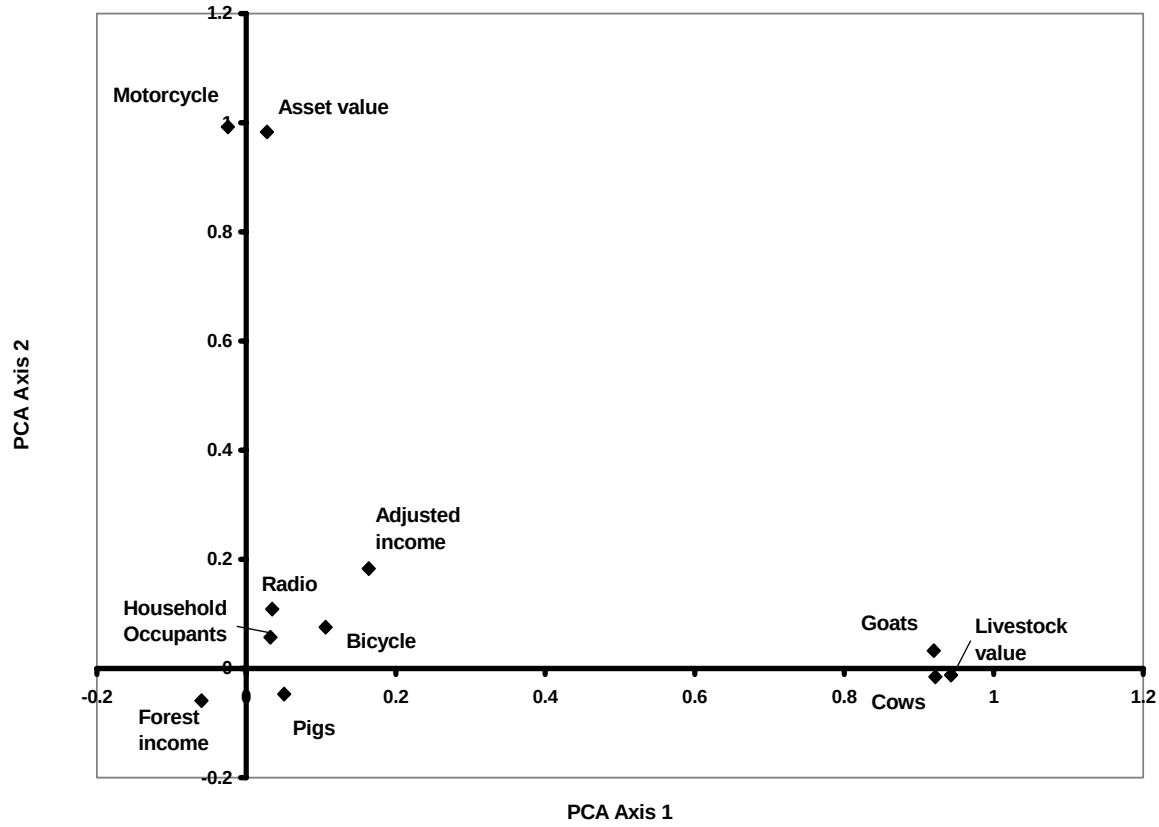

Figure 3. Principle components analysis plot of the centroids of the 11 variables entered

In addition those that own material assets such as radios, bicycles and motorcycles tend to not own livestock, as depicted by the point for livestock being at the extreme end of the X axis and for material assets being towards the extreme end of the Y axis. This shows that the ownership of livestock and material assets are unrelated to one another but both are probably indicators of wealth.

The data presented are aggregated over the four forest types, and it should be noted that the agricultural opportunities in each area differ. Fore example it could be that there is a topographical issues at play that might skew the result i.e. Kasagala as savannah woodland is much more suited to extensive livestock production and therefore households would have more livestock. This may well be the case, however the analysis compares all households over all forest areas and what it is telling us is that no matter what forest type, on a household level there is a tendency of the household to either have material possessions or livestock. Therefore regardless of forest type a household displays two different ways of capital accumulation one through the possession of material assets, the other through the possession of livestock. It is interesting to note that some of the elements of capital accumulated (bicycles, and motorcycles) are useful elements in the marketing of produce and can increase income in the same way that breeding of livestock will increase income.

An analysis of the mean household occupants between wealth groups showed that wealthy households had significantly higher numbers of total household occupants than poorer households (ANOVA – F=28.350, d.f. = 2, 634, p=0.001 – Tukey HSD). As wealth groups were allocated according to the adjusted household income, wealth per capita issues will not skew the result.

Other socio economic factors that influence household use of forests were identified. These included the distance the household lives from the forest and household size. There was a negative correlation between increasing distance from the forest (r=-0.093, p=0.019) and total forest income. However, the 'r' value was small indicating a lot of scatter around the trends. The result may reflect the opportunity cost of exploiting forest resources over using the time and energy spent on other productive activities. In addition it indicates that there are potentially some positive benefits of living closer to the forest edge and actively using the forest as part of a livelihoods strategy. However it is not possible from the data to verify if households actually chose, as a livelihoods option, to live closer to the forests to exploit them.

There was also a positive correlation between household size (r=0.113, p=0.004) and forest income. The 'r' value again was small indicating a lot of scatter around the trends. This is perhaps not surprising, as larger households will have relatively higher levels of labour resources than smaller households. This factor coupled with the observation that wealthier households also had higher numbers of occupants indicates that it is easer in terms of labour for wealthy households to exploit the forest.

An alternative method for examining the distribution of income is through a Lorenz curve analysis (Figure 4). The Lorenz curve depicts graphically the inequality in the magnitude of distribution of income between given proportions of a population. If there were complete income equality the bottom quintile (bottom 20%) would receive 20 % of the total income, the bottom two quintiles (bottom 40%) would receive 40% of the total income and so on. The Lorenz curve would then coincide with the diagonal line in figure 4. The further the curve bends away from the diagonal the more unequal the distribution. Figure 4 below depicts a Lorenz Curve of the distribution of total and non forest income amongst the survey population.

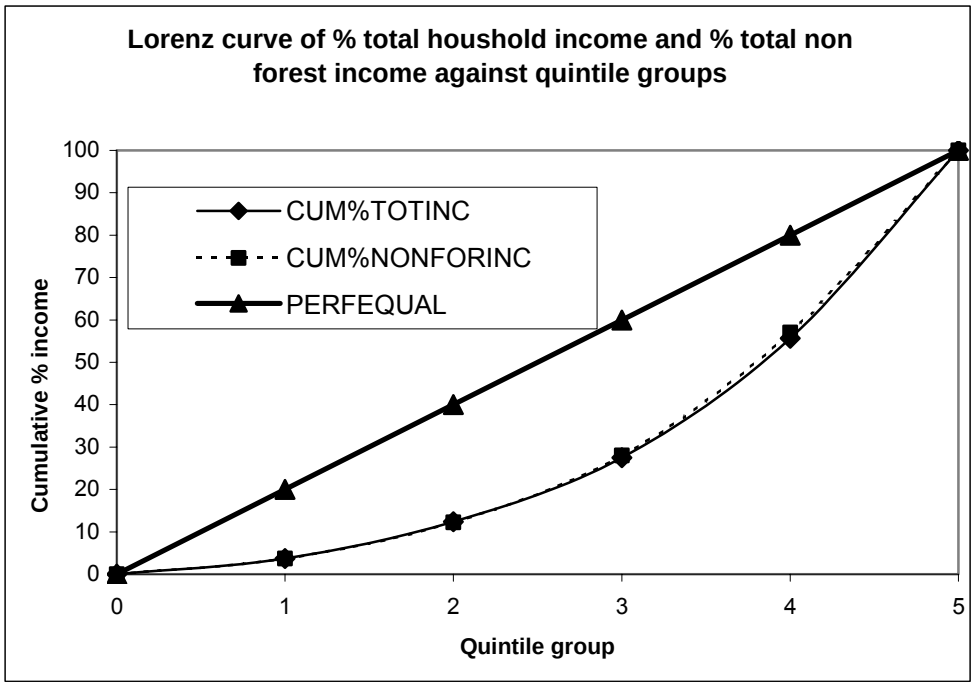

Figure 4. A Lorenz Curve analysis of Total and non-forest income for each quintile group of wealth.

The quintile groups were divided according to the measure of adjusted household income, so are comparable on the basis of income per adult equivalent unit. The chart shows that in terms of total income and total non-forest income there is inequality in the distribution of income between quintile groups with the wealthy quintiles receiving more of the income available than poorer quintiles. There is little difference in the degree of curvature between total income (TOTINC) and non-forest income (NONFORINC) however both lie lower than the line of prefect equality (PERFEQUAL). This demonstrates that total income and forest income is unequally distributed amongst the quintiles. Focusing on forest income, this indicates that wealthy households (those in the upper quintiles) gain a larger share of the total income available than poorer households (those in the lower quintiles).

3.2.5 Seasonality and forest use

The survey also investigated seasonal aspects regarding forest use. Respondents were asked questions about which months they used the forest most, which months they needed to purchase food and which months they needed cash most. A positive correlation was found between the months when the forests were used most and the months in which food was most scarce (*Spearmann* r=0.140, p=0.000). In addition a positive correlation was found between the months when forests were used most and the months in which cash was most required (Spearmann r=0.188, p=0.000).

The months of most frequent forest use overall were December through to March, which not surprisingly correspond with the long dry season over much of Uganda and a period often termed in socio economic literature as the 'hungry gap', where harvests or food stocks have run out and it will be some time before the next harvest. The above correlations provide strong evidence regarding the role of forests in reducing vulnerability and providing a buffer against seasonal shocks.

3.2.6 Spatial relations of income around forests

An analysis was made of the spatial variation in income by mapping the average incomes per parish around each of the forests (Figure 5). This shows marked variations between parishes around the same forest. Over all forests the majority of households in the parishes (LCII) surveyed derive between 0% and 40.5 % of total income from the forest. Only in the southern parts of the Rwenzori does forest income exceed 40.5%. Around Rwenzori this is probably related to law enforcement effort with higher incomes derived in the south where no patrol post exists. Around Budongo the variation may relate to availability of alternatives in the surrounding environment. In the east of the forest, more woodland exists outside the forest and households may utilise this for firewood and charcoal rather than the main forest. Other reasons for the spatial variation may be dependent on factors such as geographical isolation, proximity to markets and market opportunities for alternative, non-forest based enterprise.

In Budongo one LCII about 10km east from the forest was sampled to make a comparison between the population of forest users and non-forest users. In that community no household interviewed claimed to use the forest directly and thus values for forest income were calculated to be zero.

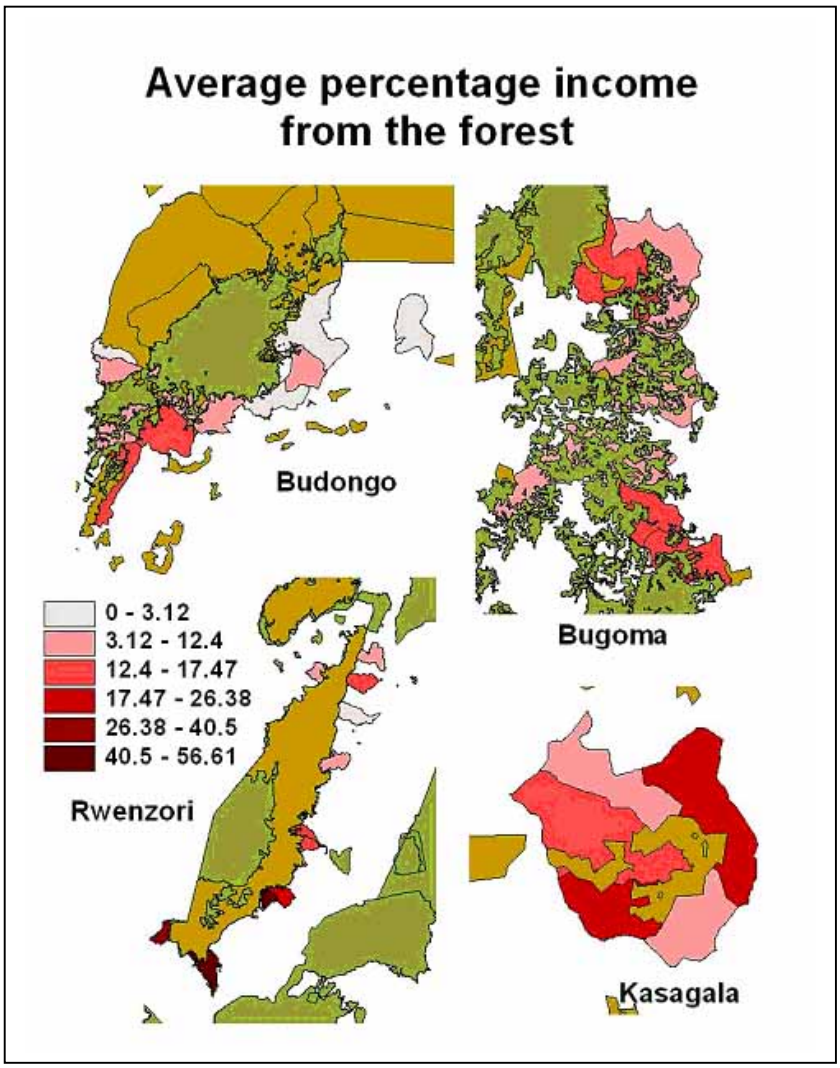

Figure 5. The percentage income derived from the forest mapped per parish for each of the four forests. It is important to note that the scale for each forest area is different.

3.2.7 Scaling up the value of forests to livelihoods

Using the results from the previous sections it was possible to make an estimate of the total financial value to local livelihoods of each forest at the level of the forests and at the national level. The calculation was based on the mean value derived per household from the forest and the total number of households that are *probable* forest users around each forest. It was then possible to calculate the average value to a household of each forest type on a per hectare basis.

Probable forest users were for the purpose of this study selected as those households resident within parishes (LCII) that share the boundary of the forest in question. Therefore they are in close proximity to the forests in terms of access. The random stratified nature of the sampling of households within parishes allows us to apply the average values obtained across households within the population of probable forest users in order to scale up the values to a forest level. The value of the four different forests per hectare was calculated per hectare (Table 15).

Table 14. **Values of forests to livelihoods**

Forest	A Area of forest (Ha)[1]	B Total N° [2]households	C Mean household income from forests USh p.a.	D Total local livelihoods value (Million USh p.a.) (B*C)	E Livelihood value per Ha of forest USh p.a. (D/A)
Budongo	79,300	12,078	118,671	1,433.31	18,074.53
[3]Bugoma	128,804	12,213	320,048	3,908.75	30,346.50
Kasagala	10,105	2,792	182,512	509.57	50,427.93
Rwenzori	97,380	32,468	727,104	23,607.61	242,427.71

[1]National Biomass Study 2003
[2]UBOS, Census 1992
[3]The area of riverine and gallery forest south of Bugoma forest reserve, not the forest reserve itself.

An estimate of the livelihoods value of these selected forest types at the national level was calculated by multiplying the values in table 15 by the area of each forest type in the country as a whole (table 16).

Table 15. **National level values broken down by Forest type, NTFP and Timber Values.** (Areas of forest were calculated from the Biomass land cover data)

A Forest Type	B Livelihood value per Ha USh	C Total Ha of forest type in Uganda	D Total livelihood value of forest type Million USh p.a. (B*C)	E NTFP value Million USh p.a.	F Timber value Million USh p.a.
[1]Protected THF	18074	427,210	7,722	4,092	3,630
Private THF Forest	30,346	350,130	10,625	3,931	6,694
[1]Savannah Woodland /Bushland	50,427	1,372,708	69,223	20,770	48,453
Afromontane	242,427	264,200	64,050	40,351	23,699
	Total	**2,414,248**	**151,620**	**69,144**	**82,476**

[1]Figure adjusted for forest type found in Afromontane zone

It is important to note at this point that the values calculated **do not** imply that the level of economic value derived is sustainable. They estimate the economic value based on current levels of use.

3.3 Contingent Valuation

This section presents the results of a contingent valuation (CV) exercise. The contingent valuation data was analysed using the LIMDEP™ econometric package. The CV questions elicit responses to a bid value regarding people's willingness to accept compensation for loss of access to the forest over a three-month period. Respondents were asked to give a yes/no response (dichotomous choice) to a bid presented to them.

There are several ways of calculating mean willingness to accept payment (WTA) from dichotomous choice data such as *binomial and multinomial log logistic and double log logistic regression* (Greene, 2003). In this experiment a *binomial logistic model* was used to analyse the responses to the string of opening bids (first value given) in order to calculate mean household WTA.

Importantly the probability value of the regression parameter must be significant in order for the estimate to be considered reliable. In this case the Chi Square probability value was significant at the 95% confidence level (X^2 = 9.532, d.f. = 8, p=0.002)

Mean willingness to accept (WTA) compensation is calculated by dividing the coefficient of the constant by the coefficient of the opening bid as follows:

$$WTA = (-\beta constant/\beta OPBID2)$$
$$= (-1.01/\ 0.0000033375)$$

$$\underline{\mathbf{= 3{,}026{,}217\ USh}}$$

Therefore the mean compensatory payment that a household would be willing to accept for loss of access to the forest for three months is 3.026 million USh or equivalent to 12.105 million USh per annum ($6,371 USD).

A further analysis was conducted between wealth groups across the entire sample the results are shown in the table 17. In this analysis the wealth category used was the one the villagers assigned to themselves in each village sampled.

Table 16. **Mean WTA by wealth group**

Wealth Group	Chi Square Statistic	β constant	βOPBID2	3 months WTA (Million USh)	Annual WTA (Million USh)
1 - Poor	1.183 d.f. 8, p=0.001	-1.598	0.00022	7.263	29.05
2 - Average	7.314 d.f.=6, p<0.001	-0.725	0.00051	1.421	5.68
3 - Wealthy	2.533 Not Significant	-0.747	0.00027	-	-

The annual mean WTA compensation for group 1 (poor) households is 29.05 million USh and for group 2 (averagely wealthy) 5.68 million USh. For group 3 the relatively wealthy the bid parameter (Chi Square) was not significant so no WTA value has been calculated.

The value that poor households need to be compensated for loss of access to the forest is higher than that which relatively wealthier households require to be paid. This indicates that the level of utility, which poor households expect to receive from the resource, is higher than that of the relatively wealthy group.

Given the current scepticism regarding the use of monetary values in determining WTA amongst subsistence households, the importance of the CV findings lies not in the determination of the absolute value of the forests to households but rather the relative values between wealth groups.

The results of the WTA estimates show that between the poor and average categories there is a great difference in the value associated with the forest. This is a clear indication of the greater level of consumer surplus derived from the forest by poor households, and in relative terms at least regard the forests to be more important to their livelihoods.

It is important to remember that the CV exercise estimates a value that encompasses both direct and indirect use values as well as non-use values of the forest. The CV values are not used in calculating TEV but are in fact a measure of people's perceptions of TEV at the local level.

3.4 Ecosystem and other values

Secondary data from a variety of sources (noted in the text) were used in conjunction with data yielded from the household survey to estimate direct and indirect values of Uganda's forests**.**

3.4.1 Indirect Values

a) Domestic Water Conservation

The forests surveyed are an important source of water for local communities. Their integrity directly affects the quality and integrity of the water sources. 59.34% of all respondents indicated that their principal source of water came from surface water sources within or emanating from local forests.

It is possible to estimate the value of the provision of clean water by forests to local communities by considering the cost of providing an alternative source of water should current supplies be made unavailable through the loss or degradation of the forests that sustains them. One option is to provide clean water by sinking a borehole, which obviously has a market cost. Whilst a borehole may not be appropriate in all cases, boreholes are perhaps one of the most common methods seen in Uganda for rural people to obtain a regular supply of clean domestic water.

