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8. Socio-Economic Assessment of Four MATF-Funded Projects

Richard Ewbank, Monicah Nyang, Chris Webo and Ralph Roothaert

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No. 8

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FARM-Africa Working Papers

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Front page image: A cassava farmer in Nakasongola (Uganda) looks out over his healthy crop.

Contents

Acronyms

AVRDC	World Vegetable Centre (Regional Centre for Africa)
AIV	African Indigenous Vegetables
CBA	Cost-Benefit Analysis
CBO	Community-Based Organisation
CBT	Community-Based Trainer
CIDI	Community Integrated Development Initiatives
CMV	Cassava Mosaic Virus
FARM-Africa	Food and Agricultural Research Management
FCI	Farm Concern International
GM	Gross Margin
IRR	Internal Rate of Return
ISAAA	International Service for the Acquisition of Agri-Biotech Applications
JICA	Japanese International Cooperation Agency
MATF	Maendeleo Agricultural Technology Fund
MBDS	Microfinance Business Development Consultants
MT	Metric Tonne
NAADS	National Agricultural Advisory Service
NADIFA	Nakasongola District Farmers Association
NGO	Non-Governmental Organisation
NPV	Net Present Value
RLCBA	Rakai Local Chicken Breeders Association
SACCOS	Saving Credit Cooperative Society
TC banana	Tissue Culture Banana

Executive Summary

Socio-economic assessment of four Maendeleo Agricultural Technology Fund (MATF) projects, namely:

- The Diffusion of Tissue Culture Banana Technology to Small-scale Farmers through Microcredit in Arumeru District (Tanzania),
- Sustainable Production, Seed Supply and Marketing of African Indigenous Vegetables in Kiambu District (Kenya),
- Cassava Processing and Marketing in Nakasongola District (Uganda); and,
- Improving Chicken Production through Programmed Hatching and Cockerel Exchange in Rakai District (Uganda),

suggest that the MATF is achieving substantial impact on the livelihoods of smallholder crop and livestock producers. Gross margins comparing the introduced agricultural technology with the previous technology show improvements from 92 per cent for tissue culture bananas (TC bananas) to 44 times for cassava mosaic virus (CMV) tolerant cassava. Using partial cost-benefit analysis to gain an understanding of the potential returns over a 10-year period show that, given the qualifications that need to be made when using this evaluation tool[1], the return on the MATF funds is shown in Table 1 below:

Table 1. Return on MATF Funds

Project	**No. of US$ generated by each US$ spent in the form of an MATF grant**
Diffusion of TC banana technology	2.8
Sustainable production, seed supply & marketing of African indigenous vegetables	24.3
CMV-tolerant cassava multiplication, processing & marketing	19
Improving chicken production through programmed hatching & cockerel exchange	16

[1] See pages 42 and 43.

Farmers emphasised both the quantitative benefits gained from the increases in economic performance, as well as the qualitative benefits of being involved in the projects. Income gained was directed towards education and the purchase of other essential food items (such as sugar, salt, etc) above other items. The benefits of group membership included access to training and knowledge, social support and access to markets, with women particularly valuing the benefits of learning from each other and gaining motivation. Existing and future challenges included drought, pests, access to water (for both irrigation and stock watering), maintaining soil fertility, theft of production and marketing issues.

1. Introduction

The Maendeleo Agricultural Technology Fund (MATF) was established by FARM-Africa in 2002 as a regional initiative with the aim of enhancing the uptake of new agricultural technologies and promoting innovative dissemination methods throughout Kenya, Uganda and Tanzania. MATF does so through providing competitive grants to a variety of organisations which operate in the rural development sector, including research institutes, government parastatals, Non-Governmental Organisations (NGOs), Community-Based Organisations (CBOs) and private companies. Through four rounds of funding, MATF has provided grants to 51technology transfer projects and an additional seven extended projects. Grants issued in Round One were £30,000 each, rising to £60,000 for the subsequent three rounds. Most projects have a two-year duration.

At the time this study was conducted, 34 projects funded by MATF had reached completion. Many valuable lessons on technology adoption, partnerships, value addition, market linkages, and micro-credit mechanisms have been learned from these projects. Projects have been subject to a range of monitoring and evaluation mechanisms by the fund management, including yearly visits by fund monitoring staff, external evaluations of each round and an external review carried out in 2006. There have also been numerous and compelling anecdotal examples of how the technologies have improved livelihoods of the farming communities involved. What has been lacking, however, has been data on the financial impacts that these technologies have generated. In order to fully justify continuation of the MATF initiative, financial impacts must be known.

The overall aim of this study is "to determine the economic returns of a selection of MATF-funded agricultural technologies to the participating farmers". To do this, projects were selected (a) from all three countries in which the MATF has funded work and (b) interventions that had been in operation for sufficient time to show some economic impact at the household level. The methodology of the assessment centred on a formal interview with 10 randomly selected farmers in each project site. In order to reassure farmers of the anonymous nature of the data gathering process and promote a relaxed and open discussion of both quantitative and qualitative results, farmers were interviewed either at their farms or at a familiar meeting point (cassava farmers in Nakasongola were interviewed at the two processing facilities and chicken farmers in Rakai were interviewed either at their farms or during a farmer group meeting). Farmers were also assured that their names would not be recorded.

The projects selected are shown in Table 2 below:

Table 2. Projects reviewed

Project	Implementers	Period
Diffusion of TC banana technology to small-scale farmers through micro-credit in Arumeru (Tanzania).	International Service for the Acquisition of Agri-biotech Applications (ISAAA), Selian Agricultural Research and Microfinance Business Development Consultants Ltd	Round 2 grant, implemented from Jan 2003 to June 2005.
Production, seed supply and marketing of indigenous vegetables in Kiambu (Kenya).	World Vegetable Centre (AVRDC) and Farm Concern International	Round 3 grant, implemented from Feb 2004 to Feb 2006.
Cassava production, processing and marketing in Nakasongola (Uganda).	Nakasongola District Farmers Association (NADIFA) and Namulonge Agricultural Research Station	Round 1 grant, implemented from Sept 2002 to August 2004, with an extension to May 2005.
Improving household welfare by improving indigenous chicken production through programmed hatching and cockerel exchange in Rakai (Uganda).	Community Integrated Development Initiatives (CIDI), St Judes Organic Farm and Makerere University	Round 2 grant, implemented from June 2003 to May 2005, with an extension from Sept 2006 to Aug 2007.

Interviewee selection was carried out in two stages. First two to three farmer groups were selected with the implementing agency based on a discussion of the nature of the project area and the need to access a representative group. Then a sample of three to five farmers was randomly selected from each group. In Arumeru, the sample included four upland farmers largely relying on rainfed cultivation and six lowland farmers with access to irrigation. In Kiambu, two groups were selected, the first with good linkages to supermarket outlets, the second relying more on local markets and traders. In Nakasongola and Rakai, groups were less differentiated in terms of either markets or agro-ecology. Slightly more women than men were interviewed in each site (a total of 23 women and 17 men over the four sites), reflecting the greater participation of women in the projects.

Interviews were supplemented with background briefings from project implementing staff at both head office and field levels, farm visits to examine the enterprises being established by farmers and in cases where the market chain extended beyond largely farmgate or local market sales, visits to processing or marketing facilities and discussions with relevant partners. To enhance the reliability of the information collected, the interviews were carried out in some depth and findings triangulated both within the questionnaire and through complementary activities, such as the use of background information and farm visits.

The assessment has also drawn on a number of background information sources, including:

- Proposals (and logframe) of each project
- Quarterly and final reports
- Grantholder Experience Sharing Workshop Proceedings (Round One - Nairobi, June 2004; Round Two - Kampala, August 2005; Round Three - Arusha, June 2006)
- Finance and Business Education Consultants (FIBEC) evaluation of Rounds One, East Africa Ltd ETC evaluations of Round Two and Three
- External Evaluation Report for the Maendeleo Agricultural Technology Fund by Colin Poulton, Margaret Mangheni, Julius Okwadi and Antony Kilewe (Feb 2006)
- Evaluation of the Indigenous Chicken Project in Rakai District by Dr Connie Kyarisiima, John Okiror and Benon Ssebina (April 2005)

2. Economic impact

The principal approaches used to determine economic impact have been gross margin analysis and partial cost-benefit analysis. Gross margins are an annual measure, defined as the value of production minus variable costs, with the definition of variable costs being those costs that vary with the amount of production. These are usually required on an annual basis and therefore include inputs such as manure, seed, feed, labour for weeding and manuring, irrigation water and transport for marketing. Costs and revenues were recorded as per the farmer response and adjusted to the average enterprise size (area of land or number of birds) to get a more representative average annual gross margin.

Cost-benefit analysis included all the enterprise costs, both fixed and variable, and were extended to cover a longer period of enterprise operation. Both costs and benefits from future years are therefore discounted by a social discount rate to give a current or net present value. In this review, an operational period of 10-years was applied (which equates to the recommended life of a TC banana orchard) and the same inflation and discount rates were applied to all four projects to facilitate comparison.

With the more qualitative information, such as use of income and benefits of group membership, responses were ranked by the farmers interviewed and then scored to give a numerical value. In conducting the interviews, it became apparent that farmers could easily list their top three priorities but beyond this, farmers generally stated that other issues listed had more-or-less equal importance. In this regard, scoring was adjusted to 4 for the top priority, 3 for second, 2 for third and 1 for all other priorities. Scores were then added up for each issue and converted to a percentage.

2.1 Diffusion of tissue culture banana technology to small-scale farmers through microcredit in Arumeru District (Tanzania)

i) Project summary

Implemented in both the irrigated lowland areas of the Pangani river basin and the upland areas around Mt Meru, the project has provided a package of clean TC banana plantlets to

320 farmers organised into six farmer field schools[2] through a microfinance scheme. Farmers were able to access the technology through a basic package of 80 plantlets, sufficient for a quarter acre orchard, at TSh 1,000/plantlet to be repaid over 15 months (after a one month grace period). A flat rate of 15 per cent was charged, giving a typical loan size of TSh 92,000. Each farmer field school was subdivided into a number of smaller groups known as ukos, with three to eight farmers per uko (although in one case, a women-only uko of 23 members was formed). The ukos in each farmer field school report to a mboko, basically a committee consisting of a Chair, Deputy Chair, Treasurer and Secretary. This comprises of the administrative and legal entity through which loan transactions to individuals are carried out.

Farmers were typically provided with a mixed package of up to three varieties. These included Chinese Cavendish (a sweet banana), Uganda Green (used for matoke), Williams and Grand Naine (both used for cooking and as a sweet banana, the latter said to most resemble the taste of local bananas), and Mshale la Ine (used for cooking and roasting). A total of 27,576 banana plantlets were distributed to farmers. Training covered land and hole preparation, planting, de-suckering, sucker selection, field maintenance and credit management. Farmers expressed a preference for Williams and Grand Naine, although there were problems reported with plant dwarfism in some Grand Naine orchards.

ii) Economic performance

Farmer interviews revealed that the average orchard size at the start of the project was a third of an acre[3], rising to 0.54 acre in an average of 33 months. The average gross margin/annum reported was TSh 478,974 which equates to an average annual gross margin for the 10-year life of a TC banana orchard of US$ 682 per acre[4] (see Table 3). Given the long-term nature of the establishment of a banana orchard and the requirement for significant investment in orchard establishment, the analysis can be broadened to include the cost-benefit analysis of the resource over its full 10-year life to give a more comprehensive picture.

[2] The farmer field school approach brings farmers together in groups for on-farm training and experimentation, usually on a collectively-managed demonstration plot.

[3] Some farmers accessed sufficient plantlets to start on half instead of a quarter acre, reducing the original target of 500 to 320 farmers.

[4] The gross margin recorded is adjusted to take into account only nine productive years in the ten year life of the orchard.

Table 3. Gross margin for TC bananas			
Variable costs & value of outputs	**For 0.54 acre, TSh**	**Notes**	**For 1 acre[5], US$**
Manure	7,800	Reapplied every 3 years (so this is a third of initial cost)	11.11
Weeding	34,507	Typically 3-6 times per year	49.16
Pesticide	659	Only one farmer used furocide at planting	0.94
Irrigation	5,782	Typically TSh 500 per permit up to 15/annum	8.24
De-suckering	27,342	Up to 3 times/year	38.95
Market transport	21,705	4 farmers only to local Tengeru market, most sell at farmgate	30.92
Total variable costs	**97,796**		**139.31**
Marketed produce	208	Bunches	386
Home consumption	30	Bunches	55
Average price/bunch	2,650	(total = 238 bunches x TSh 2,650)	2.04
Total value of outputs	**629,989**		**897.42**
Gross margin	532,193		758.11
Adjusted gross margin	478,974	To take into account 9 years of productivity for the 10-year life of the orchard	682.30

[5] TSh 1,300 = US$ 1

The fixed costs for establishing a banana orchard include the cost of the plantlets, interest on the loan, cultivation prior to planting (land clearance, hole digging and manure application) and the various farm tools and other equipment needed to maintain the orchard and harvest its produce. For a 0.54 acre orchard (see Appendix 1 Table 1), these averaged TSh 399,885 or US$ 308, or US$ 570/acre. With a one year interval from planting to first fruiting, a farmer requires 34 months of operation to cover fixed costs.

Applying cost-benefit analysis reveals a net present value for a 0.54 acre orchard of TSh 2,752,331 (US$ 2,117) and an internal rate of return of 123 per cent (see Appendix 1 Table 1). Year one returns reflect the average yield measured by the assessment with years two to nine based on the average of those farmers that have not experienced start-up problems (dwarfism[6] and weevils) on the assumption (based on farmer responses) that these can be addressed through replanting[7] to bring these orchards up to full production in year two. Costs were inflated at 5 per cent per annum[8] and a discount rate of 14 per cent[9] was applied.