Using figures from the IUCN (2002) study on Sango Bay, a borehole should sustain 300 people and 276 head of livestock (cow equivalents). From the same study (IUCN 2002) Based on the cost of installing a borehole depreciating it over 5 years and including the costs of maintenance the average annual cost of providing a borehole was calculated to be 557,000 USh per annum. The stages in the calculation are set out in the following tables.

Table 17. **Stage 1 Borehole costs for human population**

Forest	Mean Nº Individuals	Total Nº households	Total number of individuals	No of bore holes required	Total cost of borehole provision p.a. Million USh
Budongo	5.79	12,078	69,931	233	129.78
Bugoma	6.14	12,213	74,987	250	139.25
Kasagala	5.80	2,792	16,194	54	30.09
Rwenzori	7.91	32,468	256,821	856	476.79

Table 18. **Stage 2 Borehole costs for livestock**

Forest	Total Nº households	Av livestock holding per household (cow equivalent units)	Total livestock Equivalents	No of bore holes required	Total cost of borehole provision p.a. Million USh
Budongo	12,078	1.08	13,044	47	26.18
Bugoma	12,213	1.33	16,243	59	32.86
Kasagala	2,792	10.01	27,948	101	56.26
Rwenzori	32,468	0.53	17,218	62	34.53

Table 19. **Stage 3 Total costs of borehole provision**

Forest	Total cost of borehole provision p.a. (human) Million USh	Total cost of borehole provision p.a. (livestock) Million USh	Grand total cost of borehole provision Million USh	Total Nº households	Value per household of water provision per annum USh
Budongo	129.78	26.18	155.96	12,078	12,913
Bugoma	139.25	32.86	171.86	12,213	14,072
Kasagala	30.09	56.26	86.35	2,792	30,928
Rwenzori	476.79	34.53	511.32	32,468	15,748
			Mean value per household		**18,415**

The mean value of water provision per household in this scenario is 18,415 Ush. This is based on 100% of the population needs. It is likely that ground water levels in the local area of the forest would also drop for two reasons. Firstly forests play a role in maintaining the height of the water table and secondly additional users of local aquifers will result in the level of the aquifer dropping to a new equilibrium level, assuming that consumption does not outweigh replenishment. Therefore existing boreholes may have to be re-sunk.

The values derived in the above calculation only take in to account households immediately around the forests in question. It does not account for the values that might accrue to households further down from the catchment forests. According to UBOS Household Survey (2000) there are approximately 3,303,000 rural households in Uganda. Assuming that the effects are fixed across all rural households, the total value of water conservation services of forests can be valued at approximately 60,825 million shillings (at current exchange rates this is equivalent to $32.0 million US).

b) Soil fertility

The economic effects from forest loss on agriculture through soil erosion and loss of fertility are difficult to quantify as the magnitude of effects are highly variable and situation specific. This is due to a variety of environmental factors such as soil type, topography, rainfall and human agro-ecological and demographic factors such as type and extent of crops grown, farming practice (extensive or intensive) and population density. In addition the calculation of the economic effects is complicated by factors such as the impacts of soil loss being spread over time. None the less the impacts of declining soil fertility are real and should be factored in to an estimation of the total economic value of forests or the resource will be undervalued.

As was established in the livelihoods survey, households rely heavily on the natural forests for fuel wood. All households interviewed obtained some or all of their fuel wood from the forest. Uncontrolled over exploitation of natural forest will result in the resource being mined, in that consumption exceeds regeneration, resulting in a decrease in the capital stock of wood. As fuel wood becomes scarce households will turn to crop residues or grass for fuel (as has already happened in Rakai and some other parts of Uganda). The result will be a loss of crop residues and nutrients to the agricultural system. Further degradation of the soil and declining crop residues will result in the use of animal manure as fuel, should there be no other options for extensification of agriculture, the result being further decline in soil fertility.

The damage cost of the diversionary use of farm yard manure from organic fertiliser to fuel can be calculated by the replacement cost approach i.e. the cost of replacing the nutrients in farm yard manure with chemical fertiliser which is available on local markets.

Standard tables of the level of annual production of farmyard manure by livestock and the available nutrient content can be used to calculate the equivalent volume of chemical fertiliser required (Soffe, 1995, Agricultural Notebook). The price for the replacement cost can then be calculated. Estimates are presented in the tables below. The calculation conservatively estimates the replacement value for each forest to those households who we have previously

considered to be the forest user group. It is an implicit assumption that current agricultural systems are sustainable.

Table 20. **Replacement cost value by forest type**

Forest	Total Livestock (cow equivalent units)	[1]Annual Volume of farmyard manure (Metric Tonnes)	[2]Volume of chemical fertiliser required as replacement (Metric Tonnes)	Replacement cost (Million USh)
Budongo	13,044	27,131	1,356	1,220
Bugoma	16,243	33,785	1,689	1,520
Kasagala	27,948	58,132	2,906	2,615
Rwenzori	17,218	35,813	1,790	1,611

[1]2.08t.per annum @ 10% dry matter
[2]50kg (one sac) per tonne of FYM @ 10% dry matter = 0.05t
[3]Average price per 50kg NPK fertiliser of 45,000Ush = 900000Ush/t

Table 21. **Value of soil fertility generated by forest type on a unit area and household basis**

Forest	Forest Area (Ha)	Value per ha per annum (USh)	No of households	Value per household per annum (USh)
Budongo	79,300	14,939	12,078	98,084
Bugoma	128,804	11,800	12,213	124,457
Kasagala	10,105	258,782*	2,792	936,604
Rwenzori	97,380	16,543	32,468	49,590
			Average	**299,994**

* the values are disproportionately high as the area around Kasagala has atypically high levels of livestock for this forest type. The value should probably be reduced by a factor of 5 to give a value more representative over the whole geographical spread of forest type.

At an exchange rate of 1900Shs to the USD ($) the average value of woodland to soil nutrient conservation is just over $159 per household per annum. This figure compares well to estimates for Uganda by Nkonya and Kaizzi (2003) who calculated that 95% of farmers in the survey were taking out more nutrients from the soil than they (and nature) were putting back. By measuring how much nitrogen (N), potassium (P) and phosphorus (K) was being mined, the study team calculated that if the loss in soil fertility was to be fixed by adding chemical fertilizer it would cost an average of 21% of the total current value of maize production (US$153 per household per annum). Scaling up the estimates from these forests to the country as a whole yields an annual value of soil nutrient conservation of 99.2 billion shillings (approx. $52.2 million US – FOREX 1900/$). The calculation is shown on table 23.

Table 22. **National values of forests to soil conservation**

Forest Type	Total Ha of forest type in Uganda	Value per ha per annum	Value per forest type per annum (Million USh)
Protected THF	427,210	46,044	19,670
[1]Private THF Forest	350,130	11,800	4,132
[1]Savannah Woodland/Bushland	1,372,708	51,756	71,045
Afromontane	264,200	16,543	4,371
		Total value per annum	**99,218**

An estimate, using a comparable method, by Newcombe (1989) in Ethiopia calculated the cost of deforestation – to soil fertility as approximately $300 million or 6% of GDP in 1983. Yaron (2003) reports on the study by Slade and Weitz (1991) has been extensively quoted in GoU

documents and reports that mention the importance of soil erosion in Uganda. This study estimates the damage caused by soil erosion in terms of the value of lost nutrients to farmers and how much it costs to replace these with chemical fertilizers. The impact of soil loss is considered to be between 4 and 12% of GDP. This probably compares well to the estimate made here as this studies estimate only considered the areas of land under forest cover which is only approximately 13% of Uganda's total land area.

c) Carbon Storage

At the global level, the forestry sub-sector is an important carbon sink, helping to reduce accumulation of greenhouse gases and hence global warming which will lead to adverse changes in climate. According to Howard (1995), the service rendered by Uganda's forestry sub-sector to the economy through its impact on carbon sequestration is estimated at US$ 17.4 million/year based on then levels of carbon stocks depreciated over 25 years.

A more recent estimate by Emerton (1999) used a similar method but with a revised value per ton of carbon sequestered. Estimates of carbon sequestration range between 10 tonnes of carbon per hectare of bushland or grassland to 210 tonnes of carbon per hectare of closed canopy primary forest (Myers 1997, Sala and Paruelo 1997). Uganda's natural vegetation is estimated to cover a surface area of almost 11.5 million ha (Emerton, 1999). With the economic costs avoided of carbon sequestration valued at between $1-100/tonne (Alexander *et al* 1997) and on average $20/tonne (Myers 1997) forests, woodlands, bushlands and grasslands in Uganda may together provide economic benefits through mitigating the effects of global warming to a value of nearly USh 70 billion a year.

Table 23. Carbon sequestration by forests, woodlands and grasslands (Source: Emerton 1999).

Vegetation	Area (ha)	Carbon sequestered (Tonnes/ha)	Carbon sequestered (Tonnes)	Value (USh mill total)	Value (USh mill/ year)[2]
Primary forest	603,880	210	126,814,800	3,297,185	33,008
Degraded forest	280,780	125	35,097,500	912,535	9,136
Woodland, bushland, grassland	10,564,450	10	105,644,500	2,746,757	27,498
TOTAL	**11,449,110**		**267,556,800**	**6,956,477**	**69,642**

Adjusting the total value from table 24 to account for forested land only means a reduction of 48% in the woodland, bushland and grassland value (grassland accounting for 5,115,266 ha). The total value of woodland and bushland is equal to 1,428,313 million USh equivalent to 14,298 million USh per annum. Therefore the revised value of Uganda's forested areas to carbon sequestration is equal to 56.4 billion USh per annum.

d) Biodiversity Option Values

Option values are perhaps the least tangible benefits from Uganda's forests. However an aspect that promises real returns is the development of plant based pharmaceuticals. Ruitenbeek (1989) was one of the first to use the valuation methodology of patent rights to estimate the potential value of undiscovered plant-based drugs for the pharmaceutical industry. Ruitenbeek (1989) estimated values for the Korup Park and surrounding management area as £0.1/ha per annum. Pearce and Moran (1994) estimate a range of values for tropical forest,

[2] (Emerton, 1999) Overall value converted to average annual amount using $\frac{1}{T}\sum_{t=1}^{t=T}\frac{V}{T}(1+r^{(T-t)})$, where T = overall period (100 years), V = overall value of carbon, r = discount rate (10%), t = year.

which are generally larger than that produced by Ruitenbeek, ranging from US$0.1/ha to US$21/ha. Recent work on this issue, by Mendlesohn and Balik (1997), produced a value for undiscovered plant-based drugs in tropical forest with average plant endemism of US$3/ha.

The number of endemic plant species per hectare is very important as a predictor of potential drugs according to Mendlesohn and Balik (1997). If an area of tropical forest had ten times more endemic species per hectare than average, their model predicts a per hectare future drug value of US$30/hectare. Howard (1995) indicated that Uganda's forests are not as species rich as the Korup Park and that many species present are widespread over many parts of Africa, so that developing plant based pharmaceuticals markets for such species would be competitive, in which Uganda' would have little competitive advantage. An example of such a plant is *Prunus africana*, which grows naturally in Uganda in Afromontane areas. However commercial exploitation of *Prunus africana* is usually based on the establishment of plantations, which are originally sourced from wild genetic material. Using the Mendlesohn and Balik (1997) estimate but reducing the lower figure by 50% as a conservative estimate gives an average of US$1.5 per ha. Over an area of 1,041,540 hectares this equates to US$1,562,310 or 2,968 million USh (FOREX1900USh/$).

In addition to the undiscovered plant based pharmaceuticals Howard (1995) reported that there is potential in wild coffee genetic material. This may be of topical interest at present as Uganda's farmed coffee is being hit by a *Fusarium* wilt against which no known cultural or chemical practices appear to succeed. Wild coffee is known to be resistant to the wilt. Howard (1995) calculated the value of this as 0.5% of the annual coffee earnings to Uganda, adding a further $1.5 million (2,850million USh).

3.4.2 Direct Values

a) Tourism

The direct use value of forests from tourism in Uganda is well documented (Howard 1995; Falkenberg and Sepp., 2000; and Yaron, 2003). Uganda's tourism is largely eco-tourism and based on forests. Tourist revenues are mostly captured through the activities of UWA and usually not attributed to the forestry sector. Six national parks established around 1991 – 1993 were created from forest reserves. Two of these, Bwindi and Mgahinga are the only homes of the Mountain Gorilla in Uganda and house over half of the world's population of these great apes. The two parks generate about 33% of the revenues of UWA through gate receipts. Tourism revenues in 1998 were approximately 2700 million USh ($1.4 million US). This does not include the additional downstream benefits of tourism such as travel, hotel use or the purchase of handicrafts by tourists within Uganda.

b) Timber revenues

Currently, sources of public revenue from the forestry sub-sector include:

- sale of forest products, licenses and concession fees;
- taxes levied on charcoal makers;
- rent for land in forest reserves;
- fees for trade and transport/movement permits for charcoal, firewood and some non-timber forest products; and
- value added tax (VAT) at 17% , and 15% for saw millers and pit sawyers whose operations fall below the VAT threshold.

Of the revenues collected at district office it was a legal requirement that 60% is transferred directly to the treasury and 40% transferred to the relevant districts. However, under the new Forestry Act, 100% of revenues are collectable by the National Forest Authority, although NFA could voluntarily share revenues in return for certain activities (e.g. some forest protection measures from the Local Government, under a contractual arrangement).

Revenues generated by the Forest Department for the fiscal year 1999/2000 were approximately USh 1,000 million (or US$ 5 million) (MWLE, 2001).

Falkenberg and Sepp (1999) estimated the potential revenues from wood utilisation on the basis of the estimated 1999 production and royalties according to rates in Schedule 4 of April 1994. The authors suggested that based on wood consumption in the formal sector, potential revenue was estimated at USh 17,000 million or about US$ 8.5 million (USh 8,900 million from sawlogs, USh 600,000 from poles, and USh 7,500 million from firewood).

It is probable that the current market value of royalties may be much higher than historical values. A sealed bid Auction held in the National Forest Authority in mid 2004 achieved average royalties of around 50,000Ush for 1m^3 of standing volume of pine, compared to the historical price paid of only 28,000. This equates to an almost 80% increase in real value compared to previous estimates. Prices offered may have gone much higher if an open auction had been held. It is likely that a similar experience may emerge with hardwoods from the Natural Forest. However it is important to note that stocks of plantations have been very much reduced and sustainable yields are down from previous estimates.

c) Forage Values

A significant part of the economics associated with savannah woodland is the value attributable to the forage value of the grass. The predominant type of agricultural activity in such foresst is extensive livestock production. In other forests the forage value is likely to be low as forage is only readily available in secondary or degraded forest where low or understory vegetative growth can be found. We therefore only estimated the value of forage in the woodland forest type.

As a market for forage is not operational, internal prices must be calculated. Falkenberg and Sepp(1999) used a value of USh 4,000 million, calculated as 1% of the livestock value. This is perhaps an under valuation of the value of forage to livestock production. Nix (1999) reports that forage value is worth about £50 (GBP) per head per annum. This equates to approximately 10.4% of the final value of the animal (£481). In addition he reports one hectare of *'in bye land'* (not rough grazing) supports 4 head of cattle. *'In bye land'* is usually high quality single species grassland usually receiving some type of fertilizer treatment to maximise output. One hectare using the same proportion of the value of a head of beef cattle, currently the average price of a Ugandan beef animal is approximately 350,000USh, of which 3.3% of this value is 3,640USh. It is probably reasonable to assume that one hectare of savannah woodland can support one beef cattle. Thus we may equate the forage economic value of one hectare of savannah woodland, bush land or grassland as 3,640USh. According to the Uganda Biomass Study (2003) there are approximately 10,564,450 hectares. Thus the total forage value of this area is 38,454 million USh, a significant increase on the value approximated by Falkenberg and Sepp (1999)

3.5 Market Survey Results

This section presents findings on some important timber and non-timber forest products sold in markets around the forests.

3.5.1 Charcoal

Charcoal traders were interviewed around all forest areas. Mean prices in different forest areas were ascertained (table 25).

The highest mean prices observed were around the Rwenzori followed by Budongo. Kasagala and Bugoma had the lowest mean prices. Rwenzori and Budongo prices were significantly different from those of Kasagala and Bugoma (ANOVA: $F= 9.497$, d.f. = 3, 40, $p<0.001$).

Table 24. **Mean price (Ush) for a sack of charcoal by forest area.**

Forest Area	N	Mean	Std. Deviation	Std. Error	Minimum	Maximum
Budongo	7	8,352	2,125	803	4,800	10,800
Bugoma	8	4,818	1,449	512	3,000	6,500
Kasagala	22	5,587	1,840	392	2,900	10,800
Rwenzori	7	9,494	3,323	1,256	5,000	14,200

A qualitative exercise to understand how price varies seasonally was undertaken by asking respondents to give an approximate price for each month. It was anticipated that there might be some significant seasonal fluctuation in price. It is difficult to ascertain anything for certain from such small data set spread over a wide area, however no significant difference was found regarding monthly prices.

Traders were also asked about the distance travelled to the point of sale or market (table 26).

Table 25. **Distance traveled to market**

Forest Area	N	Mean Km	Std. Deviation	Std. Error	Minimum Km	Maximum Km
Budongo	18	1.3833	3.8104	0.8981	0.3	16.00
Bugoma	11	12.9964	15.9796	4.8180	0.5	36.00
Kasagala	5	10.6000	19.5397	8.7384	1.5	45.00
Rwenzori	8	1.4000	3.9598	1.4000	0.4	11.20

Traders from around Kasagala and Bugoma travelled the furthest to market with traders around Budongo and Rwenzori travelling the shortest distances (ANOVA – $F=3.390$, d.f. = 3, 38, $p=0.028$). Tukey's HSD separated Kasagala and Bugoma from the other two forests.

An analysis of mean prices between different categories of trader was also performed (table 27).

Table 26. **Mean sack sale price by trader type**

Trader Category	N	Mean	Minimum	Maximum
Producer/Wholesale	15	5,038.30	2,958	8,958
Retail	29	7,268.92	3,500	14,167
Total	**44**	**6,508.48**	**2,958**	**14,167**

Two types of charcoal trader were identified in the markets those that are primary producers/wholesalers and retailers. The mean price per sack in the retail trade was significantly higher than that in the wholesale trade (ANOVA: $F = 8.015$, d.f. = 1, 47, $p=0.007$).

3.5.3 Handicrafts, Rattan and Bamboo

A total of 45 key informants were interviewed regarding the production of handicrafts. It was apparent from the interviews that there was a wide diversity of items available within this group of forest products, ranging from items of basketry to woodcarvings and the production of bark cloth. Thirty-nine different items were recorded as being produced or sold by the respondents. The five most frequently occurring items are listed in Table 28.

Table 27. **Most frequently observed handicrafts items**

Item	% Respondents marketing item
Basketry	13
Matting	8
Home decorations	6
Bags	6
Hats	6

The handicrafts industry uses a wide variety of materials from forests of timber and non-timber origin (Table 29).

Table 28. **Most commonly reported classes of materials used in handicrafts**

Material	Frequency	Percent
Reeds and Grasses	46	28.0
Wood	53	32.3
Palm leaves	36	22.0
Bark Cloth	9	5.5
Rattan	8	4.9
Clay	6	3.7
Skins	6	3.7
Total	**164**	**100.0**

The frequency of responses shows that the most popular materials amongst our respondents were reeds and grasses as well as palm leaves, which are the principal constituents of basketry and mat making. Wood was also an important resource. However reeds and grasses are not likely to come from the forest directly, more likely from wetlands. Bark cloth usually comes from trees retained on farmland and skins are probably from domestic rather than wild animals. So the value of forests to handicraft production is probably less than might at first be expected on first appraisal.

Respondents were asked about their main type of customer, whether primarily domestic (i.e. local people) or primarily tourists (i.e. foreigners) or both (table 30).

Table 29. **Who purchased handicrafts**

Trade type	Frequency	Percent
Domestic	103	21.0
Foreigners	13	2.7
Both	30	6.1

Rattan was evidently used to make handicrafts. It is commonly found as items of household furniture. Three rattan harvesters were interviewed, one involved in wholesale and two in harvesting as well as one rattan furniture maker.

The rattan harvesters were in the Bugoma area. Both reported receiving 3,500 USh for a bundle of rattan. A bundle consisted of 40 stems each measuring around 2-3 meters. Harvesters travelled between 6 and 6.5 km to sell their goods transporting them by foot to the nearest road. The harvesters reported that in terms of abundance in the forest the dry seasons were the times when it was most difficult to obtain rattan. The wholesaler, at the time of interview (January 2004), received 8,000 USh for a similar bundle. However he transported his

goods 250 km to Kampala. He reported that the rattan sale price he received was higher during the rainy season.

The furniture maker, who was living locally to Kasagala, reported purchasing bundles of rattan at between 8,000 USh to 15,000 USh with higher prices in the rainy seasons. It is important to note that rattan is found in THF not savannah woodland and is likely to be coming from Budongo and Bugoma areas. Items of furniture range in price from 4,500 USh for small individual items such as stools and small tables to 400,000 USh for living room suites. This clearly illustrates the added value of processing rattan. For instance a stool selling for 4500 USh will use only 2 or 3 stems from a bundle of 40 stems, which cost between 8000 USh and 15000 USh.

Interestingly at a local level it was easier to find and harvest rattan, during the rainy season, hence the lower prices at the forest gate during the wet season. However difficulty in transporting materials to processors may explain the apparent inconsistency regarding the higher prices for processors during the same period.

3.6 Total economic value and revised GDP of Uganda's Natural Forests

The total economic value of Uganda's forests is calculated by adding all of the financial and economic values that accrue at different stages in the economy. Falkenberg and Sepp (1999) made a revised estimate of the value of forests to Uganda's GDP. This revision was an important step in taking into account of significant forest values that had previously gone unreported. However this valuation exercise was constrained by the limits of available information about Uganda's forests at that time, especially the value to local livelihoods.

In light of the results regarding livelihoods values and revised estimates of key environmental services table 31 presents these findings about the TEV in comparison to those reported by Falkenberg and Sepp (1999). Figures for 1998 have been adjusted using the underlying rate of inflation to bring them up to parity with current (2003) values.

In the absence of data for 2003, Uganda's officially reported figure for GDP in 2002 was 5.8 billion USD (World Bank, 2004). In Uganda shillings at the exchange rate of 1900USh/USD, this is approximately 11,020 billion USh. Adjusting the GDP figure by adding the value of informal and non marketable goods and services (190.02 + 222.2 = 412.24 billion USh) will give a new adjusted GDP figure of 11,432.24 billion USh of this the forest sector represents 5.2 % of GDP in current terms.

The revised percentage figure is a bit lower than that estimated by Falkenberg and Sepp (1999). However in absolute terms it represent a substantial increase, from 468.4 billion USh in 1998 to 593.94 billion USh in 2003, on the value that had been previously estimated. The lower percentage is because Uganda's GDP has also grown over the period from 1998 to 2003.

Table 30. **Total economic values of Uganda's natural forests.**

Item	Falkenberg and Sepp (1998 prices) Billion USh	Falkenberg and Sepp (2003 adjusted values) Billion USh	Revised Estimate (Data from this study) Billion USh	Beneficiary
Formal Sector				
SawnTimber(Sawmill Gate price)	40	42.7	42.7	National consumers
Poles	5.4	5.7	5.7	National consumers
Fire wood	21	22.4	22.4	Local community
Charcoal	57	60.8	60.8	Local community, National Consumers
Other (NTFP)	20	21.3	21.3	Household, Local City
Tourism	2.7	28.8	28.8	National Economy, global consumers
Total Formal Sector	**146.1**	**181.7**	**181.7**	
Informal Sector				
Poles	6.0	6.4	2.88	Household, Local Community
Firewood	160.0	170.8	79.60	Household, Local Community
Other (NTFP)	40.0	42.7	69.14	Household,
Livestock Forage	4.0	4.3	38.4	Local Community
Total Informal Sector	**210**	**224**	**190.02**	
Non Marketable Values				
Watershed benefits	20.7	22.1	60.8	Local Community District
Carbon sequestration	26.1	27.9	56.4	Global Community
Biodiversity value	3.5	3.7	5.82	Global Community
Soil Conservation	60.0	64.1	99.2	HH, Local Community, National Economy.
Total Non Marketable Sector	**112.3**	**117.0**	**222.22**	
Total Economic Value	**468.4**	**522.7**	**593.94**	

The total economic value presented here is still likely to be an underestimation. The livelihood values are probably underreported. Estimates about watershed values have only taken into account the two aspects of soil fertility and domestic water consumption in the community around the forests in question. The downstream costs of the effects of erosion or siltation of surface water sources further down the catchment and the impact of eutrophication on fisheries have not been included.

It is important to note that strictly speaking non market values are not included in the formal calculation of GDP. The TEV of Uganda's forests has been presented in the context of GDP for illustrative purposes in order to provide some relevant context and an easy reference point for comparison.

Ownership of Uganda's forests are divided between three broad groups, the forestry authorities (NFA, DFS and FID), Uganda Wildlife Authority (national parks) and private owners.

Table 31. Proportion TEV accruing from forests under different land management structures

Forest Type	Forest Authorities	Uganda Wildlife Authority	Private	Total
THF Normal (Ha)	286,408	190,659	173,083	650,150
THF Degraded (Ha)	60,405	36,587	177,047	274,039
Woodland (Ha)	426,442	449,413	3,098,248	3,974,103
Total forest cover (Ha)	773,255	676,659	3,448,378	4898,292
% share of total forest cover	15.8	13.8	70.4	100
Value (Billion USh)	**93.65**	**81.95**	**417.64**	**593.94**

An overwhelming 70% of Uganda's forest resources are on private land i.e. not national park, game reserve, district or local forest reserve or strict nature reserve. The largest proportion of the forest on private land is made up of woodland. This clearly points to the need to promote the right combination of regulation and incentives in these areas especially in light of the value of the public goods aspect of their value. However a significant proportion of forests remain within the jurisdiction of the forest authorities and the Uganda Wildlife Authority, thus the institutional and organisational basis for their sustainable management is in place.

4.0 Discussion

4.1 Forests and Livelihoods

4.1.1 Typical features of rural farmer economies

It is important to understand some contextual issues regarding the mode of production and consumption in the livelihoods of the survey population. There are two main distinguishing features of rural farmer economies; partial integration into markets and the incomplete nature of the markets in which they operate. Incomplete integration refers to the ability to engage in or withdraw from markets as individuals choose. This in part is due to a variable capacity to provide much of the households own food requirements as well as from imperfect market in which it operates. Market incompleteness refers to their sporadic operation. For example Ellis (1993) cites seasonal demand for labour for harvesting at differential wage rates, the difficulty in obtaining imported inputs and the restricted availability of consumer goods in rural areas. Peasant societies often exhibit a form of barter or non-market transactions between farm households that of course have an economic basis but their reciprocal nature makes it difficult to value such transactions in a market context.

The inseparability of many economic functions from within a peasant household provides a major difficulty in analysing the peasant household economy. Production, consumption and investment decisions are based on family circumstance, for example the amount of food that is stored, or sold in order to buy new goods is constrained by the consumption demand in the home. Therefore these decisions are not independent of one another; a large proportion of flows of products and factors do not enter the market. It is for such reasons that the **measure of income** used in this study **includes the consumption of own produced and harvested goods**.

4.1.2 Relationship between wealth and forest use

People that dwell on the edge of natural forests are perhaps amongst some of the poorest in Uganda today. However living on the edge of natural forests also brings specific benefits in that the forests provide a wealth of financial and food security services, a backstop in times of need. In geographical terms their locations might be thought of as being on the frontier of human expansion into remote and isolated regions. Typically communities on the boundaries of forests have poor communications to markets and key services so are constrained in terms of their ability to engage in the transforming structures and processes of a market economy.

It has been demonstrated here, that in relative terms, poor people derive a greater proportion of their income from natural forests than wealthier people. Principal components analysis showed two main approaches for the accumulation of capital assets are adopted; investing in livestock or investing in other assets. These represent resources that can be sold or exchanged in times of need by a family. Importantly bicycles and other motorised transport are assets that can be used in the marketing of produce so are important in transforming products into income. However the agro ecological and geographical context is important as a factor of choice over which strategy is followed. In the Rwenzori for example high population pressure and land scarcity means that on a per household basis it is not possible to invest heavily in livestock, as there are limits on access to forage. However in Kasagala animal husbandry is the favoured means of capital accumulation as the population density is low and land is not a scarce resource. For the poorest households access to the forest can be considered a principle financial and economic safety net, providing both food and financial security.

4.1.3 Household Labour and forest use

In the context of rural peasant farming economies, Upton (1987) states that " access to labour, rather than land is the basis of economic and political power." This statement reflects the

generally labour intensive nature of agricultural or animal husbandry tasks. As a result labour is an effective constraint on production. Delays cause yield losses and the labour requirements to complete a task are concentrated in a peak period. Therefore households may have less labour than they need at work peaks and more than they want at troughs. Labour can be seen as a critical limiting constraint on livelihoods success despite unemployment at slack times. However should opportunities arise surplus labour, especially in slack periods, can be usefully employed in other activities such as harvesting goods from forests.

The survey showed that wealthier households tended to have higher numbers of total occupants. We can extend this observation to conclude that wealthier households will have a relatively higher level of household labour available than poorer households and are able to generate more wealth. It is possible to conclude this as differences of composition between households was taken into account by the use of an adjusted income measure to make inter-household comparisons.

This is an important consideration in the ability to exploit forests. There was a clear link between increased forest use and higher numbers of household occupants. For relatively wealthier, or larger, households it concludes that forests represent an opportunity for wealth creation, a stock of goods that allows the optimisation of other resources. As such natural forests should be considered an important resource to help drive rural economic development as they assist rural households (forest users) to generate cash and produce surpluses that improve household income.

4.1.5. Role of Natural Forests in filling the "Hungry Gap"

A predominant feature of the effects of seasonal change on peasant households is the "hungry gap" which relates to a pre-harvest shortage of food. Upton (1987) identifies the hungry gap, as the period when food is scarce and energy requirements are high, there also tends to be a high incidence of disease, exacerbating the problems many families' face at this time. Cash stocks will also be lower and food prices higher. All of these factors occurring simultaneously reinforce the problem of the "hungry gap" for the peasant household.

The survey results show a clear link between seasonal stress on the household and forest use. Across all forests households were more likely to use the forest at times of year when both cash and food stocks were low. For poor households, the effects of seasonality are more severe in absolute and relative terms in that they have less buffering, are more constrained and have fewer options for coping. Survey evidence shows that poorer households have a proportionately greater reliance on forests. This supports the conclusion that forests play a proportionately greater role in securing a basic livelihood for the poor than for the wealthy.

4.1.6 Forest benefits and forest dependency

It could be argued that what we are describing as forest dependence might be better interpreted as a 'benefit' of living near a forest. In support of the benefit of living near a forest theory it is interesting to note that a significant but weak correlation was observed showing that average income decreased with distance from the forest.

It is difficult to conclusively say that the poor are more dependent on forests than the wealthy. The term dependency is emotive because it is difficult to define in absolute terms. If access to the forest were suddenly denied to local households it is clear that a great financial 'gap' would have to be made up, in terms of income and consumption, to maintain a households current level of welfare. In addition it is difficult to conclude that one wealth group would be more dependent than another on forests as no significant difference was found between the incomes derived from forests between wealth groups. In light of the higher proportional income derived from forests by poorer households it is clear that forests play an important role in securing or augmenting their livelihood. It must be remembered though that in this study the majority of households would be classified as poor or ultra poor in a global and national context.

However, assuming that if all other factors remain the same and there are no viable alternatives to securing a livelihood for the survey population, dependency can be defined as the lack of viable alternatives to sustain a given level of welfare. We must then accept from the survey results that households who live near Uganda's natural forests are dependent upon them to secure a basic livelihood. In addition poorer households are proportionately more dependent on forests to secure their livelihood than wealthier households.

4.1.7 Implications for Policy

What does this mean in terms of forest policy and management? People on the edge of forests are forest dependent. Any policies that exclude local people from using the forest therefore run the risk of contributing to rural poverty and livelihoods insecurity. Such a policy, in order to be successful, would have to account for the need to assist in generating alternative income or food security options.

Conversely policies that promote and integrate local people into the management and use of local forests have the potential to contribute significantly to local communities livelihoods and welfare. However such policies are context specific, their success dependent on a number of factors such as the integrity of the resource, the size and homogeneity of the population relative to the sustainable stream of benefits coming from it, well defined property or user rights and adequate protection and monitoring of the resource.

It is clear that the use of Uganda's natural forests is currently unsustainable and that great efforts must be made to better manage their use so that local people can derive significant proportions of their income both now and in the future. These two facts point towards sustainable management practices actually having the effect of reducing the income that local people will derive form natural forests. In fact it is implicit that reducing local use of the forests to a sustainable level will in some part actually contribute to local poverty. This gives rise to a clear moral issue that in order to reduce the livelihoods contribution of forests through limiting local access to sustainable levels will require other efforts to maintain local peoples livelihoods or provide alternative welfare measures.

An important question that arises from the discussion is, to what extent should the NFA or protected area authorities be willing to go to, or are able to go to, in order to promote alternative livelihoods amongst current forest users? It is clear that the principal focus for the NFA is to manage the forests directly. The capacity in terms of finance and expertise to become involved in broader rural development activities is clearly limited. Instead it calls for a more integrated rural development policy, which is in some ways achieved, by having sectoral planning processes. However forestry tends to get merged with *environment and natural resources* but agriculture is planned separately. In general an important issue is the need to balance the incentives for agriculture and forestry.

In the wider rural development context it is sometimes argued that as households become wealthier their impact on the environment will reduce. Therefore rural development activities that focus on communities in close proximity to protected forests could have beneficial impact in mitigating the unsustainable use of forests. From the survey data it was observed that a large proportion of household forest income was consumed within the household. However in absolute terms there was no significant difference between the total income derived from the forest and wealth group of households. Therefore it is logical to conclude that making households wealthier will not in absolute terms make people use the forest less, only less dependent on them.

The survey evidence also indicated that wealthier households had a greater number of individuals, which could be synonymous with higher levels of labour. In the short term, assuming that such a socio-economic trend continues, richer and typically larger households may in fact be more able to exploit the forests. Indeed studies from other countries have shown

that as wealth increases so does forest use. For example in a study from Eastern DRC, bushmeat hunting increased as households became wealthier because the resources (rifles and cartridges) with which to hunt became affordable (Brown, 2003). Therefore the impacts of economic growth at a local level, in the short term, could have serious negative effects on the integrity of forests and the environment generally. Many factors affect how people might change their pattern of use on environmental resources and the uptake of alternative activities. Interventions to improve the welfare of local communities must take into account the environmental impacts of their actions and plan to mitigate them from the outset.

Given the inherent limitations of sustainable production of forest produce from natural forest in Uganda, the difficulty in artificially boosting this, and the increasing human population and therefore demand for forest products there are clearly three categories of solution:

- Increase supply – the trend is currently the opposite with a declining area of natural forest. I might be achieved through more on-farm forestry activities, and more intensively managed plantations.
- Increase efficiency of timber use- Charcoal production is notoriously inefficient and timber harvesting is very wasteful.
- Change demand – current consumption patterns tend towards the use of high value tropical hardwoods for everything from floor and housing timbers to low quality domestic furniture which pine or eucalyptus would be more suitable for.

The suggestions above are more obviously within the realms of possibility of the forest sub-sector to promote. This should be done in conjunction with harmonisation of forest /agricultural policy formulation and implementation.

An additional factor in developing added value activities or in the uptake of more efficient technologies is investment capital. Increasing household wealth might provide more opportunities for investing in value adding and efficiency measures. However waiting for households to become wealthier will take time. A constraining factor at presenting in Uganda is more likely to be access to capital. The judicious application of micro credit in the context of forestry is to make investment capital available to enable poor rural entrepreneurs implement value added and efficient technologies. However the capacity of the NFA or DFA to manage micro credit themselves is probably low and further reinforces the need for integrated rural development policy.

A question that also arises is what might the economic impacts of converting woodland to plantation be? Firstly, in the short term, there could be significant effects on the local soil and water balance if the process of converting woodland to plantation is not managed well and economically speaking could cause losses of the type described in sections 4.4.1 a & b. However once the plantations are established and managed according to sound environmental management guidelines, soil and water conservation values should be maintained at similar levels to natural woodland.

Secondly, in the long term, the conversion of natural woodland to plantation implies a change in the balance of local biodiversity. The biodiversity found in natural woodland contributing substantially to the welfare of local people through the provision of an array of non timber forest products and services such as wild food, bushmeat and grazing for livestock. Conversion to plantation would mean the loss of the NTFP and forage value to local communities.

The value of plantations to local communities is an important issue concerning the equitable distribution of financial values between local communities or private forestry investors. Clearly if natural woodland is converted to plantation by private investors the benefits in terms of the revenue or profit generated will accrue to the private investor. Whilst local communities may gain some low level of revenue through involvement as wage labour in the establishment and management of the plantations, the real benefits in terms of profits realised will accrue

privately. Methods to enhance the benefits from plantation forestry for the local common good must be a priority issue in order to address poverty alleviation issues.

4.2 Contingent Valuation

It is important to remember that values derived through contingent valuation express the household economic value. Economic values differ from financial values in that they encompass the indirect and non-use benefits (non marketable benefits that households derive). The expression of the use and non-use values reflects a level of utility that a respondent expects to receive from the forest, in other words the satisfaction that a household receives from consuming forest goods. The contingent value derived through WTA compensation is the respondents stated monetary equivalent of all the benefits received that would be necessary to maintain their current level of welfare

Table 1 (page 13) outlined some of the direct and indirect use values derived from forests. However there are in addition a number of non-use values also associated with the economic value that can be termed as social values. The social values of interest are option (to use in the future), existence (right of the resource to exist for its own sake) and bequest (to future generations) values. In addition to the non-use values, contextual issues about the value of forests to local people will be taken into consideration when responding to CV questions. Issues such as alternative sources of income or fuel are probably considered in the response. Whilst the compensation value may seem high it may better capture the real uncertainty as well as financial and economic cost of sourcing the alternative means to live in very remote places.

Contingent valuation data can be an important source of information about the values and attitudes to forest use by local people. The value of the CV study is not so much in absolute value derived from the WTA estimate but in the relative differences in value placed on forest resources by different wealth groups. The CV exercise revealed an interesting difference between poor and wealthier households in terms of the expected utility that can be derived from the forest**.** The higher value for poorer households clearly reflects their relatively higher level of dependence on the forests and may also be compounded by perceived lack of tangible alternatives to secure their livelihood, should access to forests be lost. The CV evidence can be corroborated by the conclusions drawn in section 3.2.4 regarding dependence and benefits received by different wealth groups from the forest.

4.2.1. Use of choice modelling in policy formulation

The CV exercise conduct in this survey could be augmented in the future by the use of **choice modelling** (CM) in order to ascertain more detail about the nature of values that are most important to forest users or to explore the effects of different policy options on forest users behaviour and attitudes in an economic way. CM is a family of survey-based methods for modelling preferences for goods, where goods are described in terms of their attributes and of the levels that these take. Respondents are presented with various alternative descriptions of a good, differentiated by their attributes and levels, and are asked to rank the various alternatives, to rate them or to choose their most preferred. By including price/cost as one of the attributes of the good, willingness to pay can be indirectly recovered from people's rankings, ratings or choices. This will allow a comparison of the economic costs and benefits of different policy options to be explored.