Conducting a similar exercise for local bananas results in a gross margin for the same area of orchard of TSh 249,558. This equates to an annual gross margin for an acre of local bananas of US$ 355, giving a net gain for the introduction of TC bananas of US$ 215/acre, an increase of 61per cent. Developing a cost-benefit analysis to cover the 10-year life of a local banana orchard (in the same way as for TC bananas) generates a net present value for the same area (i.e. 320 farmers each with 0.54 acre orchards) of US$ 360,401 compared with US$ 677,497 for TC bananas. The direct net gain for the introduction of TC bananas is therefore US$ 317,096 or put another way, for every US$ 1 of MATF investment, a net return of US$ 2.80 is generated.

[6] Dwarfism of banana plants is caused by an error in the tc laboratory. A batch of off-type plantlets affected a few farmers' plantations.
[7] Farmers that needed to replant had their loans written off by MBDC.
[8] Current inflation rate in both Tanzania and Kenya.
[9] Tanzania Reserve Bank discount rate, used for all four projects to aid comparison.

A young farmer inspects a healthy bunch of TC bananas

iii) Use of credit and access to markets

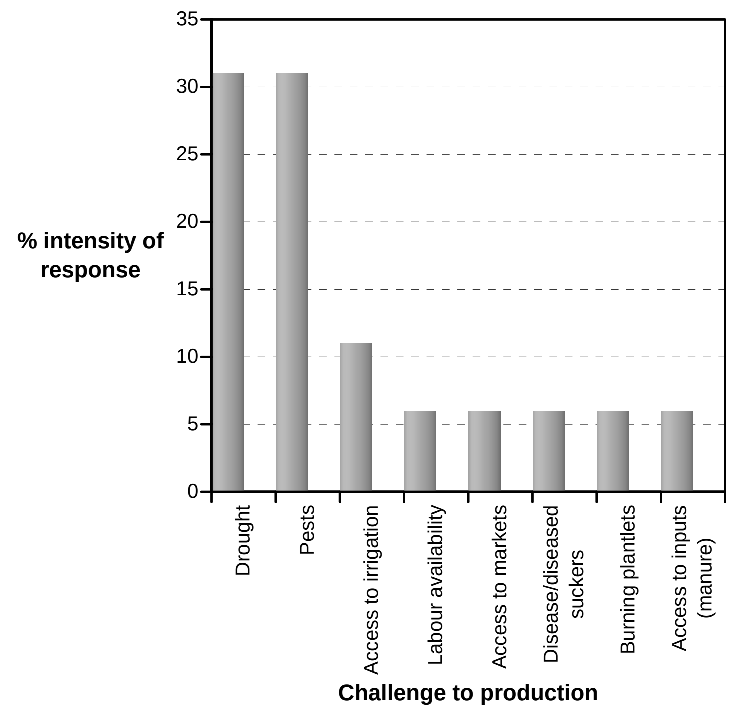
To facilitate the provision of plantlets to farmers, a total of £26,896 in principal plus £4,746 in interest was extended in credit. As of December 2006, £5,612 had been written off against cases of farmers receiving plantlets that subsequently exhibited dwarfism. A further £10,448 had been repaid (about 40 per cent of the remaining loan fund) leaving £15,582 still outstanding. The project is currently planning to return the amounts repaid to each of the six farmer field school groups so that they can establish self-managed revolving funds and register as savings & credit cooperative societies (SACCOSs). It is anticipated that this decentralisation of the loan fund will also create sufficient peer pressure and local follow-up of outstanding loans to stimulate recovery of the remaining 60 per cent of the loan fund.

In terms of marketing, most farmers are using local markets such as Tengeru (which has developed a reputation as a banana market for traders in northern Tanzania and southern Kenya), with about 20 per cent sold at farmgate. None of the farmers interviewed had developed links with either Banana Investment Limited or Nyirefami Limited Company, which produce banana wine and banana flour respectively, although discussions have taken place between project partners and these potential markets. Major issues related to accessing these markets include continuity of supply and pre-delivery processing.

iv) Challenges to technology adoption

Farmers listed a number of challenges they face, of which the most important was the risks associated with drought and pest infestation[10] (see Figure 1). Drought was listed as an issue in both irrigated and non-irrigated area as it affects the irrigation scheme and the amount of water available to irrigation users, although group membership has reduced the possibility of individual farmers being unable to access irrigation when supplies are relatively scarcer. The main pests mentioned included banana weevils, which can be a problem in orchards not sufficiently cleaned in the transition from local to TC banana varieties.

Figure 1. Challenges faced by TC banana farmers



Two farmers described problems they encountered with plantation establishment, one describing problems related to weevil infestation and a second with dwarfism of plantlets received. The latter affected 60 per cent of the plantation area established, which needed to be uprooted, cleaned and replanted[11]. Among other factors, the concern about access to markets focused on the dominance of Tengeru market as the main outlet and the lack of

[10] Intensity of response was obtained by asking farmers to list and then rank the problems they faced, with the most important problem scored at 4, the second at 3, the third at 2 and all others listed scored 1 each. The graph represented these scores aggregated and converted to percentages.
[11] The project itself reports that 89% of orchards were successfully established.

influence of banana farmers over prices, although at least one group[12] has agreed a floor price of TSh 3,500 per bunch below which no member would sell their output. Both labour availability and access to manure were not considered serious problems, but farmers expressed concerns that their availability could become more limited and prices increase as the area of TC bananas increases, particularly given the large amounts of manure needed at orchard planting time. One farmer predicted that as TC bananas are more widely grown and food security in the area improves, so the availability of labour for hire will decrease.

2.2 Sustainable production, seed supply and marketing of African Indigenous Vegetables in Kiambu District (Kenya)

i) Project summary

The project in Kiambu District (Central Kenya) is part of an intervention implemented in both Kenya and Tanzania. The Kiambu intervention has engaged with 500 small-scale farmers organised into 20 groups of 25 members each, whose existing horticultural enterprises were based largely on cultivation of either conventional vegetables such as tomatoes, cabbages and kale or cut flowers. The project sought to diversify the farmers' production by introducing African Indigenous Vegetables (AIVs) such as African nightshade, amaranthus, spider plant and cowpeas – all used as green leaf vegetables – providing farmers with an alternative crop for which it anticipated both high demand and improved profitability to the grower. Activities have focused on both the production and marketing aspects of AIV cultivation. AIVs have been promoted through the distribution of leaflets, brochures, in-store promotion and radio programmes. Producer groups have been linked with formal supermarkets such as Uchumi and Nakumatt, as well as independent grocers in Nairobi.

Farmers generally grow AIVs on small beds, often terraced, with up to 20 or more beds being cultivated per farmer at any one time. These are planted sequentially to ensure that the farmer can provide a steady supply to market during the year – those farmers producing for Nairobi supermarkets have this formalised into a group-managed planting and harvesting schedules to maximise the regularity of supply.

[12] Valesca farmer field school group.

ii) Economic performance

Assessing the gross margins of AIVs production provided some of the most interesting challenges among the four projects assessed. The fragmented nature of cultivation (a quarter of an acre split into 20 or more beds) and the sequential nature of harvesting made assessing land area, yields and labour requirements problematic. From an average of 0.09 acre when the project was established, farmers have almost tripled the average area under AIVs to just over a quarter of an acre per holding. The average gross margin for 0.263 acre was calculated as KSh 97,088 (see Table 4), which equates to an annual figure of US$ 5,274/acre[13]. This compares with average margins of US$ 1,213/acre for conventional vegetables, usually cabbage or tomatoes, grown by the same farmers. The introduction of AIVs provides the farmer with a net gain of US$ 4,060/acre, or an increase of 335 per cent with conversion to AIVs.

Fixed costs for operating an AIV enterprise are primarily cultivation tools and irrigation equipment, which range from watering cans to motorised pumps and associated hosepipes depending on the farm, averaging KSh 36,743 or US$ 1,995 per acre. It takes 4.3 months for the farmer to cover the investment associated with the fixed costs; inclusive of the one-month period from planting to first harvest. Factoring both fixed and variable costs into a cost benefit analysis for the enterprise over 10-years (using the same inflation and discount rates as the TC bananas) gives a net present value for a 0.263 acre enterprise of KSh 509,424 or US$ 7,277 (see Appendix 2 Table 2). Scaling this to 500 farmers and deducting the equivalent net present value for conventional vegetables for the same area and number of farmers gives a Net Present Value (NPV) for the introduction of AIVs of US$ 2,768,159 or US$ 24.30 for every US$ 1 provided through the MATF grant.

[13] The annual gross margin of US$5,274/acre for a mixed enterprise compares with equivalent figures cited in the AVRDC/FCI final project report of US$9,341/acre of African Nightshade and US$13,358/acre for amaranth.

Table 4. Gross margin for African indigenous vegetables			
Variable costs & value of outputs	**For 0.263 acre, KSh**	**Notes**	**For one acre[14], US$**
Seeds	3,711	2-3 kg at KSh 1,600/kg	201.60
Manure	5,358	Manure costs can vary considerably depending on source - some as far away as Maasai areas cost KSh 20K per truck	291.02
Preparation	1,085	Labour costs, which vary from KSh 100 to 200/day	58.93
Sowing	1,171	Labour costs	63.58
Weeding	722	Labour costs	39.23
Pesticide	2,337	Mainly for spider mites (KSh 350/100ml)	126.92
Spraying	357	Labour costs	19.38
Fertiliser	1,389	DAP fertiliser for basal dressing plus 17:17 fertiliser for top dressing to supplement manure	75.43
Irrigation	1,379	Manual labour for irrigation	74.90
Electricity (irrig.)	2,101	Using motorised pumps	114.14
Harvesting	3,614	Some farmers have no harvesting costs as the buyer harvests and takes away	196.33
Marketing	2,855	Transport costs & market fees	155.08
Group fees	900	Varies from KSh 600 to 1,200/annum according to group	48.89
Total variable costs	**26,978**		**1,465.42**
African Nightshade	67,446	Typically 60% of the area under cultivation, 3 cycles at 4-5 cuts per cycle, KSh 7-10 per	3,663.54

[14] KSh 70 = US$ 1

		bunch	
Amaranthus	28,938	Typically 20% of the area under cultivation, 6 cycles at 2 cuts per cycle	1,571.86
Spider plant	19,985	Typically 20% including cowpeas (interchangeable), 6 cycles at 1-2 cuts per cycle	1,085.54
Cowpeas	1,553		84.36
Value of home consumption	6,145		333.76
Total value of outputs	**124,066**		**6,739.07**
Gross margin	**97,088**		**5,273.65**

An interesting feature of the relative variable costs of AIV versus conventional vegetables is the greatly reduced reliance in AIV cultivation on chemical fertilisers (less than half of conventional vegetable expenditure) and pesticides (about a third less). AIVs appeared to have greater resistance to pests and diseases. Farmers highlighted that they thrive on manured plots, which benefit from better soil structure and moisture retention[15]. Farmers also expressed concern over the need to increase the frequency of spraying on conventional vegetables to three sprays or more per month in order to keep pests and diseases at bay, as opposed to a similar number of sprays per growing cycle for AIVs. This appears to compromise the observance of correct no-spray periods prior to harvest and raised farmer concerns on health issues.

[15] Farmers often referred to chemical fertiliser as "tiring" or "acidifying" the soil, with yields declining after two to three years of heavy fertiliser use.

A waist-high crop of African nightshade ready for harvest

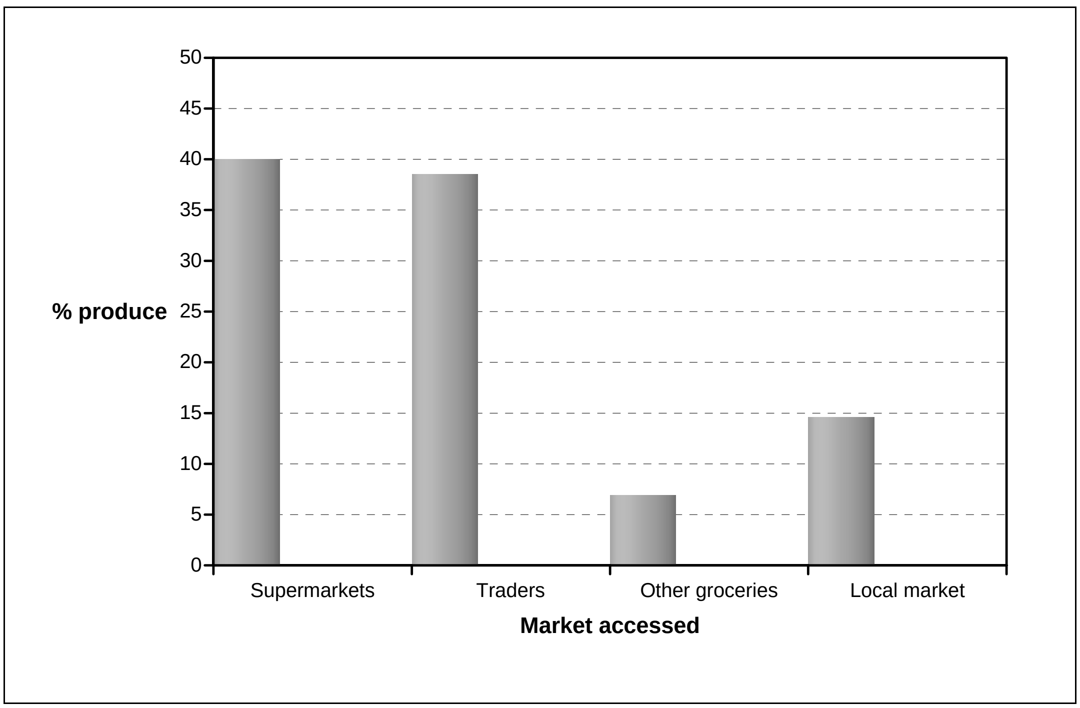
iii) Linkages to supermarkets and groceries

A feature of the project is its development of market linkages to both supermarkets and independent groceries in Nairobi (40 per cent and 6.9 per cent of the market respectively, see Figure 2 below). AIVs have now grown to account for about 5 per cent of Uchumi Supermarkets' fruit and vegetable turnover since they began marketing these vegetables in 2001. Farmer groups develop planting and harvesting schedules that are staggered to promote continuity of supply. Produce is harvested prior to bulking at a group centre at 3.00 am in order to supply Uchumi outlets at 6.00 am prior to opening. Their 150 rural suppliers (including the groups supported by the project) are all within a 50 km radius, some developing linkages with other farmers to ensure they meet with Uchumi's bulking requirements and deadlines. Uchumi described demand as "through the roof" with 400 bunches per outlet lasting no more than two hours in the morning shopping period (8.00 – 10.00 am). They currently estimate that they are meeting 75 per cent of daily demand at best.