The use to policy makers of such approaches is explored by Hanley et al (2001) where it is concluded that by focusing directly on attributes, choice modelling techniques seem to be ideally suited to inform the choice and design of multidimensional policies. In Uganda, until relatively recently, there was no or only little consideration given to comparing the environmental costs and benefits of policy, the result of which can obviously lead to costly errors. However, the situation has changed with the advent of the National Environmental Management Authority (NEMA) and developments in environmental law and regulation within Uganda's policy environment.

In this context, it is recommended that policy makers should increasingly call upon environmental valuation to aid improvement in policy design. For example if the NFA is charged with managing forests in a manner which maximises net social benefits, then decisions over species mix, age diversity, the provision of recreation facilities and community management schemes in forests would be helped if managers have estimates of the marginal values of various attributes.

4.3 Marketing of forest products

Non-timber and timber markets for raw materials and goods from the natural forests of Uganda are important to local livelihoods. These markets provide a means of monetising goods from the forest at critical times of year for forest users. It was seen in the household survey (Table 11) that over all forests types, 58% of the value of forest goods harvested was from sales in local markets.

Charcoal production around Bugoma and Kasagala was of a more commercial nature. Here producers, who also tended to be wholesalers, travelled greater distances than those in Rwenzori and Budongo to bring their produce to local markets. Distance is probably synonymous with effort. Only individuals producing in a commercial sense would be willing to make the effort, or have the means to transport large volumes of produce to a wholesale market. Thus it seems likely that both Rwenzori and Budongo are too far from the commercial markets (mainly Kampala) to compete, so preserve production for local markets.

Markets for timber and NTFP fall into two broad categories:

1. **Commercial** markets
2. **Ad hoc** and spot markets

By and large charcoal and also timber, fall into the first category where large volumes of local produce are purchased by organised traders. Goods are then taken to central markets for sale. This type of marketing receives some control and regulation through the application of taxes on harvest, movement permits and market taxes. However some production falls into category two.

Most NTFP with the exception of rattan and bamboo are traded in the second manner. Where individuals decide that it is opportune to produce and sell certain types of goods, but are only able to access local markets. Out of all the respondents interviewed about handicraft production only one was part of an association to market produce (Uganda Community Tourism Association). For rattan and bamboo there exists a formal commercial market as that for charcoal. However it is likely that much of the trade is illegal and unregulated. A proportion of the trade will also be in the realms of category two, where local producers sell bamboo and rattan products on local markets.

The scope of the marketing elements of this study was reduced due to time and resource constraints, however it indicated that there is a substantial commercial trade in non-timber forest products, charcoal and timber from Uganda's natural forests and that a proportion of the trade goes unseen officially. This unseen trade value at the level of the local livelihood can be estimated at approximately 37.2 Billion USh per annum, this being the proportion (24.6%) of monetised forest goods from the estimate of total annual livelihood value of forests (Table 11). This represents a significant gain in terms of taxes that could be derived from the regulation of the NTFP trade.

However the use of taxes to regulate the trade in NTFP could have negative repercussions in that it ultimately would reduce the margins and thus the value of the NTFP to harvesters. This could have two effects: firstly to cause harvesters to increase harvesting effort and take more from the forests, or secondly to reduce the value to such an extent that the incentive to maintain private forest over other forms of use is changed. However these issues are highly contextual, depending on the role of NTFPs in the individual household livelihood, if the forest is on private

or protected land, and the capability to enforce regulations over the management and protection of forests. Ultimately choice in taxation lies in focusing on either consumption or production. With the focus on poverty alleviation high on the government agenda taxes must logically fall more towards consumption rather than production. Production taxes could be seen as a direct tax on the poor.

Some choices over courses of action to regulate the trade in NTFP more sustainably are:

1. more regulations and taxes to boost government earnings? But what cost / benefit of putting in place all the regulatory machinery?
2. minimum regulations and taxes and instead invest government funds into supporting the management of private forests
3. Combination of above, regulate to put some controls in place, and tax to reduce demand for over-exploited products

Further market analysis should seek to document the marketing margins channels and returns within the system for different categories of trader and also at different types of market (table 32).

Table 32. **Market Types**

Market type	Description	LC Level Centre
Central Markets	Large markets where wholesaling occurs and numbers of specialised markets may be found	5 and Kampala
Intermediate markets	Operate a step closer to markets	3,5 regional level
Standard	The effective interface for the end sale of city based, or import goods and the entry point for rural goods to move into larger regional markets	2,3 local level
Minor markets	Locations for exchange by local people	2 village

Understanding and documenting market performance for forest products will in turn aid in designing policy and interventions that effectively regulate for a sustainable trade that optimises the social and environmental benefits from forests.

4.4 Using Forest Economic Values

4.4.1 Integrating forest values into policy

The integration of forest values into policy is a crucial step. Forest users and managers are often reluctant to modify their management practices even when the importance of environmental factors is acknowledged. This may be in part due to a relentless pressure to reduce costs and increase revenue. Careful design of forestry regulations, concessions and tax policy can encourage forest users and managers to account for non market benefits in their own interests. This can in turn reduce the need for costs of supervision by regulatory agencies, whilst achieving a more efficient mix of market and non-market benefits.

Values can be applied at different geographical and policy levels, for example in deciding about land use planning policy, or about how individual stands should be managed. In both cases the scope for improving policies runs from zoning and property rights to regulation and pricing and incentive schemes. However bringing the values presented in this report to bear on policy at the national level still presents some significant challenges which must be addressed as a priority. The Ministry of Finance does not listen directly to sub sector issues. MoF requires the presentation of sub-sector issues as part of a coordinated and unified sector plan. In order to take the evidence and recommendations of this and other forest sub-sector reports forward the Ministry of lands water and environment must put together a Sector Investment Plan as the basis of further discussion with the MoF. Forestry having already taken clear steps to evaluate

economic issues in their sector is in a strong position to provide some strategic lead in the compilation of such a plan and such a lead must be taken in the short term.

In examining some contextual issues in Uganda, it is clear that Uganda is approaching a national fuel wood deficit. In addition much of the wood fuel and timber used in Uganda comes from natural forest/woodland sources and is probably unsustainable. At the same time there is little expansion of plantation and forestry business activities. This gives rise to three important of questions:

1. How should Uganda wean the public off or at least reduce to sustainable levels the demand for natural forest wood sources whilst at the same time encourage the development of a private agro-forestry sector?
2. How can the above be done before the natural forest reserves in Uganda are exhausted?
3. How much forest and of what type does Uganda need?

In section 2.3.4 the concept of externalities was introduced. In addressing the above questions we are attempting to mitigate or 'internalise' the market externalities. Virtually all forests have some sort of positive non market value (e.g. soil conservation ,biodiversity). This implies that the ***economic*** value of keeping land under forest (especially natural forest) is always greater than the ***financial*** values that can be derived by a private firm producing for the market. Conversely because the full economic value cannot be captured by the private sector this means that private firms or owners of private forest will systematically under provide forested land, especially in the case of natural forests. It is therefore necessary for governments to consider the country's needs and ensure that sufficient forest resources are conserved for their nation's population.

Valuation studies worldwide (Bishop, 1996) have shown that, in terms of forest composition, the general public values forested landscapes composed of mixed species and varying ages. This would also support the needs of local forest users as such a mix of forest is likely to produce a more diverse array of non-timber forest products. However it is a scenario that generally runs contrary to commercial forestry interests. Thus it implies that private firms would undersupply diverse forest landscapes. Therefore forest policy needs to balance the supply of both public and private goods.

4.4.2 Forests goods and Property Rights

Economists often argue that a fundamental undersupply of non-market benefits is the result of lack of exclusive property or user rights. The notion is that private property where it is enforceable creates an opportunity for profitable exchange and is thus an incentive for sustainable management. Generally economists tend to advocate for the provision of property rights over regulation or price policy and this is also appropriate in the case of Uganda's forests. An advantage of such an approach is that government agencies need not concern themselves with the difficulties of setting prices or taxes but can devote its efforts to enforcing property rights and contracts.

To this end the pilot collaborative forest management scheme is a well focused, and appropriate vehicle to deliver public and private goods at the level of the forest stand whereby a defined user group (community) is allowed defined, secure user rights over a given area of forest. Such use rights could cover NTFP, firewood or recreational use, and access to at least a proportion of timber licenses. Community management of forests potentially has significant advantages over private concessions, which include the difficulty to exclude poachers, or illegal loggers, many of whom might originate from the local community.

The focus of the discussion so far has been on protected forest areas. For natural forest on private or open access land enforcing such schemes is difficult in light of the overriding need of the private individual. This was the case around Bugoma where, whilst households derived

significant income from the private forests, the principle value in it was for conversion to agriculture. This dynamic could be seen as a product of current agricultural technologies being employed and land scarcity in the area. To change such attitudes requires a more complex approach, which may be outside the mandate of forestry authorities i.e. the promotion of agricultural intensification rather than the current extensive approach to agricultural production.

Developing an integrated approach to land use planning has interesting implications in terms of coordination between ministries. Agriculture has it own line ministry and this represents its economic and political importance over other environment and natural resource sectors of. Agricultural policy will therefore have a profound impact on the viability of other ENR sectors, but ultimately it is the integrity of the environment and the important role of Uganda's forests in maintaining healthy agro-ecosystems that will underpin the success or failure of agriculture in the future. In order to maintain natural forest on private land incentives must be developed and coordinated between ministries.

As an example of incentive schemes to maintain private forests currently Uganda is seeking support from the World Bank–Global Environment Facility to initiate a direct payment scheme for households to conserve natural forest on their private land. The design of such a scheme needs to take into consideration patterns of ownership and tenure over the forested land in question as well as setting a price to ensure that maintaining forest cover is at least as profitable as converting it to other forms of land use. In addition the form of payment, as well as the institutional and organisational structure for the scheme is very important. Simply paying a direct subsidy to an individual is unlikely to prove sustainable, as sources of finance will be difficult to locate indefinitely. Much more sustainable would be to look for ways for households to pool their forest resources into a private community forestry programme. Money from the GEF could be used to purchase the land for a community trust and then to develop a community management scheme based on sustainable exploitation of the forest area as well as for continued rural development activities amongst the community to promote sustainable agricultural production and marketing activities as well as income generating and enterprise projects.

4.4.3 Forest goods and forestry regulations and taxes

Some environmental values of forests may already be accounted for either implicitly or explicitly in current practices especially where the enforcement of private property rights is not feasible. Proposals or attempts to establish timber cutting limits, rotation lengths, stream side buffer strips and wildlife corridors under the National Environment Statute and the Forest Act and implementing regulations or other programmes may all work to mitigate the loss or damage of non-timber benefits from logging. However enforcement is an issue as the regulations are only as good as the level of enforcement or compliance received.

If it is not feasible to enforce private property rights such as on non-marketable public goods (e.g. watershed or carbon values), it may be possible to account for the values through taxation in other areas. For example levying a marginal tax on water users that is restricted for forest conservation could provide some finance to offset the costs of watershed protection and management activities. Where the benefits are global public goods such as carbon sequestration a number of innovative schemes such as the World Bank Carbon Fund are being developed and tested to use global public financing to address the loss of forest cover. Such schemes need to take into account the equitable distribution of benefits especially at the local level.

Consumer price is perhaps the most influential and efficient incentive to reduce the demand for natural wood. Until such time as sufficient quantities of plantation timber with a lower price than timber from natural woodland is available on the Ugandan markets consumer substitution will not be possible. Incentives to promote on farm forestry and community management of natural forests are a critical step in this process and the saw log production grants and the CFM

schemes are important activities that must be promoted and expanded. However these schemes will yield results only in the medium to long term.

Imports of timber at concessional prices could be one way of augmenting the short-term supply of quality timber onto Ugandan markets. However concessions need to be set so they do not undermine the nascent on farm timber production in Uganda. In addition consumers need to be educated about other types of wood. Changing cultural practices or perceptions about wood is perhaps one of the most difficult hurdles to overcome. Schemes to promote the production of alternative timber (eucalyptus and pine) products in the construction and cabinet making industries should be invested in.

4.4.4 Forests and land use policy

Uganda needs its natural forests because of the broader ecosystem services that help maintain the environment and productivity of other natural resource activities. In order to make up the shortfall in fuel wood and timber needs investment in on farm timber production is necessary. Landowners are sensitive to taxes in their choice of land use. Similarly timber concession holders are sensitive to royalties, taxes and other fees. The results of valuation exercises can be incorporated into the selection for policies to induce changes in land use and logging practice.

For example the sale price of timber concessions on public forestland can be adjusted to account for the relative importance of non-timber benefits in different areas and the impact of timber harvesting or plantation development on them. On private land, rates of tax may be adjusted according to the importance of non-timber benefits in that area. However both options require detailed knowledge of local conditions and are best suited to a decentralised administration.

Proper enforcement of regulations on forests and natural timber products is the entry point to controlling the use of timber from natural forests. There is no substitute for effective policing. The NFA and DFS should make special effort to ensure the implementation and management of effective enforcement regimes.

4.5 Developing the role of environmental economic valuation

Forest management policy cannot be held in isolation from wider development policy. Importantly there needs to be close coordination at a local and national level to ensure policy coherence, hence the importance of the PEAP process. How the process translates into supporting appropriate and coherent policy and action at the level of the forest is of great concern.

The decentralised approach to forest management through establishment of both the NFA and District Forest Services is obviously one way of ensuring this. However their capacity to address local level policy issues regarding public goods activities depend on being able to secure sufficient public finding; where a sufficient level of funding is that which allows the public interest to be administered without affecting the ability of the authority to raise income.

This study has attempted not only to conduct a valuation of important aspects of Uganda's forest values but also to illustrate a range of techniques applicable in this context. However it has not been within the scope of this work to allow an exhaustive treatment for all the possible valuation techniques or environmental policy options. A number of other reliable methods have been developed that could be useful in informing the selection of appropriate policies in future exercises (IIED, 2003; Bateman et al, 1999; Baumol, 1992; Hanley et al, 1997).

Clearly the PEAP process is an ideal platform to incorporate economic aspects of forests into policy or budgetary planning and development. The evidence presented should be used to promote meaningful discussion between the authorities mandated with the protection and

management of Uganda' s forests and also with other agencies and organisations that conduct activities in sectors which have a direct impact on forest use or the socio-economic state of forest users i.e. agriculture and micro finance.

Some recommendations for further activities regarding economic valuations include:

- As a priority, valuation should be developed within routine systems for monitoring and evaluating non-timber benefits on a national and local scale i.e. UBOS household survey or part of a NFA monitoring program;
- Uganda seems to suffer from a lack of comprehensive data on land use management. As a priority a systematic survey of the relative profitability (gross margin analysis) should be undertaken to understand the economic performance of crops, livestock and trees on different soils in different agro ecological and climatic zones. Future valuation exercises should help to assess the change in the economic importance of forest benefits at the level of the forest site, region or nation under different land use and management schemes;
- A comprehensive survey of market prices, performance and integration should be conducted in order to give insights into how the trade could be regulated;
- Valuations should be used to make informed trade offs between the marketed and non marketed benefits from forests;
- Valuations should be used to devise a balanced combination of regulations and incentives that lead forest managers to account more fully for the non-use benefits from forests in their decision-making. Further studies should be undertaken to examine the qualitative and quantitative impacts of different combinations of policy options
- A thorough assessment of current and future demands for forest products needs to be made as a framework for plans to promote the use of natural forests and the development of on farm forestry.

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Appendix 1

I. Methods

The three methods employed generated new empirical data disaggregated by wealth about household use of forests, an estimate of the consumer surplus derived from forests and used secondary data to make estimates about the value of forest ecosystem services. In addition a market survey of selected forests goods was used to develop a picture of the marketing margins and market chain.

I.I Household Survey

The objectives of the household survey were to:

- Gather quantitative economic data on household consumption of timber and non-timber products
- Assess the contribution of those products to overall income generation.
- Understand the proportion of household income derived from forest products through assessing gross household income
- Qualify the role of forest products in livelihoods security and the reduction of vulnerability.

A structured survey questionnaire was developed to elicit quantitative and qualitative data on the above mentioned issues (Appendix 2: Household Survey Questionnaire). This relied on people's own perceptions and own reported values about household wealth and income in their own local context.

Draft questionnaires were prepared in advance of a training workshop, which took place from 13th – 15th November 2003. The method, background theory and questionnaires were reviewed with enumerators. Some role-playing exercises were used to familiarise the enumerators with the survey tools. A pre test was made on volunteers from the local rural community around the workshop site near Entebbe, to further iron out problems with language and comprehension. This resulted in a questionnaire survey ready for further testing.

Further extensive pre-testing took place at Budongo Forest, Masindi District, in the LCI of Nyabyeya I and Nyabyeya II. The team was based at Nyabyeya Forestry College, Masindi from 17th to 19th November 2003. This allowed additional familiarity with the survey tools as well as the chance to apply the method and review it all. Additional changes were proposed and reviewed and incorporated in to the survey questionnaire. These addressed issues to do with enumerator ambiguity or poor comprehension of the questions and to address issues to do with respondent comprehension of questions.

I.II Contingent valuation

The **contingent valuation method** (CVM) uses a direct approach to valuing an environmental good or service in that it asks people through surveys what they are willing to pay for the good or willing to accept for the loss of the good. Contingent valuation is particularly attractive because it can estimate values where markets do not exist or where market substitutes cannot be found. For these reasons, CVM is widely used to measure existence values, option values, indirect use values and non-use values.

People reveal their value for the benefits derived from a protected area through their willingness to pay (WTP) for those benefits. A person's WTP can be elicited through surveys or surrogate markets. People also reveal their value for an environmental benefit through their willingness to accept (WTA) compensation for foregoing the benefit. In the case of loss of access to a resource, people reveal their values through a willingness to pay to prevent the loss of access and their willingness to accept compensation to tolerate the loss.

These two concepts of benefit, WTP and WTA, should reveal the same values for the protected area. But empirical studies suggest this is not the case. It is generally believed that this is because people value the things they have more than those things they do not have. Therefore WTP is usually smaller than WTA.

Values produced by CVM are "contingent" because value estimates are derived from a hypothetical situation that is presented by the researcher to the respondent. The two main variants of CV are open-ended and *dichotomous choice* (DC) formats. The former involves letting respondents determine their "bids" freely, while the latter format presents respondents with two alternatives among which they are asked to choose. Open-ended CVM formats typically generate lower estimates of WTP than DC designs (Bateman *et al.* 1995).

Proponents of CVM (e.g. Carson 1991) argue that its theoretical foundations are firmer than those of other valuation techniques, because it directly measures true WTP (or WTA). Moreover, CV is the only generally accepted method for estimating non-use values, which are not traded in markets and for which there are no traded substitutes, complements or surrogate goods, which can be used to impute values.

On the other hand, because no payment is made in most cases, some observers question the validity of stated preference techniques. Critics argue that CVM fails to measure preferences accurately and does not provide useful information for policy (Diamond and Hausmann 1994). Even practitioners accept that poorly designed or badly implemented CV surveys can influence and distort responses, leading to results that bear little resemblance to the relevant population's true WTP.

Recent attention has focused on overcoming potential sources of bias in CVM studies. Resolving these difficulties involves careful design and pre-testing of questionnaires, rigorous survey administration, and sophisticated econometric analysis to detect and eliminate biased data.

The hypothetical scenario that is established as the basis of a response must enable the respondent to fully understand the good being valued as well as the market. The criteria in the table (Table A1) below set out guidelines which if not met in the questionnaire design will result in biased and inaccurate data.

Table A1. **Scenario Design Criteria for CVM**

If the scenario is not…	*The respondent will…*	*Effect on measurement*
Theoretically accurate?	Value the wrong thing (theoretical misspecification)	Measure wrong thing
Policy relevant?	Value the wrong thing (policy misspecification)	Measure wrong thing
Understandable to the respondent?	Value wrong thing (conceptual misspecification)	Measure wrong thing
Plausible to the respondent?	Substitute a condition or not take the exercise seriously	Measure wrong thing or give unreliable, biased or protest response
Meaningful to the respondent?	Not take the exercise seriously	Give unreliable, biased or protest response

This survey (Appendix 2) used a willingness to pay (WTP) format and a double bounded (the responses are bounded by an upper and lower limit either side of an initial bid) and dichotomous choice (yes or no response) approach over a range of stated values to calculate the direct use values of forests to local peoples livelihoods. The question was delivered with the household survey questionnaire and benefited from the pre testing trials.