Customers exhibit high levels of substitution between different AIVs, for example buying more African nightshade if cowpea supply is limited. They also blend AIVs with conventional green leaf vegetables, such as spinach and kales. Another interesting feature of AIVs is the purchase by Uchumi of 95 per cent of their supply direct from farmers/farmer groups, whereas 70 per cent of conventional vegetables, such as carrots and tomatoes, are sourced from brokers with only 30 per cent from farmers/farmer groups. Coordination among farmers supplying Uchumi ranges from issuing local purchase orders via mobile phone detailing amounts, dates and quality to be supplied; farmer group meetings to discuss schedules, quality issues, etc and two meetings per annum to discuss more strategic business issues.

The rapid increase in demand for AIVs over the last six years is attributed to a number of factors. One significant issue has been the increases in fuel costs (charcoal has increased from KSh 200 to KSh 700 per bag) with customers switching from pulses to green leaves to reduce cooking costs. Health concerns have also had an effect, with the benefits of AIVs promoted by the project and Uchumi through leaflets, posters, in-store tasting promotions and radio programmes. Marketing problems are largely related to Uchumi's internal management problems which, prior to 2006, meant that farmers were not always paid on time for their produce. In June 2006, Uchumi went into receivership and closed for three weeks prior to reopening (they have now resumed operation in 14 of their 28 sites). Some suppliers switched markets as a result, see Figure 2 below for the markets accessed by the AIV farmers.

Figure 2. Markets accessed by AIV farmers



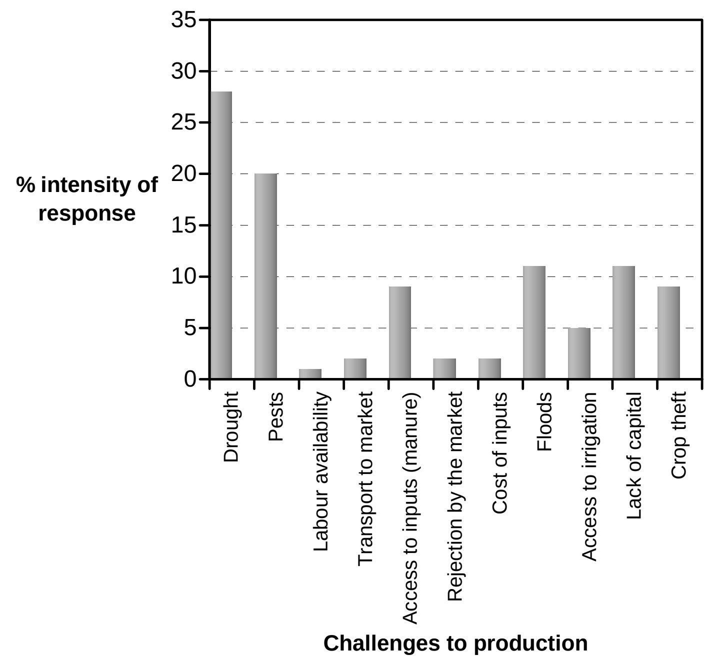
Alternatives include smaller independent groceries. One example is Karothi Egg Supply, situated in central Nairobi, which switched as a result of increased competition from supermarkets from a wholesale to retail operation in 2005 and the proportion of sales from AIVs has risen steadily. Karothi devotes about 40 per cent of display space to AIVs and now sells three bunches for every bunch of conventional green leaves. African nightshade is the most popular, selling at four times the rate of spider plant and amaranthus. Mercy, the business owner, cites undersupply as her main problem and is often sold out by 1.00 pm leaving her afternoon customers disappointed. Her priorities are to develop better linkages with producers (especially on quality although rejection of produce is very rare) and renovating her premises to promote AIV sales (which, given her location, she feels is a better investment than advertising).

A bucket of African nightshade seed

iv) Challenges to technology adoption

Like TC banana farmers, AIV growers highlighted drought and pests (see Figure 3) as their most important problems, although recent climate conditions have also resulted in floods in the growing area, particularly of land in the valley floor. While AIVs are recognised as having a greater disease resistance than conventional vegetables, there are still pest-related problems, with spider mites being cited as a particular concern in this respect. Access to manure is a high priority and with small holding sizes (less than two acres) being the norm, the integration of livestock through stall-fed dairy cows or poultry units is popular. AIV farmers also purchase manure trucked in from the lowland pastoralist areas in the south.

Figure 3. Challenges faced by AIV farmers



Other important concerns include the difficulty of accessing capital to purchase the more expensive capital items, such as water pumps, seen as essential to enterprise expansion, and crop theft. Marketing problems were not rated highly – farmers are relatively close to both local and Nairobi markets and supermarket rejection has been minimised by better inspection at bulking points.

2.3 Cassava processing and marketing in Nakasongola District (Uganda)

i) Project summary

In 2002, Nakasongola District Farmers Association (NADIFA) began implementing a cassava multiplication project with 10 farmer groups of 50 farmers per group (five groups in Wabinyonyi Subcounty and five in Lwampanga Subcounty). Local varieties of cassava, the main staple and food security crop, had been so badly affected by the interrelationship between drought and Cassava Mosaic Virus (CMV) that the district had become a perennial recipient of emergency food relief. Using material from Namulonge Agricultural Research Station, farmers first multiplied planting material and then began replacing their diseased local cassava with CMV-tolerant varieties such as NASE1, 2, 3 and 12, SS8 and TME14. Of these, TME14 and NASE12 have proved the most popular.

Farmers were trained in cassava agronomy (planting, soil and water conservation, pest and disease control, environmental factors as well as gender and HIV/AIDS issues). Planting broadly occurs in either of the two rainy seasons (March-June or Aug-Sept) though farmers stagger it to provide a continuous supply of tubers year round. The project was granted an extension year to consolidate multiplication and address post-harvest and marketing issues. With increased production, the issue of processing and marketing the surplus has become a significant challenge. As a result, two cassava processing plants have been built in the project area to convert cassava into dried chips and flour for sale through more formal channels, such as supermarkets in Kampala.

Improved cassava stretches to the horizon

ii) Economic performance

From an average of just 0.55 acre at the beginning of the project, the area grown under cassava cultivation per farmer has increased to an average of 4.6 acres, both through replacement of local diseased varieties and expansion of cassava cultivation into areas previously used for rough grazing. The average yield revealed by the gross margin analysis of 6.2 MT/acre was triangulated through on-farm assessment where farmers indicated recent harvested yields of 1,280 kg per quarter acre after some pre-harvest lifting of tubers for home consumption (5.12 MT/acre + home consumption). With home consumption averaging nearly 30 per cent of output, this gives a likely yield of 6.66 MT/acre from farm visits. The gross margin of 0.46 acres of CMV-tolerant cassava was about USh 2.6 million or US$ 1,627 (US$ 354/acre, see Table 5 below).