The strength of this approach is that each respondent gives two answers to two payment amounts. Analysis of the results using nonparametric approaches avoids bias introduced through making assumptions about the underlying distribution of true WTP within the sample.

I.III Sampling for the household survey and contingent valuation

A multi stage stratified random sample of households was employed. The target population for the survey were households that used the forests. Therefore the sample frame was made up of all LCII (parishes) that directly border the forest sites in question.

The target population were all forest users in a focal forest area. A key assumption was that various income groups used the forest resources in different ways and displayed varying levels of dependence on the forest to maintain their livelihood. The sample organisation used is summarised in the table below.

Table A2. **Sample Organisation**

Stage	Organisational Group	Strata	Selection Criteria
I	LC II or LCII segment		Parish bordering or overlapping with focal forest
II	LCI		LCI within selected LCII
III	Household	Wealthy, Average, Poor	Participatory wealth ranking to develop indicators of categories

Stage I

The criterion for selecting a LCII was that it must border directly or overlap with the focal forest. In order to avoid clustering, sampling was constrained so that each parish sampled was relatively evenly spaced around the forest yet still randomly selected. This was achieved by dividing the number of parishes around the forest into 12 units with equal numbers of parishes and selecting one parish at random from each unit.

Where there were less than 12 LCII around a focal forest the LCII were subdivided in to segments so that there were 12 segments. Where there were more than 12 LCII the LCII were chosen at random from a list. The list was constructed in sequence of the LCII occurring around the forest.

Stage II

Once the list of LCII was selected another list of the LCI within the selected LCII was constructed using tables of LCI names and randomly selecting them with random number tables.

Stage III

In the LCI, the criterion for selection of households was by wealth rank: rich, middle or poor. A participatory wealth ranking exercise was conducted by asking a focus group of key informants in the community about the indicators of wealth. The focus group was then asked to place the names of all of the individual households in that community within the three categories. This stratified list was then used to select 5 households at random from each category for interview.

I.IV Market Survey

The objectives of the survey were to:

- Define the marketing chain for key timber and NTFP
- Identify how and where in the chain values were accruing

A structured survey questionnaire (Appendix 3) was devised in order to elicit quantitative economic data and qualitative data about prices and marketing of key timber and non-timber products. The market survey was conducted alongside the household survey but was of secondary importance. Due to constraints in resources a small sample of key informants was interviewed in different markets.

The questionnaire was devised to understand some of the physical and exchange functions of the markets. This included transportation, prices and seasonal aspects to the market. This information allowed us to develop a basic understanding of market structure, conduct and performance.

I.V Valuing Ecosystem Services and other values

In Uganda a significant body of data is available from which to make reasonable estimations of the value of certain ecosystem services. This is particularly the case in terms of demographic data but less so of quantitative environmental data, especially in the study areas in question. However enough is available on which to make some reasonable estimates. As an example, data on different subjects were available from the following sources:

Table A3 **Typical Sources of Data**

Source	Data Type
Uganda Bureau of Statistics	Demographic
Forestry Department	Biomass
	Timber revenues by district
	Timber marketing
	Timber management data
	Forest Tourism revenues
Uganda Wildlife Authority/Uganda Tourism Department	Tourism Revenues in National Parks and other areas
Ministry of Agriculture	Land use data
Ministry of Finance	Economic indicators for key natural resources
	Natural Resource Trade Figures

Appendix 2. Household Survey and Contingent Valuation Questionnaire

Environmental Economic Value of Forests to Local Livelihoods

Interviewer:	**Date: Time:**
Checked by:	**Check Date:**
Village (LC1):	
Parish (LC2):	**Respondent Age:**
Sub-county	**Respondent Sex:**
Forest:	**Wealth Group:**

Introduction and explanation of survey

1.Household Composition
How many people are in the household?

Status	Description	Age	Sex	Education level	Occupation
Head of Household					
Spouse					
Member 1					
Member 2					
Member 3					
Member 4					
Member 5					
Member 6					
Member 7					
Member 8					
Member 9					
Member 10					

Description – *1)husband, 2)Wife, 3)Child 4)Relative 5)Orphan 6) Visiting worker 7)Dependent 8) Female head*
Education Level *– 0) no formal education, 2)Primary, 3) , secondary)4) College/University education*
Occupation *– 0) no work 1)Farming-including subsistence 2)student 3)Own business 4) wage labour 6)Salaried employee 7)Infant 8) Other – specify*

How many years has your family been in this village/location?……
1)Less than 1 year 2) 1-5 years 3)5-10years 4)10years or more

2. Assets
House Materials for Main Dwelling (try to make discreet observations on approach)
Walls
1)Timber/poles 2)Brick 3)Mud 4)Iron 5)Plastic Sheeting
Door/Window Frame
1)Timber/poles 2)Brick 3)Other-specify
Floor
1)Timber/poles 2)Mud 3)Cement 4)Tiles/bricks
Roof
1)Thatch 2)Tiles 3)Iron Sheets 4)Plastic Sheeting

Do you own a Bicycle? How many? How about any of the other things below?
1)Radio 2)Television
3)Bicycle 4Motorcycle 5)Pickup truck or car 6)None

Livestock Assets
Do you have any animals amongst your household assets?

Livestock Item	Number
Goats/	
Sheep	
Pigs	
Chickens /ducks/ pigeons	
Rabbits	
Cows	
Dogs	

3. Land Resources - How much land do you have? What do you use it for?

Land Type	Area (Local Unit)	What % is this of your total land holding?

Land Type *– 1)Natural forest/woodland, 2)Woodlot, 3)Arable, 4)Wetland, 5) Grassland Pasture 6)Woodland/forest pasture 7)Cash crop plantation*

4. Do you own a woodlot? If woodlot is owned:

Species of tree	Area (Ha)	Purpose

6.In Which months do you experience high cash expenses and what are they?	
Expense	**Month**

7. Do people use the forest?

8. How far is it to the forest in Km

9.How long does it take to walk there?

10. Which months of the year do you use the forest most?

Month	Reason

11. Which months is food scarce or expensive?

Month	Reason

12. Which fuels do you use each week and how much?

Source	Use	Volume (unit)
Wood		
Charcoal		
Paraffin		
Gas		
Electricity		
Other?		

Use- 1)Cooking 2)Lighting 3)Heating

13.What trends have you noticed regarding the following resources from your local forests or market in the last year?

Charcoal		Fuel wood		Timber	
Supply		Supply		Supply	
Quality		Quality		Quality	
Price		Price		Price	

0) Decrease, 1)Increase 2) No change 3) Don't know

12. How far on average do you travel each day to collect firewood? Is it from the forest reserve?

14. How has this changed in the last 5 years? 1) No change (go to 15) 2) travel further 3)travel shorter

15. What is the reason for the change (if any)?

16. Where do you get your water?

Bore hole/well	
Stream/river	
Spring Protected	
Spring Unprotected	
Pond/Dam	
Lake	
Other Specify	

16 b Does your water come from the forest? Yes/No

17. How far is it from your home (one way) to the water source?

18. Who collects water in the household? (If hired labour skip to 19)

19. How many 20l jerry cans do you use each day?

20. What type of treatment do you use to purify water for drinking?

Nothing	
Boiling	
Boiling and Filtering	
Chemicals	

21Does the quantity of drinking water change during the year? Why?
22. What is the quality of your drinking water?
1.Excellent 2.Good 3.Fair 4.Poor
23. How has the quality of water from your domestic source changed over time? I f (no change go to 24)

Time	Quality
5 years ago	
1 year ago	

Score - 1.Excellent 2.Good 3.Fair 4.Poor

24. How do you expect water quality to change in the future?
1.Improve 2.Deteriorate 3.No Change 4. Don't know (go to 25)

25.Why would you expect the above?

26. Do you collect medicinal plants from the forest? 1) Yes 2)No (go to 31)

27. What is the main reason you collect medicinal plants?
1) Own Consumption 2) Sale

28. Can you tell me about some of the most important medicinal plants you collect from the forest?

Local Name of Plant	Part Used (bark, root etc.)	To treat which illness?	Where is it sold?	Price per Unit
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

29. Which would be the most important medicinal plants from the forest to you?

Plant Name	1	2	3	4	5	6	7	8	9	10
10										X
9									X	X
8								X	X	X
7							X	X	X	X
6						X	X	X	X	X
5					X	X	X	X	X	X

4				X	X	X	X	X	X	X
3			X	X	X	X	X	X	X	X
2		X	X	X	X	X	X	X	X	X
1	X	X	X	X	X	X	X	X	X	X

Rank: 1. 2. 3. 4. 5.

30. What is the most significant factor for you about the top 5 plants (you can tick more than one?

Factor Plant Number=>	1	2	3	4	5
Income generating potential					
Use in the household					
Cultural belief					
Other					
Other					

31. Do you cultivate any medicinal plants (specify)?

32. Why do you cultivate these plants?

	Reason	
1	Income generation	
2	Home use	
3	Other	

The following questions on household income and consumption should concentrate on recalling events from the past 12 months.

33. Household Income/Consumption (Non forest based)

Item			**Annual income from own produce/labour**	**Weekly consumption of own produce**	
	Local Unit	**Total annual harvest**	**Units Sold/received**	**Units Consumed**	**Average Price per unit**
Crop Income					
Coffee	Tin				
Tea	Kg				
Cocoa	kg				
Tobacco					
Processing Cane	tonne				
Beans (dry)	kg				
Staple Food (starches, maize matooke etc):					
1					
2					
3					
4					
Vegetables:					
1					
2					
3					
4					
5					
6					
7					
Fruits:					
1					
2					
3					
4					
5					
6					
Tree Crop Income					
Woodlot Timber:					
1					
2					
3					
4					
Woodlot poles:					
1					
2					
3					
4					
Charcoal	Sac				
Moringa	Kg				
Neem	Kg				
Seedlings	Piece				
Livestock					
Large animal					
Small animal					

Animal products					
Renting out of livestock					
Wage Labour					
Unskilled Agricultural/seasonal labour					
Other employment					
Skilled/regular employment					
Crafts and small scale enterprise					
Beer	Jerry can				
Waragi	litre				
Sale of crafts	item				
Trading goods					
Renting out goods					
Miscellaneous cash income					
Total Cash Income (excluding environmental cash income)					
Private Cash gifts/donations received					
Private non cash gifts received					
Total gifts received					

34. Household Income/Consumption (Natural Forest based goods)

Do you have any problems with crop raiding animals from the forest? 1)Yes 2)No

Which Species?
1)Buffalo 2)Antelopes 3) Chimpanzee 4)Monkeys 5)Baboons 6)Porcupines 7)Wild pigs

8)Other (Specify)……

Which species is most problematic?

Do you ever trap some of these problem animals?

Do you eat them? 1)Yes 2)No

Do you harvest or sell anything from the forest?

Item	**Local Unit**	**Own harvested units Sold Annually**	**Own Harvested Units Consumed Weekly**	**Price Per unit**
Sale of forest goods				
Yams	Heap			
Bamboo shoot	Bundle			
Mushrooms	Basket			

Wild honey	Litre			
Afromamum	Heap			
Passion fruit	Heap	".		
Guava	Heap			
Mango	Heap			
Jackfruit	Head			
Pawpaw	Head			
Palm nut (oil)	Basket			
Wild Coffee	Kg			
Tamarind	Bundle			
Small wild animals:				
Rats	Piece			
Rabbits	Piece			
Duiker	Piece			
Primates	Piece			
Snakes	Piece			
Porcupine	Piece			
Guinea fowl	Piece			
Francolin	Piece			
other				
Large wild animals:				
Big Antelope	Piece			
Hippo	Piece			
Buffalo	Piece			
Other products:				
Building Poles from forest	Piece			
Timber from forest				
Grass for thatching	Bundle			
Rattan	Bundle			
Bamboo	Bundle			
Sand	Heap			
Clay	Heap			
Stones	Heap			
Other				
Large carpentry items	Item			
Small carpentry items	item			
Medicinal plants	Kg			
Mats/woven goods	Item			
Handicrafts	Item			
Firewood	Bundle			
Charcoal	Sac			

Contingent Valuation

Enumerator:	**Date:**
Village:	**Forest:**
	Wealth Group:

Contingent Valuation

Without good management it is unlikely that your forest resources will last long in to the future, let alone be viable for future generations. This exercise tries to understand the values that you put on your local forest resources. It requires you to think about alternative situations and express your value in terms of a money value.

1.What other benefits do you get from the forest apart from the products you harvest?

2. Suppose you had to vote for a forest department management scheme. As part of a management scheme, it would be proposed that you would not be allowed to use the forest for **three months**. In this time the forest would be left alone, have time to regenerate and become more productive, after which you would be allowed access again.

If alternative goods were available on local markets would you accept *X* to compensate your loss in livelihood in order to vote for the new regulation? YES (go to a) NO (go to b)

a) Would you be prepared to accept 0.75X as compensation?
YES NO

b) Would you be prepared to accept 1.5X as compensation?
YES NO

Respondent	**Amount (X)**	**Vote YES/NO**	**1.5 (X)**	**Vote YES/NO**	**0.75 (X)**	**Vote YES/NO**
1	**800,000**		120,000		600,000	
2	**1,500,000**		2,250,000		1,125,000	
3	**3,000,000**		4,500,000		2,250,000	
4	**3,500,000**		5,250,000		2,625,000	
5	**4,000,000**		6,000,000		3,000,000	

3. Suppose that a local run management scheme were devised to maintain and improve your forest resource so that you had more secure access to and better quantity and quality of forest products.

Would you be willing to pay *X* annually toward the scheme?
YES (got to a)
NO (go to b)

a. Would you be prepared to pay *1.5X* of the value? YES NO

b. Would you be prepared to pay *0.75X* of the value? YES
NO

Respondent	**Amount (X)**	**Vote YES/NO**	**1.5 (X)**	**Vote YES/NO**	**0.75 (X)**	**Vote YES/NO**
1	**10,000**		15,000		7,500	
2	**15,000**		22,500		11,250	
3	**20,000**		30,000		15,000	
4	**25,000**		37,500		18,750	
5	**30,000**		45,000		22,500	

Notes:

- Only one value of X per respondent should be presented
- Each value should be presented to a different respondent within the socio economic group so that all values have been asked

Appendix 3 Market Survey Questionnaires

Commodities

Key informant/Focus group Questionnaire

Interviewer:	**Date: Time:**
Checked by:	**Check Date:**
Town/Village:	
Parish:	**Respondent Age:**
Sub-county	**Respondent Sex:**
Name of Market/trading area:	

1.Commodity:

1) Charcoal 2) Rattan 3) Bamboo 4) Timber

A. Sales

2. How would you best describe your involvement in the commodity trade?

1) Processor/producer 2) Agent 3) Retail

3. Where do you sell your commodity? *Name of market/district and distance. Export?*

4. How do you transport goods to market?

5. How much does a return trip cost or time of trip?

6. What is the normal unit of trade?

7. How much do you sell a unit for? Does this price vary with season. If yes how?

8. What is the sale price at different times of the year?

Month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Price												

9. What other factors affect the sale price i.e. quality what are the factors of quality?

10. How do your sales vary throughout the year?

Month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Score												

1)Peak 2)High 3)Middle 4)Low 5)Negligable

B. Purchases

11. Where do you purchase the commodity/raw materials?

12. How do you collect it/purchase it?

13. If transport is required how much does this cost per load?

14. Are there any storage costs involved?

15. Are there any taxes charged to you. If yes what are they, how much per unit?

16. Does your purchase price vary with season?

Month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Score												

1)Peak 2)High 3)Middle 4)Low

17. At which times *(month)* of year is it difficult to obtain the commodity/raw materials?

18. How much did you sell last year? *(state unit)*

19 Timber Locally produced:

What are your average prices for purchase:

Size	**Mahogany**	**Mvule**	**Musizi**	**Eucalyptus**	**Pine**
4x3					
6x2					
12x1					
12x2					

What are your average sale prices?

Size	**Mahogany**	**Mvule**	**Musizi**	**Eucalyptus**	**Pine**
4x3					
6x2					
12x1					
12x2					

NTFP Markets - Handicrafts

Key informant Questionnaire

Interviewer:	**Date: Time:**
Checked by:	**Check Date:**
Town/Village:	
Parish:	**Respondent Age:**
Sub-county	**Respondent Sex:**
Name of Market/trading area:	**Forest:**

1) Which handicrafts do you most commonly trade?

Name of item	Main raw materials used	Where is it sold?	Who to?	Price per item
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Rank them in order of economic importance to you:

Item N^0	1	2	3	4	5	6	7	8	9	10
10										X
9									X	X
8								X	X	X
7							X	X	X	X
6						X	X	X	X	X
5					X	X	X	X	X	X
4				X	X	X	X	X	X	X
3			X	X	X	X	X	X	X	X
2		X	X	X	X	X	X	X	X	X
1	X	X	X	X	X	X	X	X	X	X

Sales

2. How would you best describe your involvement in the handicraft trade:

1) Wholesale 2) Processor 3)Retailer

3. Where do you sell your commodities? *Name of market/district and distance. Export?*

4. How do you transport goods to market?

5. How much does a return trip cost (or time of trip)?

6. Does sale price vary with season? Why?

7. What other factors affect the sale price i.e. quality what are the factors of quality?

8. How do your sales vary throughout the year?

Month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Score												

1)Peak 2)High 3)Middle 4)Low 5)Negligible

9. Where do you purchase raw materials?

10. How do you collect it/purchase it?

11. If transport is required how much does this cost per load (or time taken for trip)?

12. Does your purchase price vary with season?

Month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Score												

1)Peak 2)High 3)Middle 4)Low 5)Negligable

13. At which times *(month)* of year is it difficult to obtain the commodity?

14. How much do you sell annually?

Item	**Units sold**

Appendix 4 Personnel

Project Director
Dr Andrew Plumptre, Director, Albertine Rift Programme, Wildlife Conservation Society

Project Manager
Glenn Bush, Research Associate, Albertine Rift Programme, Wildlife Conservation Society

Field Supervisors and Data Processors

Simon Nampindo
Caroline Aguti

Support Staff
Scovia Kobunsigye– Administrator, Wildlife Conservation Society
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Field Team

Enumerators
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Richard Kushemerwa
John Rwagara
Richard Odong –Too
Sam Mugenzi

Appendix 5 A guide to collecting field survey data

Adapted from, Upton M (1987) African Farm Management

Purposes and methods

Livelihoods Research involves farm household investigation and their descriptive, quantitative and diagnostic study. This is aimed at description of the farm and household system, estimation of underlying relationships, specification of household objectives and diagnosis of key constraints and weaknesses. In either case many items of information are needed; it is a multi-subject enquiry.

Other studies needed for planning purposes may appear to have a simpler purpose such as estimating the average cost of production per tonne of maize on a particular type of farm. Even in cases such as this the simplicity may be more apparent than real. Not only are there many items of cost to be considered, but also, if the full opportunity cost of the resources used is to be estimated, some analysis of the whole farm household system is needed.

Thus all farm household studies are multi-subject enquiries. Further, it is difficult to be precise about what we need to know or which items of information are essential. However, the following categories of data are generally needed.

1*. Descriptive material on livelihoods systems:*

This includes not only the areas and combinations of crops grown together with seasonal cropping pattern and sequences, but also numbers of each class of livestock and the methods of production used. It may also be appropriate to describe associated off-farm activities.

2. *Resource endowments*

It is generally useful to know the resource base or the quantities of resources controlled by a typical household. This requires estimates of (i) the area of land controlled, (ii) the total family labour force and (iii) physical productive assets owned, such as livestock, permanent crops, tools and buildings. In addition, information is needed on the scope for acquiring more of the resources, extending the farm area, hiring labour or obtaining credit.

3. *Input-output data*

These are measures of quantities of resources actually used as inputs and the physical yields obtained. They must be related to a given production period usually taken to be a year. However, more detailed information may be required on the seasonal spread within the year of labour use for instance. To obtain such information accurately may require fairly continuous observation or recording. Problems of measuring inputs and outputs under mixed cropping are discussed later.

Some productive activities, particularly permanent crops continue over many years. The pattern of annual inputs and outputs is likely to vary over the lifetime of such investments (see chapter 8). Ideally, the whole input-output profile over the life of the investment would be measured, but the fact that most field investigations cover only one year precludes this. It may, however, be possible to record inputs and outputs for a given permanent crop on different plots established at different times. For example, inputs and outputs on cocoa nurseries may be separated from inputs and outputs of mature trees. In such a way a time profile of inputs and outputs might be built up.

4. *Purchases and sales*

These data are needed for two purposes: one is to evaluate the financial position and cash income of the farm household; the other is to provide price data for evaluating all inputs and outputs. For some purposes it maybe sufficient to know aggregate costs and returns, while for others a breakdown of these totals by enterprise may be needed. Clearly wages and remittances from off-farm occupations are included.

5. *Farmers' attitudes and objectives*

As already emphasized an understanding of farming systems and farmers' behavior requires information on farmers' attitudes and objectives. This information would include attitudes to risk, to food self-sufficiency, tastes and food preferences, leisure and off-farm work requirements as well as social customs and taboos.

Warnings are often given regarding the dangers of collecting unnecessary data. Where, as in farm household investigations, there are multiple objectives, these should be ranked in order of priority. Unnecessary or trivial data should be omitted from the study to limit costs and facilitate data collection and analysis. Problems however arise when we are unsure as to whether a particular piece of information might be useful. It may be very costly to go back after the main study is completed, to recover some critical datum item which was omitted from the main study.

Some information from each of these five main categories listed above is likely to be needed but it is impossible to generalize regarding the precise requirements. The importance of data on purchases and sales depends upon the farmers' attitudes to cash and subsistence farming. The need for detailed records depends upon whether labour is thought to be a critical constraint on production. Thus some prior knowledge of the system is needed in order to determine what data to collect. This lends support to the idea, adopted in much Farming Systems Research, of carrying out an area familiarization study using rapid rural appraisal before embarking on a more detailed formal survey. The preliminary investigation permits more precise specification of just which data items are needed from the formal study.

Data collection methods
There are three main methods for collecting farm household data, which are in order of increasing cost

1. Records kept by respondents
2. Interviewing respondents
3. Direct observation

Records kept by respondents Where farmers keep formal records and accounts, these provide an ideal source of household or farm management data. In such circumstances a postal survey may be possible, thus eliminating the costs of enumeration. However, farm accounts are only likely to be kept on a large scale commercial or state farms and estates. This approach has little relevance to the vast majority of small farms. Early studies in Kenya relied on literate children to keep farm records and accounts for survey purposes (MacArthur, 1968) while 'emergent farmers' in Zambia were able to provide bank statements of their financial position (Bessell *et al*., 1968) but such cases are atypical of majority of farmers.

Interviewing respondents This is the usual method of investigating attitudes and objectives, and may be used for collecting factual information on farming systems, resource use, crop and livestock yields and research constraints. It is likely to require less frequent visiting and to be less costly than direct observation and measurement, but may produce some inaccuracies or biases.

Attitudes and objectives are described as 'latent variables' existing in the individuals mind but not necessarily easily expressed. Very few of us could specify precisely what is our aim in life in

a response to a simple question. There is temptation to give answers which will satisfy or please the interviewer, rather than carefully exploring ones own motives. With regard to factual information, there is a problem of recall. Clearly, this is a possible source of inaccuracy or error. We return later to the question of frequency of visiting and errors of recall. However, there are possible advantages in relying on farmer recall when there is substantial year-to-year variation in the weather, resource use and yields. The study period may well be atypical in some sense, so that data collected by direct observation will also be atypical. The farmers' estimates of resource use and yields may be influenced by his judgment of what is average rather than what has occurred in the current season.

We may remind ourselves at this point of the possible difficulties in defining the basic unit of analysis: the household and the farm. There are difficulties in deciding exactly who should be included in the household in terms of both their contribution to household resources and their dependence upon household income. There are difficulties in identifying who makes the decisions and therefore who should be interviewed regarding his attitudes and objectives. In some cases decisions are made jointly by household members and group interviewing is more appropriate than individual questioning. There may also be difficulties in recording all the resources under the family control. Distant plots of land, areas under bush fallow and herds of livestock grazing far afield may easily be overlooked. Some authors have argued that the household is too small a unit to capture the multidimensional relationships affecting decision making on African farms. (Ancey, 1975 or Gastellu, 1980). Arguably the whole village or lineage should be basic unit of investigation.

Direct observation This clearly involves regular visiting by the investigator or his enumerator and is therefore very time consuming and costly. However, if it is done properly the results should be accurate and reliable. Clearly, it is impractical to follow every member of the farm household all the time and record their every movement, besides observing crop and livestock growth and development. Hence direct measurement is always used in conjunction with interviews, to collect missing data. Direct estimations can be made of land areas and the resource stock with periodical measurement of labour use, crop yields and other input and output flows.

The three main types of field investigation are (1) case studies, (2) farm surveys of the rapid rural appraisal kind and (3) the cost-route method (Spencer, 1972). These are distinguishable in terms of (a) the number of farms involved and (b) the frequency of visiting. All three methods have been acceptable in Africa.

Farm case studies relate to a few farms, which are studied in great depth with regular visits, observations and possibly record keeping. Clearly whole village studies must be limited to very few cases, but some farm household studies have been of this nature (eg see Clayton, 1961). Unit farms, which are case studies established by a researcher, often on a research station, have been used to provide data and for on farm testing in various parts of Africa; at the International Institute for Tropical Agriculture, Ibadan, for example.

Rapid rural appraisal is based mainly on interviews and informal observation. It involves few visits to each household, possibly only one, so the cost per household is relatively small and a larger sample can be covered for a given total expenditure that than using the cost-route method. This approach is increasingly favoured because of its low cost and the advantages of completing a study within a short period of a few months (see Collinson, 1982; Byerlee *et al,* 1980). By contrast case studies or the cost-route method usually involve record collecting over a period of at least twelve months often with a similar additional period to analysis and presentation of results. The greater timeliness achieved with rapid rural appraisal is a major advantage in providing data which are a still relevant in a rapidly changing situation.

The cost-route method refers to repeated visiting of the same sample of farms over an extended period to collect data on inputs and outputs, costs and returns, some by questioning and some by direct observation. It's generally claimed that this method provides the most

accurate and reliable data particularly for items such as labour use and crop yields. However, the cost per household of regular visiting is substantial. There is therefore an important trade-off between sample size and visiting frequency for a given total expenditure.

Summary statistics

The information collected from a farm household survey may be quantitative: areas of land, hours worked or kilograms of grain for instance or qualitative as in response to questions regarding attitudes. It may be further categorized in terms of the number of possible response classes. Thus we may identify

(1) Binary data with only two response classes, such as whether the household head is male or whether any permanent crops grown;
(2) multiple category data where there are a number of discrete categories: (a) non-numerical and unranked data as in a set of alternative farmer objectives; (b) numerical or ordered data; such as the number of ox teams owned, the number of the month of planting or soil quality;
(3) continuous data on plot areas, crop yields or length of time worked.

For most practical applications we need to summarize the data, and different summary measures are suggested for each of the above categories. In the first case the appropriate summary measure is the proportion of positive responses. For category (2), the mode or most frequently occurring response may be used. Indeed if continuous data are grouped into classes, a modal class may be identified as the most frequently occurring class. However, for numerical or ranked data, whether discrete or continuous, the most common measure of central location is *arithmetic mean* or simply the mean. This is defined in the same way as the 'expected value' given that each observation is assumed to a probability of 1/n where n is the total number of observations or sample size. For some purposes (e.g. risk analysis) it may also be useful to have a measure of the variation, such as the variance. In the case of a simple random sample, as described below, the variance (now written as S^2 to emphasize that it is the square of standard deviation) is estimated by;

$$S^2 = \sum (X_i - X)^2(n-1)$$

where X_i is an individual observation and X is the mean.

Each of the statistics discussed above relates to a single characteristic or measurement for each household. However, the objective in farm household surveys is to arrive at a description of the whole system, which requires estimates of many interrelated characteristics. A problem then arises in deciding which characteristics to use to describe the typical farm. This is often referred to as the 'modal farm' but clearly it is most likely that any individual farmer will fall into the modal class for every variable that is measured.

The alternative is to create a theoretical model of imaginary farm that is typical of the sample. In taking this approach it would be appropriate to use the sample model for each variable, since this measure is unsuited for accounting and other arithmetical manipulations. For instance, we cannot assume that the modal quantity of maize produced times modal price equals the modal price of maize produced. Mean values on the other hand, can be manipulated in this way. Hence there is a stronger case for using the mean of each variable in describing and analyzing the typical farm. The only possible disadvantage in using the mean is that for indivisible items such as cows or machines, unrealistic fractions may result. However, it is questionable whether this need invalidate the analysis.

Another advantage of using mean, rather than the mode, is that we can measure its precision as an estimate of the true population mean. For simple random sample the error of the mean is calculated:

Standard error = $\sqrt{(S^2(1-f)n)}$
= approx $\sqrt{S^2/n}$ when f is small
where S^2 and n are as already defined
and f= sampling fraction = n/N where
N is the population size

The standard error maybe used either (i) to estimate a confidence interval for the population mean, such that we can assert with a given probability (e.g. 95%) that the interval actually contains the population mean; or (ii) to test the hypotheses regarding the population mean (see any basic statistics test, e.g. Freund, 1979). It is argued that presentation of a confidence interval is more meaningful and useful than a single point estimate of the population mean in descriptive studies, since it gives some guidance as to the precision of the estimate. Hypothesis tests may be used in on-farm testing of innovations to investigate whether there is a significant difference (one unlikely to have occurred by chance) in performance between adopters and non-adopters.

Several points should be noted, however. First, estimation of confidence intervals and hypothesis tests are only valid if appropriate random sampling techniques are used. Second, in these circumstances, precision can be increased by increasing the sample size (note that the standard error is proportional to $1/\sqrt{n}$). More sophisticated sampling techniques may further increase precision for a given sample size or survey cost. Third, in practice, non-random sampling methods and measurement errors may introduce bias in the estimation of the population mean. The overall precision or size of the error depends upon both sampling error and bias.

$(\text{expected error})^2=(\text{standard error})^2 + (\text{bias})^2$

the latter often being much larger in practice

There is probably a trade-off between these two influences. Sampling error can be reduced by increasing the sample size but given a limited budget, this will necessitate less careful measurement on the individual farm with a possible increase in measurement bias.

Sampling

i. *Why random sampling is desirable*

The sampling problem is to decide how to select the sample from the population. This sounds, and indeed is, a simple thing to do but unless we ensure that there is no bias involved in our sampling method, there is no hope whatever of our being able to make scientific statements about the population from the knowledge we obtain from the sample. It is by no means easy to ensure that there is no bias.

Suppose, for instance, the agricultural extension service is asked to recommend names of farmers likely to be willing to cooperate in providing farm management data. These farmers are likely to be progressive than their neighbors and may have introduced new techniques not commonly employed on the majority of in the population. If this error is avoided by eliminating these farmers from consideration when selecting the sample, this would be little better, for the bias would be the opposite direction.

We do not usually know what biases there are in our sampling procedure if we choose it for reasons of mere convenience, speed, or cheapness, or because it has no obvious disadvantages. In sampling it is never enough not to have detected a bias; the sample should

be drawn in such a way that no possibility of bias can arise. We are only really safe in this respect if the sample is selected in some way which is completely unrelated to any conceivable variable. To ensure this, we employ a chance mechanism to select the sample that is we take random sample every farm in the population has an equal chance of being selected.

ii. *The simple random sample*

The random sample is therefore the ideal to be aimed at to avoid bias. However, a random sample is not always possible for farm management surveys. Thus a great deal of information, some of it is highly personal nature, must be collected over at least one cropping season and preferably longer. This may require many visits by the enumerators and may take up a great deal of farmer's time. It is therefore essential to find farmers who are able and willing to cooperate. Not all members of a random sample will be agreeable. Furthermore, in many parts of Africa there is no complete list of all the farmers in the population. Without such a list or 'sampling frame' it is impossible to ensure that every farmer has an equal chance of being selected.

For some purposes, such as land use surveys, it is possible to use areas of land (or their equivalent on maps) as the sampling frame, but where, as with a farm management survey, contact with the individual farm families is necessary, the best frame to use is one based on a list of human population. Such lists may be prepared from the returns of the most recent population census, or in their absence from the records of local administrators, tax collectors or a centralized marketing agency. Most of these records are likely to be either out of date, or incomplete, or both. If no comprehensive and up to date information for a sample frame exists, it may be desirable to make a reconnaissance survey of all farms covering only a few items, such as farm area, type of land and family size, in order to compile a complete list farms in the area. Thus every effort should be made to obtain a complete sample frame and to select a random sample. Where this is not possible, the danger of bias must be borne in mind.

iii. *Systematic sampling*

Involves choosing every j^{th} member of the population systematically, where 1/j is the desired sampling fraction. Thus a 5% or 1 in 20 sample of households in a village might be obtained by selecting every 20^{th} dwelling passed in a tour of the village. It is generally easier to draw a systematic sample than a simple random one, but there is a danger of introducing bias if the sample units are not arranged in a random order.

iv. *Stratification*

There are possible modifications to the simple random sample in which every farm has and equal chance of selection, although these modifications involve random selection at some point. For the stratified random sample, the population is divided into a number of groups or strata. These strata may consist of: (1) administrative units, (2) ecological/agricultural zones, (3) village or farm size groups, or any other means of classifying farms. Within each stratum a random sample of farms is selected, which means that every farm has an equal chance of being selected. This chance, however, might not be equal to that in a different stratum of the population. A stratified random sample is thus, in effect, a collection of simple random samples from a collection of populations.

It is generally the case that a stratified random sample gives more precise results than a simple random sample, especially if the strata are selected so that the variation between strata is as large as possible and hence the variation between farms within each stratum is minimized. The results are more precise, simply because the variation within each stratum is less than the variation in the whole population. However, in order to define the strata, it is necessary have some additional information on the population, besides the sampling frame. This additional information will obviously be available if the sample is to be stratified by administrative units, but

this method of defining strata is likely to be less effective in improving precision than stratifying by ecological zone and farm size.

Obviously since many items are being recorded on each farm, one basis of stratification may not be equally effective in improving precision for each item. For example, the types of crops grown and the area of each crop per farm are likely to differ considerably between climatic zones *but* family sizes or the amount of capital used might vary more between zones. Unless we are very fortunate, therefore, we must expect the gains from stratification to be relatively modest but it will practically bring about some improvement for every item, no matter what the basis of stratification.

v. *Cluster sampling*

The random cluster sample involves dividing the population into a number of groups. A random selection is made from these groups. All the individuals in the chosen groups then constitute a cluster sample. Whereas with stratified random sample, or groups or strata are included but only a sample of farms within each group are surveyed; with random cluster sample only a sample of groups are included but all farms within the sample groups are surveyed. Unless the clusters are very carefully defined so that each one includes as much variation as possible, or reflects a full range of variation in the whole population, this method is likely to be less precise than simple random sampling for a given sample size. However, its a big advantage is that it is likely to be cheaper than other forms of sampling, because the cost of enumerator's travel from one farm to another is much reduced. Hence the level of precision per unit expenditure maybe increased.

Random cluster sampling is particularly useful (1) where there is no population list to serve as a sampling frame, and (2) where there is a large dispersed population or where communications are bad. Cluster sampling was used by *Bessel et al*. (1968) in Zambia.

Generally speaking, some of the advantages of both techniques can be obtained by means of a multi stage random sample. For a two stage sample, the population is divided into a number of groups, villages, for example: a simple random selection is made from the groups; then a simple random selection is made from the farms in each selected group. All the individuals selected in this way, taken together constitute a two-stage sample. Thus a two-stage sample may be viewed as a cluster sample, in which only a sample of the farms within each cluster are studied, or a stratified random sample in which only a sample of the strata are included. Most of the field enquiries in the agricultural sector in developing countries have been based on multi-stage samples. Thus the first stage groupings maybe ecological/agricultural zones; the second stage groupings villages; the third stage groupings farms or families; and for some purposes the fourth stage groupings are individual plots.

Where there are no population data available to serve as sampling frame, ecological zones and villages maybe distinguished and sampled from aerial photographs or maps if available. Each village in the sample may then be subjected to a population census in order to provide data for sampling farms at random within the villages.

The very brief review of sampling methods should show that the selection is by no means the simple and obvious matter that it at first appears. Before embarking on any survey it is advisable to get the help of a statistician or to study the theory of sampling methods before drawing a sample.

One general point regarding sampling is worth noting, namely that is sample size and not the fraction of the population sampled which almost entirely determines the precision of estimation for a given population. For most purposes a sample size of thirty farms in each stratum for which an independent estimate is required is probably adequate. There is little point in surveying a sample of a thousand or more farms. Resources would be better used in improving the accuracy of the data collected or in collecting additional data. Even where the number of

farms studied is an insignificant fraction of the total population, a random sample of sufficient size can be used to draw reliable, unbiased results and to test the accuracy of these results. If, however, it is impossible to draw a random sample then it is important to check as thoroughly as possible whether the results are biased in anyway.

Where a survey is made in just a single year or only a few years, the years are in fact a sample from the whole population of an infinite series of years. Random sampling is not possible in this respect so it important for the investigator to determine to what extent the information gathered each particular year represents normal or average conditions, particularly from crop yields, animal production and price levels. This of course does not apply where farm management surveys are made continuously year after year. Indeed there is much to be said for establishing surveys on permanent basis. Farm conditions and factors, which influence farm business are constantly changing. Thus data rapidly become outdated. After a farm management survey has been repeated in the same area for a number of years, the data become more and more accurate, and the time involved and money spent diminish because farmers become more familiar with the nature of the survey and the type of information required. Enumerators become more experienced and do not need to repeat the initial training. Furthermore, data from repeated surveys make it possible to identify trends in yields, prices, and factor inputs.

Questionnaires and schedules

There are two types of form that may be used:

i. the schedule for collecting factual information in tables or lists;
ii. the questionnaire for collecting opinions, attitudes and aptitudes by asking the respondent questions framed in a precise way.

The schedule is often designed for ease and convenience of coding and summary of the data, although it is also necessary to set it out in such a way that the enumerator is unlikely to miss any items. Sometimes sets of schedules are bound together to form record books. One possible set of schedules for farm management data collection and analysis have been designed by FAO (Friedrich, 1977).

With a questionnaire it is important every respondent should be asked the same question in the same way. It is therefore necessary to translate the questions into the local language on the questionnaire to avoid any slight misinterpretations by the enumerator.

All the terms used in schedules and questionnaires must be clearly understood by enumerators and agreed before the survey starts. Difficulties may arise over the definition of 'a farm' for instance. It may be defined as 'all the land and other resources under the control of one farm family', but then problems may arise in defining the 'farm family' and deciding how to treat resources under family control but not used in farming. The correct translation of local crop names must also be agreed.

Pre-testing of schedules and questionnaires is highly desirable, either as part of a pilot survey or as part of the training programme for enumerators. This allows the opportunity to correct omissions, or ambiguous questions and to discover terms, the meaning of which may not be clear to farmers or enumerators.

Organizing the survey

Preparation
The organization of a survey is a major administrative task, which involves;

i. Formulation of objectives
ii. Delineating the study area
iii. Choosing samples

iv. Designing and testing questionnaires
v. Selecting and training enumerators
vi. Preparing for their needs in the field and back up services in the office
vii. Carrying out a pilot survey, all before the main survey can begin. Thus it is important that adequate time is allowed for all these preparatory tasks before the main survey period and that plans and phasing of the whole operation are worked out in advance.