Comparing CMV-tolerant cassava varieties with local varieties revealed not just greater disease tolerance but larger tuber size and earlier maturing. Local varieties averaged 1.6 years from planting to harvest whereas CMV-tolerant varieties were generally ready for harvest in 10-12 months (some farmers reported harvesting tubers for home consumption as early as seven months after planting). Local cassava yielded an average of 1 MT/acre[16] giving a gross margin of just US$ 8/acre, revealing a subsistence situation in which the value of output barely compensated for the value of farm family labour used to cultivate the crop.

Fixed costs for cassava cultivation are related to soil conservation structures (as a result of Nakasongola District Farmers Association (NADIFA training), farm tools (hoes, pangas and ploughs) and marketing resources such as baskets to transport cassava tubers. These total USh 128,450 or about US$ 80. Given the usual 12 months from planting to first harvest, it takes a farmer 12.6 months of operation to cover fixed costs. Developing a cost-benefit analysis for 4.6 acres of CMV-tolerant cassava over 10-years gives a net present value of US$ 6,694, compared with US$ 186 for the equivalent local cassava (see Appendix 1 Table 3). Scaling this up for 500 farmers gives a net present value for the increase in benefit of US$ 3.25 million, or a return of US$ 19 for every US$ 1 spent through the MATF grant.

[16] International Institute of Tropical Agriculture's review of the impact of CMV tolerant cassava varieties across Africa revealed yield increases of 49 per cent, somewhat less than recorded in Nakasongola, which suggests that other local factors could include increased severity of CMV infection in the project area, improved climatic conditions since the project began and increased yields on land more recently brought into production (having previously been used for extensive grazing).

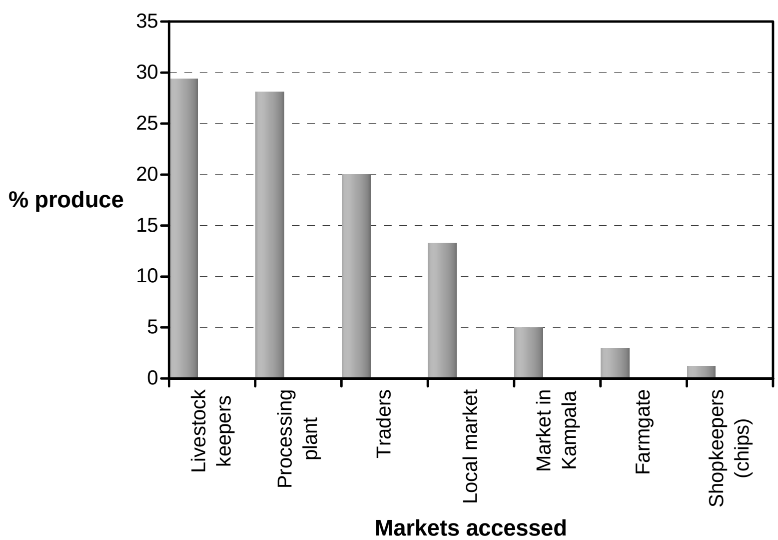
Table 5. Gross margin for CMV-tolerant cassava			
Variable costs & value of outputs	**For 4.6 acres, USh**	**Notes**	**For 1 acre[17], US$**
Stems	239,908	Purchase of stems (farmers mix own with purchased stems, usual cost about 60,000 per acre)	32.60
Clearing land	67,231	Labour costs (only for uncultivated areas)	9.13
Ploughing	107,923	Home labour or hire of plough	14.66
Planting	48,654	Labour costs (usually 10,000/acre approx.)	6.61
Weeding	138,708	Labour costs, up to 5 times/year	18.85
Harvesting	120,308	Labour costs	16.35
Other labour	8,846		1.20
Transport	150,031	Hire of pick-up or ox cart	20.38
Peeling	62,985	Peeling and washing tubers at processing plant	8.56
Total variable costs	**944,592**		**128.34**
Tubers	1,822,055	USh 100 per kg at processing plant	247.56
Stems	524,223	Sale of stems to other farmers for planting	71.23
Dried chips	171,262	Home dried chips, usually sold to local shops	23.27
Home consumption	1,029,945		139.94
Total value outputs	**3,547,485**		**482.00**
Gross margin	**2,602,892**		**353.65**

[17] USh 1,600 = US$ 1

iii) Access to markets

The traditional cassava marketing relationship is between smallholder farmers and pastoralists in the area. Farmers either sell cassava tubers to cattle keepers at the farmgate or in the field – several farmers described how a row of cassava can be sold to a pastoralist and then harvested over several months by the purchaser. However since the project began, the increase in cassava output has triggered investment in two cassava processing facilities, the first funded by Japanese International Cooperation Agency (JICA) and managed by a consortium of three of the Lwampanga subcounty groups, the second funded by MATF and managed by NADIFA and a consortium of the remaining seven groups. The former has been in operation for two years and the latter began receiving cassava from group farmers in January 2007, with 28 per cent of farm output now being purchased by the two plants (see Figure 4 below).

Figure 4. Markets accessed by cassava farmers



The first factory has 181 shareholders (from the three groups), 55 per cent of whom are women. The factory purchases tubers at USh 100/kg if peeled and washed, USh 80/kg if not. Dried chips and packaged cassava flour are produced and sold at USh 550/kg and USh 800/kg respectively. The factory also blends cassava and millet flour which it sells for USh 1,000/kg. Flour, used for porridge, pancakes, ugali and in bread making, is sold through distributors in Kampala to supermarkets. The dried chips are sold to millers.

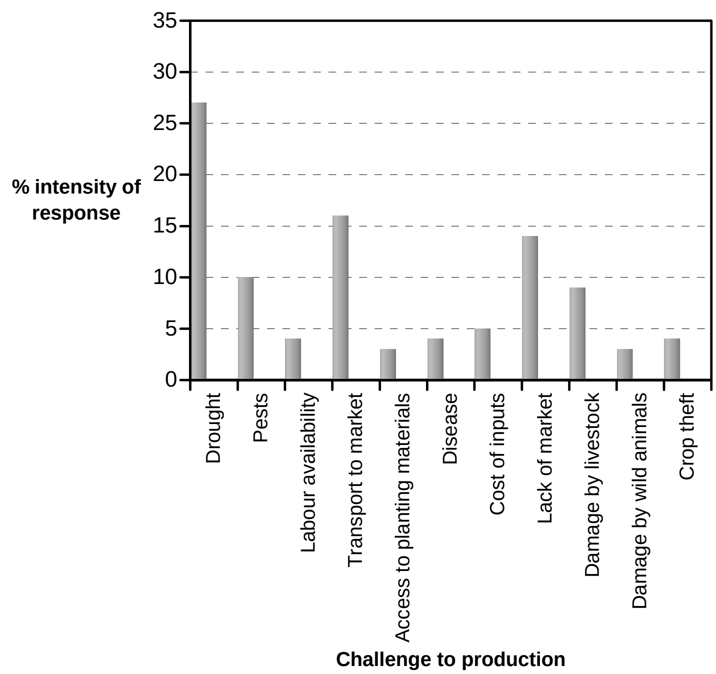
In its first year of operation, the factory made an operating profit of USh 770,000, rising to USh 900,000 in the second year. This performance is about half the target – the manager cited cash flow as the main constraint to achieving full capacity. Although the factory pays cash for purchases from farmers, distributors only pay once they have sold the cassava flour to supermarkets thus breaking the flow of operating capital and the ability of the manager to maintain a regular flow of cassava from farmers to the factory for processing. A further constraint is the capacity of drying yards, currently operated using tarpaulins. There are plans to upgrade these to concrete drying yards if profits allow - a proposal has also been submitted to the Government's extension service (the National Agricultural Advisory Service (NAADS) for this. Given that the first factory is only operating at half capacity and the new factory has only just started operation, the proportion of cassava marketed to these two facilities by farmers should increase in the future.