It is also desirable in most cases, to hold meetings with chiefs, village councils and farmers before the main study in order to explain the aims and objectives and to enlist farmers' support and cooperation.

Some investigators have thought it necessary to provide incentives in the form of free issues of fertilizers or other inputs or in the form of cash. However, apart from the cost, the promise of a gift may alter the farmer's behaviour so that it becomes atypical. It is likely that observing local customary procedures of communication and keeping farmers informed at all times about the purpose and progress of the study is more important than the provision of financial or physical incentives.

Arrangements must also be made for housing, transport and equipment for enumerators, as well as communications for returning questionnaires, supervision and payment of wages. Generally, the enumerators can be left to make their own accommodation arrangements but it is important that they should live in the survey area to minimize travel time and cost.

Generally enumerators need some form of transport to visit farms and this can prove a costly item. If cluster sampling or multi-stage sampling is used, it may be convenient and not too costly to take a small group of enumerators by motor vehicle to a sample village, dropping them one by one sample farms or allowing them to walk between farms. Where the sample farms are too widely scattered for this approach, it may be necessary to provide each enumerator with a bicycle or, where distances are greater still, a motorcycle. Careful planning and budgeting is needed to find the most suitable form of transport in terms of convenience and cost.

Enumerators require, besides a stock of schedules and questionnaires, clipboards, and writing materials. They may require other equipment depending upon the records to be collected, such as surveying equipment for measuring areas of plots of land harvesting tools and weighing balances for crop-cutting and weighing of yields or stop watches for timing labour use. All such equipment should be acquired in advance, before the main study begins.

Communication between the enumerator and the survey office is probably best maintained by regular supervisory visits, when the enumerator can be paid, completed survey forms can be checked and collected while progress and problems can be discussed. Unless enumerators are very experienced and trustworthy employees, regular supervision is essential.

The personality and behaviour of the enumerators has an important effect on the willingness of farmers to cooperate. A good working relationship must be established. Thus choice of enumerators, their training, motivation and supervision are important considerations.

Enumerators must be fluent in language used by farmers and it is desirable that they should know something of local farm conditions and practices so that they ask questions intelligently and check on the accuracy of the farmer's replies.

There are, therefore, advantages in recruiting local inhabitants of the survey area. However there are also possible disadvantages if the enumerator is a member of a particular faction, religious group or political party whose opponents may refuse to cooperate. Also it may be difficult to sack an enumerator who is unsatisfactory in the work, if he is a member of the local community, since this may turn farmers against the study and create problems for his replacement.

Another consideration in choosing enumerators is the educational standard required. This must depend upon local circumstances. In some places there may be unemployed university graduates who could be recruited for such work whereas in other places, primary school leavers are the most highly educated people one could hope to recruit. Generally speaking, a high education standard is needed provided that the applicants are reasonably literate and numerate and educate training is provided. Selection may be based on an interview and simple test of ability to write clearly and make simple calculations.

The possibility of employing part-time enumerators should be borne in mind. People such as extension agents or school teachers may be used. However, there is always a problem of dual allegiance, which makes supervision and control difficult. There is a danger that they will withdraw from the project when an opportunity for promotion occurs or when annual leave is due. University students may be used if the main survey work can be restricted to the vacations. Such experience can be very valuable to students' agricultural projects.

Motivation of enumerators is important and they should be paid adequate wages comparable with those they could earn in similar employment elsewhere. Ideally, there is regular and fairly continuous survey work in progress; a permanent cadre of professional enumerators should be established with opportunities for promotion resulting from good service. However, this may not be possible if there is inadequate work to keep them fully employed.

Whatever the background of the enumerators, some training is needed before they start in the field. Generally a period of two to three weeks, made of for instance one week of office training and the rest in field training, will be adequate. During the office training, purpose and importance of the study can be explained. The survey questionnaires and schedules should be studied in detail with some discussion of the ways in which the results will be summarized in order to give trainees a thorough understanding of their interview procedures. They should also be instructed in the techniques of assessing areas, weights and measures. Field training is devoted, in the main, to giving enumerators practice in completing questionnaires and schedules with farmers.

The number of farmers each enumerator can be expected to visit each week must depend upon;

i. The time it takes to travel from one farm to another farm to another, which in turn depends upon distances and means of transport.

ii. The time it takes to complete each interview which depends upon the amount of information collected and the method of measurement used,

iii. Whether farmers are only available at certain hours for interview or at any time.

A decision may, perhaps, be delayed until after a pilot survey, which will give a clearer picture of what is possible but a crude guide, four or five visits per day or twenty to twenty five visits per week should be possible if sample farms are relatively close together. When most of the time is spent in traveling the number that can be visited is of course reduced.

Frequency of visiting farmers

A critical decision, which affects both the cost per farm surveyed and the accuracy of the data collected, is the number of times each of times each of the chosen farms is visited. It may range from once only to daily visiting over a whole year or longer. There is apparently a trade-off between savings in cost and gains in accuracy per farm. However, certain gains in reliability are obtained increasing the sample size so if the reduction in cost per farm allows an increase in the number of farms studied there may be an overall gain in reliability of results.

In part the decision may be whether to rely on recall (i.e. farmer's ability to remember inputs used and yields obtained in the past) or direct observation. Clearly direct observation of amount of seeds used as well as amount of crop harvested is impossible when the farm is only visited once. However, even with quite frequent visiting, it is necessary to rely on the farmer's recall, though only over a short period since the last visit. Accuracy is likely to be greater, when the period of recall is shorter.

The scope of saving by infrequent visiting depends upon the complexity of the farming system. In the case of a simple system with a single, short cropping season, no perennial crops or livestock, a single visit just after harvest might be sufficient to provide acceptable data. More frequent visiting would probably be essential to study systems with two or more cropping seasons, some perennial crops and livestock.

A distinction may be made between; (i) Single point data such as area of land, numbers of livestock, or productive trees and stocks of machines, equipment and materials and; (ii) Continuous data such as daily labour use and quantities of other inputs and outputs. Whereas single point data may be collected in a single visit, reliable records of continuous data may require regular and frequent visiting.

Within each of these categories of single point data and continuous data, a further distinction may be made between 'registered' and 'non-registered items'. The former consists of items such as rented land areas, hired labour use or cash crop sales, which are associated with market transactions and therefore are 'registered' in the farmer's mind if not on paper. Non-registered items include family labour use and household consumption of food stuffs which are far less likely to be recorded. Registered items can be recalled more easily and hence can be collected satisfactorily with infrequent visiting. Overall then, reliable information on single point, registered items may be collected in a single visit, but to get accurate information continuous, non registered items may require regular and fairly frequent visiting; say every two or three days. (See Collinson, 1979 op. cit.)

Where farmers have more than one dwelling, for instance, where, as in parts of central and southern Africa, the cattle post is located at quite a long distance from the calculated plots, it maybe necessary to visit each of the holdings to make observations and collect records. The risk that the farmer may not be at home on a single visit is perhaps greater than in a more settled system of farming.

Measurement

Measurement of land areas

The area of land farmed is clearly a single point-item but it may not be registered; that is the farmer may not have a very precise idea of the exact data. Direct measurement may not be necessary.

The first objective is to locate and identify which plots or fields are cultivated by the sample farm household, since many family farms are made up of several scattered plots. Omission and errors may occur at this stage for several reasons.

i. The farmer may not wish to disclose how much land he controls because he fears he will be taxed upon it or other reasons.

ii. Wives or other household members may have their own plots, which the family head may fail to mention although strictly speaking these plots form a part of the family farm.

iii. The farmer may only mention those to which he has long-term usufructory rights and may fail to mention land, which is rented or pledged.

iv. He may fail to mention very distant plots.

Having identified the plots on the ground it may be useful to make a sketch map of the whole farm for inclusion with the other records as a visual check that information is collected on all the plots. It is also desirable to paint some identifying mark or number for each plot, on a convenient tree or rock.

Difficulties may arise in defining crop boundaries, especially where crop plants tend to spread or ramble. Furthermore boundaries may change over the reason as more land is cleared or some reverts to bush. More than one visit will be necessary to discover this.

Generally if the farmer does not know the area of his plots, direct measurement is required. Methods which might be used include;

i. Triangulation (i.e. dividing the area up into triangles) and measuring the sides by pacing, surveyors' chains, tapes or a measuring wheel.

ii. Measuring offsets, perpendicular to a straight, base-line using survey chains and tapes,

iii. Compass survey, again using any of the devices mentioned above to measure distance,

iv. Plane table

v. Aerial survey, though cost may be prohibitive for this last method

Some of these alternative methods are discussed in Upton & Anthonio (1965) Appendix II and Hoyoux (1979).

Areas are either calculated using the formula for the area of a triangle for instance, or estimated from scale drawing over which a squared grid, of the same scale is placed. The area is then found by counting the squares.

Inter-cropping raises special measurement problems. The simplest approach, and perhaps the most realistic is to treat the mixture of say maize intercropped with beans as a single crop different from sole crop maize and from sole crop beans, with its own pattern of labour requirements, costs and returns. Unfortunately, mixtures frequently include many more than two crops and since the proportions in the mixture can vary, the range of possible alternative combinations is practically infinite. Hence, in order to distinguish between different crop mixtures (and possibly to assess their relative merits), some information on plant densities is needed. It may possibly be based on visual assessment of the plot by the enumerator, or on quantities of seed used or on plant counts of sample areas within the plot. None of these methods is wholly satisfactory.

Special problems arise in assessing the areas of fallow land and communal grazing land per family. However, in both these cases, the collection of accurate data may not be considered very important. The area of fallow land might be estimated by asking the farmer how many years of fallow and how many years of cropping occur in a rotation, then multiplying the area cropped by the ratio years of fallow/years of cropping.

This is not very reliable, especially where different rotations are practiced on different plots or where the length of fallows is changing over time.

For communal grazing land the only solution may be to estimate the total area and divide it by the number of families using the land.

Measurement of labour inputs

A very crude assessment of the total labour input can be based on the numbers of men, women and children in the labour force multiplied by the number of hours each is expected to work. However, since the number of hours worked can vary widely from one individual to another, the margins of error may be very large and this method gives no detail of the allocation of labour between different activities.

For most farming-systems analysis and farm planning, information is needed on the seasonal pattern of labour requirements for individual crops (or crop mixtures) and livestock enterprises. As already mentioned, labour use is continuous and (except perhaps for hired labour) unregistered, so the collection of reliable data requires regular and frequent visiting.

At each visit the enumerator records the date, and (day by day since the previous visit) the operations carried out on each crop plot and the time spent on each. Similar details are collected for work connected with livestock.

For completeness, as a means of checking records and for other users, it is desirable to record hours of sickness, hours spent in entertainment and relation and hours of non-farm work. Difficulties arise in defining whether a particular task is farm or non-farm work, for instance processing and marketing of produce. Decisions on categories of work must be made and agreed by all enumerators before the survey begins. Time spent travelling to and from the fields may take up a significant portion of the working day. It is normal practice to include travelling time as part of the work time.

In collecting labour records it is necessary to separate different categories of worker, say (i) family head, (ii) other adult male family members (iii) adult female family members (iv) children (under 14 years old) of the family (v) hired women (vi) hired children. This is necessary because there is generally some division of labour between sexes and classes of labour so they are not perfect substitutes. Even when one category can substitute for another, hourly work performance may vary with physical strength and motivation. Thus while on light work there may be little difference in performance between men and women, on heavy bush clearing and cultivations men may achieve much more per hour. For hired labour, wage and other payments must be recorded together with information on associated bullock or equipment hire.

Assessment of hours worked may be unreliable without clocks and watches. It may be necessary to relate periods to the movement of the sun, or to prayer or meal times in questioning the farmer.

All this assumes that labour records are based on recall by a farmer of the hours worked. However, direct measurement of rates of working using work-study techniques may be an alternative, (see Farrington, 1975). The time spent carrying out a specific task on the measured area of land or quantity of produce is timed accurately by stopwatch. The advantages of this approach are; (i) work study requires a far smaller volume of labour data, than to do frequent visit surveys to produce mean values with comparable errors; (ii) the cost involved in the separate surveys of areas and yields required for estimates of per hectare requirements by frequent-visit surveys are avoided by work study where measurement of the work achievement is performed directly at the end of each observation; (iii) the directness of the technique excludes the possibility of respondent confusion or omission inherent in memory based techniques.

The disadvantages are; (i) there are certain operations for which it is practically impossible to measure the work achieved during observations of only a few hours' length, e.g. tobacco curing or bird scaring. (ii)The study only provides information on work rates, survey data are still needed to provide information on the seasonal pattern of operation of operations and the number the number of times they are carried out.

Nevertheless, some saving might be made by using a combination of survey and work study.

Most farm survey data collectors in the past have been concerned to find a means of aggregating different categories of labour into a total labour input in standard man-hours' or man-equivalents. Weighting factors are used for converting the work of women and children into man equivalents, for instance weights of 1.00 for adult males, 0.67 for adult females and 0.33 for children under 14 have been proposed for this purpose. However, for reasons given above any such weighting system must be arbitrary and there may be advantages in keeping labour records subdivided into separate categories.

Measurement of crop yields

Very often harvesting is fairly continuous, rather than single-point operation, and unless the crop is sold immediately quantities are not registered. Thus estimates based on long periods of recall are likely to be vague and inaccurate. Regular visiting desirable over the harvest period so that amounts harvested can be recalled more easily.

To avoid total reliance on recall, direct measurement by crop cutting on sample plots may be used. These sample plots should be marked out within standing crop sometime between planting and harvest, generally the earlier the better as this limits crop damage. Each sample plot is of a standard area (e.g. 3 meters square or 9 sq meters) marked out with pegs and wire or string, but is located randomly within the whole cropped area. The number of samples taken in any one parcel of land ranges from one up to ten or more but it must depend in part on;

(i) the parcel
(ii) the variability of the crop stand
(iii) the level of accuracy desired, and
(iv) the costs that can be afforded (see Spencer, 1972).

The sample plots are cultivated along with the rest of the field but are harvested separately, the yield from each plot being weighed accurately. Since the weight of most crops can vary significantly according to their moisture content, it is advisable to measure the moisture content when weighing the plot yield so that the yield can be adjusted to a standard moisture level. The yield estimates obtained are then multiplied by the total area of the crop to arrive at an estimate of total output. The main disadvantages of crop cutting are

(i) it is somewhat inconvenient for the farmer so he may not be ready to cooperate
(ii) it is only costly and time consuming for the enumerator, especially where many sample plots are involved;
(iii) yields are usually overestimated because the useful yield (actually available to the farmer) is often less than the total biological yield which is measured from the sample plots. See (Zarcovich, 1965).
(iv) It may be difficult to arrange the crop cutting the most appropriate time, when the rest of the crop is being harvested, especially where mixed cropping is practiced and the component crops are harvested at different times.

It has been suggested that experienced enumerators may be able to make reasonably accurate estimates of crop yields simply by looking at the mature crop and judging the yield. Clearly this must give rather crude estimates, less satisfactory than actual measurement.

For some tree crops, where the fruit grows in bunches yield estimates can be based on count of the total number of bunches and sample weightings of a few of them.

It is a good idea to ask farmers at some stage whether they consider the yields obtained this year to be about average, better or worse than average to give some idea as to whether the results are atypical.

Other yields and sales

For livestock such as dairy cows or laying hen, yield recording, if it is not already done by the farmer requires regular visiting by the enumerator. Births, deaths and slaughtering of most classes of livestock are more easily recalled and can be collected at relatively infrequent intervals.

If records are kept of produce disposals, both sales and home consumption, these may provide a cross check on the estimated yields and total production. Discrepancies may arise as a result of wastage, losses in store, gifts and so on.

Another reason for recording sales is to collect data on market prices obtained. In order to carry out a financial analysis of the farm business, total gross output of various different farm products, is evaluated in money terms using current market prices. Hence price data are an essential part of a farm business survey. Where some produce is marketed through a cooperative or a marketing board while other produce is sold in local markets, it is useful to record this too.

Measurement of capital assets

On practically every farm there will be certain capital assets, which must be taken into account in farm business analysis. These may include livestock, standing crops, irrigation works, drainage and other land improvements, buildings, machinery and equipment as well as stocks of food, seed, agricultural chemicals both purchased and home produced. Increases in value of certain assets such as growing livestock and tree crops or stocks of food and seed represent a part of the total farm gross output, where as decreases in value (depreciation) of machinery and equipment represent costs of production.

Generally information on farmer's capital assets can be collected in a single visit or preferably two visits, one at the beginning of the production period (opening valuation) and one at the end of (closing valuation).

The first task in assessing capital assets is to make a list or inventory. This should be fairly straight forward except possibly for recording the numbers of free ranging livestock or quantities of grain and other produce on hand.

Valuation of capital assets can raise problems. For items which are commonly bought and sold such as stocks of food, seed and chemicals, livestock and some tools and equipment the current market prices can be used, but where there is no established secondhand market, as is probably the case for permanent crops, irrigation works, other land improvements and some kinds of machinery and equipment, this is not possible. In theory, the present value of such assets should be based on estimates of their future productivity, but since such estimates would be largely guess work, the normal practice is to take the original purchase price or cost of establishment and subtract a depreciation allowance for the age of the asset. This s not entirely satisfactory since prices and costs may change overtime and estimation of depreciation is rather arbitrary. It is therefore advisable to use standardized average prices, costs and depreciation rates on all the survey farms when valuing capital assets.

It may be desirable to collect information on the farmer's cash assets, his credit and his indebtedness but farmers might be reluctant to provide such sensitive information unless there is very rapport between enumerator and farmer. However, such information, although valuable and interesting, is not essential for analysis of the farm business. If it is to be collected the following suggestions should be borne in mind.

(i) such information is best collected towards the end of field work.
(ii) Questionnaires on those items should be short and simple.
(iii) It is better to interview the farmer in private (Spence, 1972)

Measurement other inputs and expenditures
Although stocks of seeds, fertilizers and other agricultural chemicals may be included in the capital valuations it is necessary to record their use levels of application for purposes of farm business analysis. Where such inputs are purchased their source and price should be recorded. Similar considerations apply to livestock feeds and machines.

In order to assess the inputs used on individual enterprises, detailed recording is needed. Local measures such as bowls or even handfuls may be used in distributing seed, fertilizer or chemicals while livestock feeds may be measured in bundles for instance. Average weights must be estimated by sample weighing, for all these local measures to convert the quantities into more widely recognized units.

Records of hours worked by oxen, power tillers or tractors, irrigation pumps and other equipment may be desirable for farm planning purposes but are not essential for farm business analysis. However, purchased inputs of spares and materials such as fuel or lubricating oil must be recorded.

Information on other sources of income, household expenditure and food consumption is valuable as a cross check on other information collected besides being interesting and useful in itself. However, such information is not necessary for analysis of the farm business and maybe costly and difficult to collect. A decision must be reached before the survey begins, whether the advantages of having these data outweigh the additional costs.

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Data Analysis

Coding and processing data

At an early stage in the planning of a survey a survey, a decision should be reached on how the results are to be analyzed in terms of both

(i) the types of analysis that will be made, and
(ii) the data handling methods to be used, including whether or not to use computer.

Whatever methods of analysis are to be used, data coding is recommended. For quantitative, numerical information this simply means setting out the figures collected on the farm in a convenient lay out for further summary and analysis. In the case of qualitative data such as sex of family head, soil type, or statements of opinion, coding consists of allocating numbers to each of the alternative possible answers and using these numbers in further analysis rather the written answers (e.g. male head might be coded as 1 and female head as 2). The reason is simply that it is quicker and more convenient to manipulate numbers rather than written answers. Coding tables may be incorporated in schedules and questionnaires or enumerators may be required to transfer their records to coding sheets daily when they return from the fieldwork.