The processing sequence from peeling and washing to drying and milling

iv) Challenges to technology adoption

As with both TC bananas and AIVs, drought was listed as the main problem, which given the history of drought and drought relief in the area, is unsurprising. However, marketing issues (lack of markets and transport to market) were raised as the second and third most important challenge (if taken together, they would have been the most important) (see Figure 5). Given the relatively recent phenomenon of cassava surpluses, farmers and farmer groups are new to many of the markets they are accessing, especially through the operation of the two processing plants. These plants are of great importance to growers and strengthening their management and access to markets is clearly a strong concern. Pest problems are primarily due to termite infestation, with CMV only rarely appearing in time of drought-stress[18]. Other significant problems include damage by both free-range livestock and wild animals, usually monkeys or baboons.

Figure 5. Challenges faced by cassava farmers



2.4 Improving chicken production through programmed hatching and cockerel exchange in Rakai District (Uganda)

i) Project Summary

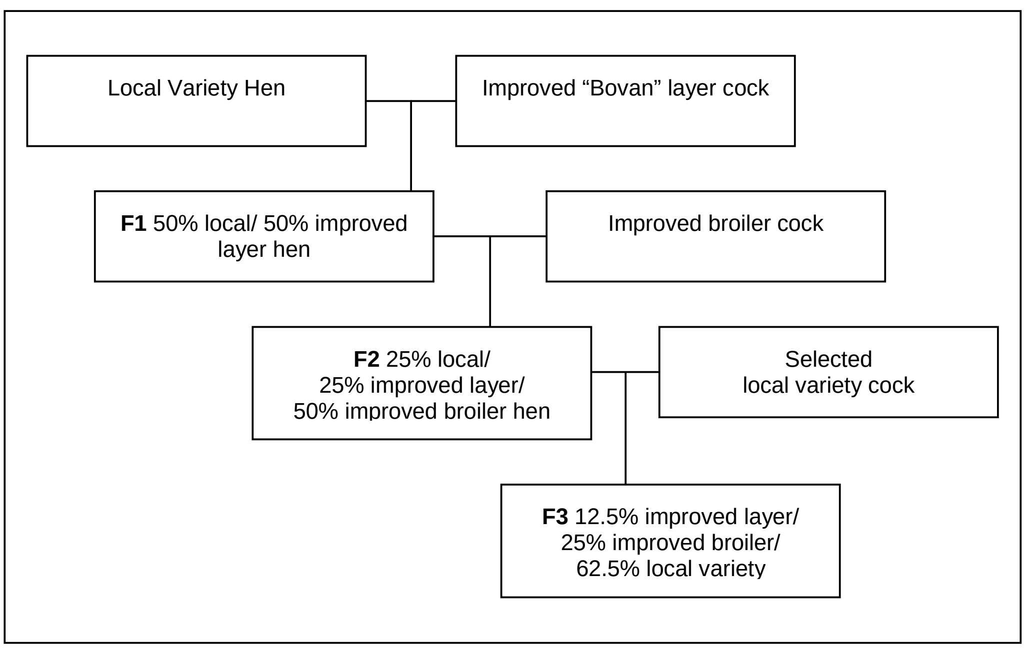
The poultry project implemented by Community Integrated Development Initiatives (CIDI) has focused on the two subcounties of Lwanda and Dwniro, promoting increased productivity through cross-breeding and thereby upgrading local poultry varieties. The project's main objectives have been to:

[18] The new varieties introduced are CMV tolerant but not completely immune under all circumstances.

- train 400 farmers on the key elements of improved poultry management (cross-breeding, disease vaccination and treatment, programme hatching, feeding, etc),
- provide direct support such as improved cocks and chicken house construction materials (initially on a 20 per cent contribution basis, now using interest-free loans),
- build the capacity of the 20 farmer groups established, including the identification of community-based trainers (CBTs) to follow-up on poultry management issues at farm level; and,
- establish a district breeders association, the Rakai Local Chicken Breeders Association (RLCBA), to improve the representation of members and identify new and profitable markets for produce.

Partners include Makerere University Department of Animal Science and St Judes Organic Farm. Through cross-breeding local chickens with commercial layer and broiler breeds and the use of programmed hatching[19], the project seeks to develop a hardy yet high yielding dual purpose F3 bird (the Rakai chicken). Group farmers pass on one two-month old hen chick for every hen received. The project has reported a further 2,400 farmers benefiting indirectly through this "pass-on" mechanism.

Figure 6. The chicken cross-breeding programme



[19] Synchronising hatching to ensure that each brood of chicks hatch more or less simultaneously, which then facilitates vaccination, improved management and marketing.

ii) Economic performance

Measuring economic performance presented a challenge given the diversity of products that farmers generated – individual preference dictated the extent to which farmers marketed either eggs (usually fertilised for purchasing farmers to hatch and rear improved layers) or chicks of varying ages. Adding old birds and manure revealed 12 different products produced and marketed (see Table 6). The average annual gross margin was recorded as USh 1,679,814 for a 40 bird enterprise, or US$ 1,050. As no land has been taken out of production to accommodate the enterprise and previous farmer involvement in poultry production amounted to a handful of birds kept for occasional household consumption, this represents a net addition to household income.

Table 6. Gross margin for improved poultry production

Variable costs & value of outputs	For 40 birds, USh	Notes	For 40 birds, US$[20]
Feed (ready mix)	374,000	USh 400 to 450/kg	233.75
Drugs & treatments	52,800		33.00
Vaccines	49,431	Especially New Castle Disease (3 vaccinations/bird)	30.89
Bedding	35,600	Coffee husks from local factory USh 2,000/bag	22.25
Labour	65,950	1 to 2 hours per day feeding, watering, etc	41.22
Brooding pots	1,810	Often cast-off household pots	1.13
Charcoal (for brooding)	51,100		31.94
Paraffin (for lamps)	41,867		26.17
Water	10,950		6.84
Pesticide (for house cleaning)	3,600	USh 2,500/bottle but frequency varied widely between farmers	2.25