Use of a computer must depend upon whether computing facilities are available. Even where these facilities are available it is by no means certain that the use of computer is justified. Against the advantages of high speed calculations must be set the costs not only of the use of computer facilities but also of learning how to prepare data for entry into the computer and how to write instructions regarding the analyses to be carried out. These preparatory stages can be very time consuming. Many software packages are now available, on both micro and mainframe computers. Of particular relevance id the farm analysis package (FARMAP) developed at FAO (FAO, 1983) and the statistical Package for the social sciences (SPSS) (Nie et al., 1975) which is designed for the analysis of farm and other surveys. Although the former is specifically designed for farm survey analysis, the latter may be more attractive because of its greater flexibility if additional analysis, including statistical calculations, are intended.

Whether all the analysis is carried out by hand with pocket calculators or whether a computer is used, analysis and summary of results together with the writing up, are very time consuming. Experience suggests that these final stages take at least as long as the survey itself. Frequently inadequate resources of time and funds are allowed. The number and type of staff needed depend on the data handling methods chosen. Hand analysis requires clerical and calculating assistants while use of computer requires computer operators for data entry and analysis.

Initial cross-tabulations

There are two broad categories of information that maybe obtained from a farm study: simple variables and composite variables. The first category includes those items, which are recorded directly in the field. It clearly includes farmer's statements about their attitudes and objectives but may apply to estimates of total land area, labour use or farm income. The other category refers to those items which are the result of certain calculations applied to the basic data, for instance when separate labour records are aggregated to arrive at total labour input or accounting methods are used to estimate household income. We deal first with methods of summary and presentation of survey data in an informative way. The same principle may be applied to the presentation of composite variables, such as household income per capita, once they are estimated. Accounting methods are used to estimate such variables are dealt with later in the chapter. The following discussion on the summary of survey statistics is, of course irrelevant when a case study approach is used. Nonetheless, accounting methods are needed to analyze the case study system.

Coded responses for any single variable grouped into classes and represented as frequency distribution of the number of observations or households in each class. For binary data there

are of course only two classes while for continuous data it is necessary to first identify the classes by defining their limits. In defining class limits the following rules are usually observed;

(i) the entire range of values is divided into generally fewer than 15 classes
(ii) the classes are mutually exclusive so that each observation can appear in one and one class only.
(iii) Where possible the classes cover equal ranges of values although this may conflict with the last rule, and
(iv) The number of observations in each class should be sufficient to justify showing that class separately.

It is a useful first step, in the analysis of any data item, to determine the frequency distribution of the responses. This is not too onerous a task when analyzing data by hand, and is very easily achieved with a survey analysis package such as SPSS on a computer.

Having determined the frequencies it is but a simple step to express the results as relative frequencies or percentages of the total. This, in effect, gives the probability distribution of responses. For ease of interpretation it may be useful to plot the frequency histogram as in Fig. 12.1

A tabulation or plot of the frequency distribution of observations is useful in several ways
(i) in data checking and validation since values lying outside the feasible range are readily identified.
(ii) In examining the form of the distribution, its spread and whether it has more than one modal class or peak (the latter case might suggest that the data come from more than one distinct population),
(iii) In identifying the modal class.

Fig. 12.1 shows the frequency distribution of responses of a sample of Zambian maize growers as to which is the busiest month. The approach of simply asking farmers to identify critical constraints in this way is clearly cheaper than using detailed records and accounts of the whole farm system for the same purpose as described below.

A useful additional step is to prepare cross tabulations, which present results for two (or sometimes more) variable at once. Each column of such a table represents the frequency distribution of variable A, within each class according to variable B. the column totals then represent the total class frequencies for variable B, while the row totals represent the total class frequencies for variable A. individual cell frequencies may be represented as percentages of either the column or the row total. The advantages of cross tabulation over and above the benefits of examining frequency distributions already mentioned is that it may assist in identifying associations between variables.

In example is given in Table 12.1 comparing decision-making responsibilities (Variable A) of different members (variable B). From this table it appears that, in the study area of east Cameroon, male farmers or husbands are dominant in decisions regarding acquisition of land or tools or when to leave land fallow. Wives on the other hand are mainly responsible for deciding when to plant, what crops to sell and when to sell them. In such circumstances the qui square statistics may be used to test whether the apparent association between the variable (in this case the difference between the sexes) is statistically significant meaning it is unlikely to be a chance effect (for more details see Freud, 1979).

Where the objective is on-farm testing of new technology and a comparison of innovators with a control group, then the binary variable, adopter might be used as one of the variables to classify the data. The cross-tabulation by another variable, say farm income would allow comparison of two groups.

Analysis of the farming system

The cross tabulation of responses and interpretation of the distributions is generally the only analysis that is needed for data on attitudes and objectives collected by interview. For most other variables used in describing a farming system

(a) Some analysis or manipulation of the data is needed within each farm household to arrive at the desired measures;
(b) The results obtained from a sample of households are summarized by estimating the mean and perhaps the variance (see chapter 11).

It is desirable to carry out these operations in this order; i.e. to analyze the system for each of the sample households before summarizing by calculating the means. This is the only way in which variation between farms can be assessed. For instance, the mean yield of maize could be estimated by dividing the total output of maize from all farms in the sample by the total area of maize; this would provide no measure of the variation in yields between farms. Furthermore, it would provide a measure of mean yield averaged overall hectares, whereas we are here concerned to estimate the mean yield averaged over households. Only in this way can we be sure that the mean quantity of maize produced per household is equal to the mean quantity sold plus the mean quantity consumed, stored or wasted. In short, every item in the analysis must be averaged across households for the accounts of the average households to be internally consistent.

Estimates of the variance between households may be used to establish confidence in intervals for the main variables measured. However, as we have seen, such estimates are themselves unreliable if the sample was not drawn randomly and the results might be biased. The other main use of variance measures is in risk analysis. Unfortunately, the variance between farm households within one season may be a very poor and unrepresentative measure of the variance between seasons. The latter is likely to be the main concern of the risk averse farmer. Nonetheless having collected data from sample farms, the estimation of the variance is relatively easy and is probably justified.

Having considered the presentation of summary data we turn now logically prior questioning of analysis of individual farming system. The types of data needed were discussed in the previous chapter. Apart from the assessment of farmers' attitudes and objectives, these consist broadly of

(i) descriptive data on the farming system; the resource base, cropping patterns and livestock numbers and
(ii) measures of inputs, outputs, costs and returns.

Variables in this last group may be estimated for individual plots of land, for specific enterprises and activities or for whole household.

Descriptive data

The description of available resources and the combination of crop, livestock and off-farm activities may be set out in a series of tables under the headings of land, labour and capital.

(i) *Land:* there are three different ways in which the total area of land under the control of the farm, family may be analyzed: (a) by land use category, (b) by tenure and (c) by crops grown. The different land use categories may include rain fed arable, irrigated arable, permanent crops, permanent pasture or rangeland and fallow. Further, distinctions may be drawn according to soil type or topography. The sum of the areas in all these categories should equal the total farm area.

Categorizing by tenure involves separation of common land from that held by individual family members. Land, which is pledged or rented, is separated from land that is owned or held under customary tenure. It is useful to supplement this with information on the relative ease of acquiring additional land.

Finally, the pattern of land use should be detailed in terms of the areas of different crops grown. Where there's only one crop season per year and sole cropping is practiced, description is straightforward. The sum of the areas of individual crops plus grassland and fallow should up to the total area of land available to the household. Where two or more crops can be grown sequentially within a year, the area of each crop should be recorded. The total area of crops (and fallow) then exceeds the total farm area. The ratio of these totals may be calculated, as a measure of the intensity of land use (see chapter 6).

More serious problems arise in dealing with crop mixtures when it is difficult to assess whether the component crops are competitive or complementary. Judgment is needed in deciding whether to treat each component crop as covering the whole area or to assume each crop covers a fraction of the area. In some cases especially for complicated mixtures of many different crops, it may be most appropriate to treat each mixture as a separate and distinctive crop. None of these methods is wholly satisfactory, and special methods of assessment based on relative crop cover may be needed for detailed analysis of mixed cropping.

(ii). *Labour*: the basic regular labour force is usually made up of family members. Even hired labourers frequently live in as members of the household. Hence an analysis of the household composition may give an assessment of the regular labour force available. Household composition is analyzed by age and sex categories. Conversion factors may then be used to estimate the total labour force in standard adult male equivalents. Due account must be taken of other on farm commitments in calculating the residual labour available for work on the farm. Household composition data may also be used to estimate total food consumption requirements. The data should be supplemented by information on the ease of hiring more labour and the normal wage rates
(iii). *Capital:* capital invested in permanent crop is recorded under the cropping pattern. The remaining capital items to be mentioned now are livestock and physical assets of machinery and equipment. Livestock numbers are obviously separated by species and sometimes by age and sex categories, to give lock or herd structures. For purposes of aggregation, livestock unit conversion factors may be used to arrive at (a) total livestock units of each species, (b) total grazing livestock units for ruminant cattle, sheep and goats, or (c) grand total of livestock units owned by the household.

Separate records may be presented for individual items of machinery and equipment used on the farm or elsewhere. However, it may be thought desirable t o estimate the total value of capital assets in money terms. The total value of physical assets plus permanent crops, livestock, stored products and cash in hand minus any outstanding debts gives a measure of the farmer's net worth. Given that some assets are rarely bought and sold so that estimating their value is essentially arbitrary, and given that farmers are often unwilling to disclose their financial position, the measurement of net worth may prove difficult in practice. In any case, the measure is of limited value to a semi subsistence farmer except as a guide to his creditworthiness.

Input-output data

The object here is to calculate the quantities of inputs used and of outputs produced per hectare of each crop or per head of each class of livestock. Crop input-output data may be estimated from individual plot records, while for permanent crops such a oil palms, it might be appropriate to calculate the amount per tree.

Let us consider the measurement of inputs. Some, such as agricultural chemicals or tractor services, maybe purchased or hired while others such as family labour are supplied from family

resources. In puts of both kinds should be recorded for each plot or enterprise and converted to a per hectare or head of livestock basis.

An alternative distinction may be drawn between stock and flow resource inputs. Resources which are available in the form of stocks such as seeds, fertilizers and other chemicals or concentrate feeds for livestock, can be stored. If they are not used at a particular point in time, they can be kept for future use. Hence it is generally not necessary to record the timing of stock resource inputs. Such inputs are generally associated with variable costs.

Resources such as regular labour, or draught animals provide a continuous flow of man hours which cannot be stored for future use in the way that seeds can. Unused labour in January will not add to the labour supply in august. The cost of the flow is fixed and unavoidable, whether the labour is actually used at a particular time of the year or not. If such resources are likely to be limiting constraints it is highly desirable that the seasonal distribution of inputs should be estimated.

Labour inputs may be recorded separately, not only different dates but also by age and sex of the worker, by plot or livestock enterprise and by operation. Some aggregation may be desirable in order to present the seasonal labour profile. Labour input for different age and sex groups may be aggregated by converting them all to standard man-days. If the labour profile is to based on monthly intervals, then labour inputs on different dates and for different operations within the month may be aggregated to give total monthly labour in put. Finally, labour inputs on different plots of the same crop may be aggregated to give the total monthly in put to that enterprise. The ultimate objective is to determine the seasonal profile of labour inputs per hectare of each crop and per head of each class of livestock. Similar profiles of inputs may be calculated for draft animals or machines such as tractors.

In measuring the output of each enterprise (or plot) it is important to include both marketed and home consumed produce. Where yields have been recorded directly, the problem does not arise but where yield data are not available, then they must be estimated by combining quantities used in the household. Furthermore, in the case of livestock, and possibly some crops, there may be change in the quantity on hand between the start and end of year and some may have been purchased or received as gifts. These items must all be taken into consideration in estimating the total yield. Losses due to animal mortality or crop wastage are generally excluded from the output measure. For illustration the total number of goats produced in a household flock in one year is estimated in table 12.2. in practice, it might be more useful to separate different age and sex cohorts (see chapter 8). Transfer into and out of different age classes would then have to be taken into account.

Having estimated the total output or yield it is normally expressed on a per hectare basis for crops and per head of livestock.

Farm business analysis

For accounting purposes, in order to compare returns from different enterprises with their cost of production we need common unit of value. Nutritional measures such as grain equivalents (see Clark & Haswell, 1964 or megajoules (MJ) of energy (see Bayliss-Smith, 1982) have been used, but clearly there are difficulties in evaluating non-food items such as cotton or rubber in this way. More values on the other hand, can usually be estimated for all commodities including those produced mainly for subsistence. In most African situations, subsistence crops surplus to household requirements are sold and the prices received may be recorded.

With data on yields and prices for each enterprise we can calculate the enterprise gross output as follows:
Gross output=yield x piece

Where there is more than one product such as grain and straw, or claves and milk, the total gross output is the sum of the values of the joint products. Also if permanent crops or livestock change in value between the start and end of the year, the gross output measure must be adjusted accordingly. Crop gross outputs are usually expressed on a per hectare basis for some permanent crops per tree. Livestock gross outputs are expressed per head or per livestock unit. The whole farm gross output is simply the sum of the gross outputs obtained from the individual enterprises. Costs of production are usually separated into (a) variable or direct costs and (b) fixed costs or overheads. In earlier chapters on the theory of production we assumed that any input maybe varied; the distinction between fixed and variable costs then depends upon which inputs are assumed to vary. However in farm business analysis, it is convenient to standardize the classification in the following way.

There is no general agreement regarding machinery fuel running costs or temporary hired labour. Although machinery running costs clearly do vary with the amount of use, it is convenient to treat them as fixed costs for general farm business analysis. Temporary hired labour is also a variable cost but if only a few farms employ casual workers it may be more appropriate to treat the labour costs as being fixed on all farms. However, where casual hiring is normal practice, say for cotton harvesting, then the cost may be treated as variable.

The distinction between variable and fixed costs has traditionally been drawn on the basis of the difficulty of allocating fixed costs to individual enterprises. However in African agriculture, the distinction might be based on the difficulty of evaluating the fixed costs. It may be noted that the variable costs generally correspond with stock in puts most of which have a market price. Fixed costs relate to flow inputs, often provided from household resources and hence free of charge. Their opportunity costs are not easily assessed.

Variable costs can usually be allocated fairly easily, to individual enterprises, except where there is mixed cropping. Just as there are various alternative ways of allocating inputs to components of mixed crops, non of them wholly satisfactory, so, too, is there a choice of methods of allocating variable costs. For any given enterprise the gross margin is the difference between gross output and variable cost.

Enterprise gross margin=enterprise gross output-variable costs

Once again crop gross margins are usually presented on a hectare (or per tree) basis while livestock gross margins are presented per head or per livestock unit. The total sum of the enterprise gross margins gives the total farm gross margin.

If fixed costs do not alter much with changes in production, then where total gross margin can be increased, farm profit or surplus will arise. If the increase in gross margin can be achieved with the existing supply of fixed resources and hence the existing level of fixed costs, profit will be raised by exactly the same amount as the gross margin. For this reason it is possible to plan changes in the farm system in terms of gross margins alone and leave fixed costs out of the calculation. In fact, in many parts of Africa, the family farmer does not incur explicit fixed costs. He pays no rent, no wages to his family who make up his regular labour for; he has hardly any buildings and equipment and does not borrow much capital. Practically all the African farmers' costs are variable. This means that practically the whole of the total gross margin represents family or social income.

Thus one useful method of completing the farm business analysis is to compute the enterprise gross margins per unit of limiting resource. In some cases, where land of a certain type (e.g. irrigated land) is limited, comparisons of gross margins per hectare are useful. In other cases comparisons of gross margins per man-day of peak labour may be more appropriate.

Alternatively, given that there is some expenditure on fixed costs, of wages for instance, land rents or machinery operating costs, these together with an estimate of the depreciation of

machinery and equipment, may be subtracted from the total farm gross margin to estimate farm income; thus

Net farm income=total gross margin-explicit fixed costs.

If income from off farm activities, including remittances and wages earned from off farm employment can be estimated, it is useful to add these to the net farm income to give an estimate of total house hold income. This estimate of the household income from all sources may be divided by the household size (measured in standard consumption units) to arrive at the income per consumption unit.

Other analyses

(i) Financial analysis

It may be useful to carry out a separate analysis to investigate the financial position of the farm household such analysis is concerned solely with cash receipts and expenditure.

The total of farm receipts from crop and livestock sales, minus total expenditure on the purchase of farm inputs, gives the farm cash surplus.

Farm cash surplus=total farm receipts – total farm expenditure

Where credit is used, the results maybe further adjusted to allow for loans received and dates repaid, thus

Farm cash surplus after financing=cash surplus + farm loans received-repayment of principle and interest.

Finally cash income from off-farm activities maybe added to give the household net cash income. This is a measure of amount of cash available for meeting all payments no relating to the farm. It is a less comprehensive measure of welfare than the total household income. Nonetheless, it may be useful to consider the financial position separately from income in kind which is consumed within the household.

(ii) Cash flow analysis. For long-term investments such as permanent, crops there are obvious problems in obtaining the long series of costs and returns data needed for a comprehensive evaluation. The only possible sources of records over the lifetime of cocoa or oil palms are the research station reports or long-established plantations. However, information maybe obtained from a farm survey on the annual costs and benefits at different stages of the life cycle, from different plots. Thus it may be possible to built up or synthesize a lifetime profile of costs and returns by combining data from different aged plots.

For purposes of evaluation it is necessary to calculate the annual cash flow meaning the difference between total revenue and total cost for the enterprise in each year. Cash flows differ from gross margins in that no attempt is made to estimate annual depreciation or appreciation of assets. Instead, the full cost of any capital investment is recorded in the year when it occurs. Similarly, if assets are sold, the sale price is recorded in the year of sale. Costs of labour, even family labour, must be estimated and subtracted in estimating cash flows. Discussion of methods of evaluating the resultant stream of cash lows is deferred until chapter 15 on investment appraisal.

(iii) in addition to the estimates of gross margins per head or per livestock unit, already discussed, further livestock productivity measures are desirable. More specifically it is useful for problem diagnosis and herd or flock growth modelling purposes to estimate

(a) reproductive rates, which may in turn depend upon age at firs parturition interval or parturition rate and average litter size

(b) age-specific mortality rates, and
(c) daily live weight gain.

Calculation of these measures is, of course, only possible if the necessary data have been recorded. The crude reproduction rate may be estimated as the total number of live births during the year divided by the average number of breeding females in the herd or flock. If the number of parturition rate ® is given by dividing by the average number of breeding females (N).

R-P/N

The mean parturition interval (I) in days is obtained as

I=365/R

While average litter (L) is the number of live births per parturition

L=B/P

Where B=Total number of live births

The crude mortality rate is simply the ratio of the number of mortalities to the mean number of animals. Age-specific mortality rates are calculated in the same way for specific age cohorts.

Two the general points may be noted. First, given that numbers of animals of animals of animals are constantly changing over time, frequent recording is needed to arrive at accurate estimates of average numbers used estimating reproduction and mortality rates. The second point is that, since individual household flocks and herds are relatively small, there maybe many gaps in the estimates of age-specific mortalities and the variations between households in all these measures is likely to be large.

Comparative analysis

The need for comparing adopters with a control group of non-adopters has already been emphasized. However, much may be learnt in the diagnosis of constraints and identification of improvements by comparing performance on different farms, given that some farmers are more innovative and successful than their neighbors. Comparisons of the farming systems of the more successful with those of the less successful may help to identify where the critical difference lies. For an example of detailed analysis of this kind see Upton & Petu, (1966), and Upton (1964)

Differences may lie in the inherent abilities of the household decision-makers or in their resource endowments; in which case the less successful family maybe unable to emulate their more successful neighbors. Nevertheless, it is useful for the researcher to discover whether this is the case. Indeed, it may be possible to promote institutional change, which will improve the resource base of poorer households. In other cases useful indigenous innovations may be identified as a result of comparative analysis.

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