[20] USh 1,600 = US$ 1

Transport	7,200	To market	4.50
Start-up hens	46,000		28.75
Start-up cocks	7,000		4.38
Replacement hens	11,000		6.88
Replacement cocks	7,000		4.38
Total variable costs	**765,308**		**478.32**
Chicks (1 day)	92,571	USh 800-1,000 each	57.86
Chicks (1 week)	264,000	USh 1,000 each	165.00
Chicks (1 month)	484,950	USh 2-2,500 each	303.09
Chicks (2-3 months)	298,500	USh 3-4,000 each	186.56
Eggs (for eating)	37,800	Sell for USh 3-4,000/tray of 30	23.63
Eggs (fertilised)	412,100	Sell for USh 6-7,000/tray of 30	257.56
Old layers	359,100	USh 4-7,00 each	224.44
Old cocks	59,000	USh 5-10,000 each	36.88
Cocks (4-6 months)	208,000	USh 7,500 each, popular at special occasions	130.00
Manure	60,133	Particularly prized for banana orchards (high in phosphate), USh 3-4,000/sack	37.58
Home consumed eggs	80,263		50.16
Home consumed birds	88,704		55.44
Total value of outputs	**2,445,122**		**1,528.20**
Gross margin	**1,679,814**		**1,049.88**

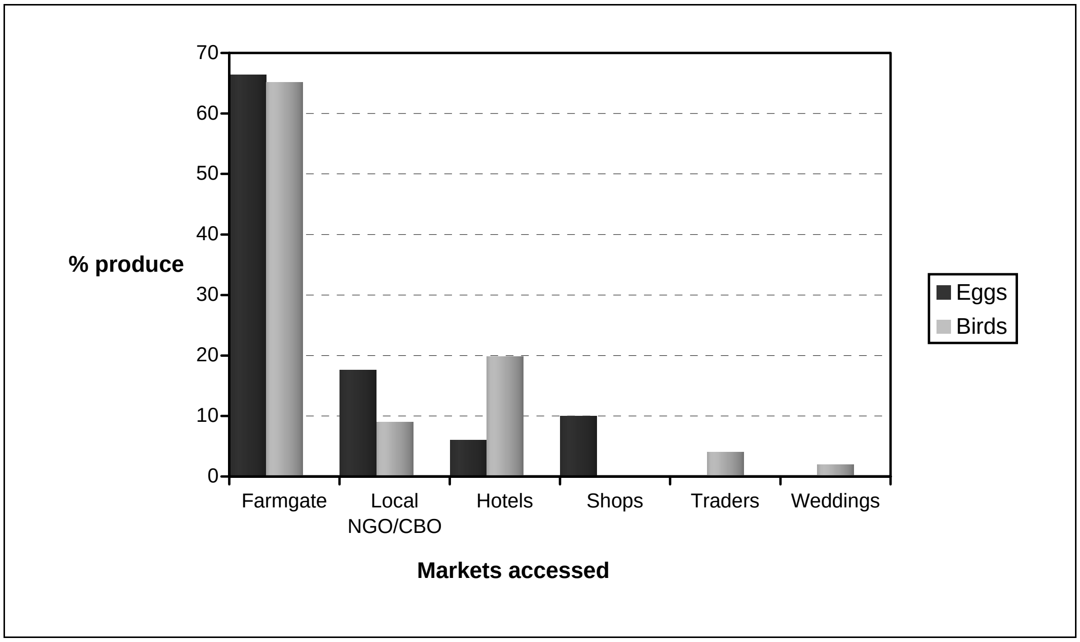
Fixed costs include the cost of constructing the chicken house (which includes bricks, wire mesh and roofing materials), feeders and drinkers, lanterns and pots for brooding chicks and various tools for adding/removing bedding, etc. Costs for 40 birds average USh 342,590 (or US$ 214) which, given the average start-up period of four and a half months reported by farmers, means that it takes nearly seven months of operation to recover fixed costs. Calculating a cost-benefit analysis for an individual enterprise over a 10-year period reveals a net present value of USh 7,279,984 or US$ 4,549.99 (see Appendix 1 Table 4). The project net present value for 400 farmers represents US$ 16 generated for every US$ 1 received through the MATF grant.

A chicken farmer's flock of local hens being upgraded by two improved layer Bovan cocks

iii) Access to markets

The current high local demand for both fertilised eggs and improved chicks has meant that the farmgate demand from other farmers is particularly high, with about two-thirds of both eggs and birds being sold to other farmers from surrounding areas that travel to project participants' farms to access their supplies (see Figure 7). Other markets include local NGOs that are accessing the technology for farmers in their project areas. Hotels provide a significant market for birds whereas shops demand eggs.

Figure 7. Markets accessed by poultry farmers



The reliance on the local market and the likelihood of the current high demand continuing has raised concerns among the farmer groups involved that, as more farmers establish their own poultry enterprises, local markets will become saturated. This has provided a key motivation in establishing the RLCBA, giving it a remit to identify and link farmers to new market outlets.

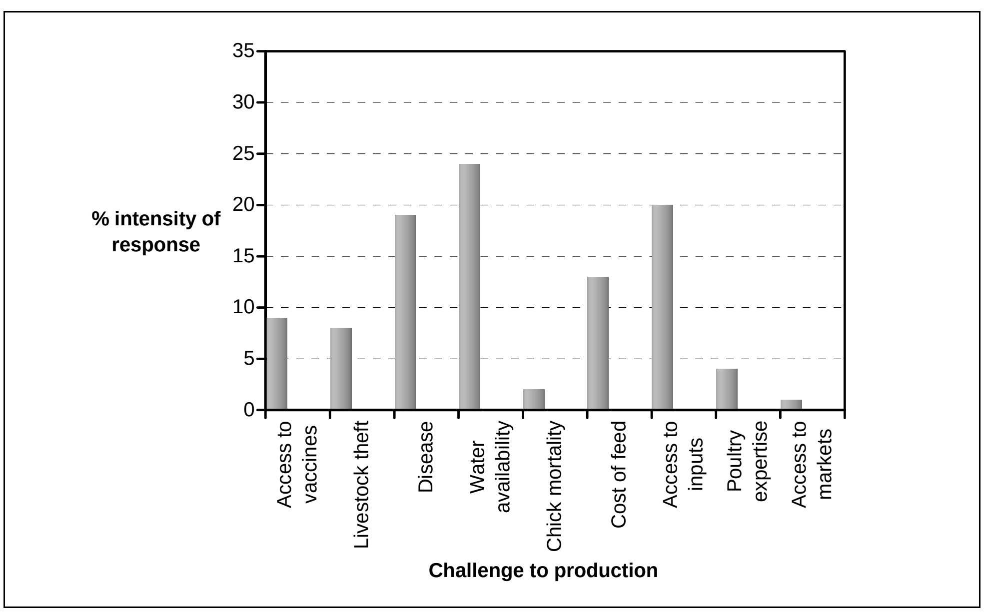
iv) Challenges to technology adoption

The major challenges faced by poultry farmers are water availability, poultry disease and access to inputs, mainly feed and animal health supplies (see Figure 8). The project has sought to address these with a number of interventions. Roof catchment tanks have been provided at cost to farmers and three input shops have been established across the project area to stock animal health inputs and the various constituent parts of poultry concentrate feed, which farmers can buy individually or as a ready-mixed poultry feed.

Farmers also raised concerns about the sustainability of access to vaccines, particularly for Newcastle disease. The cold chain required to ensure the delivery of this vaccine is currently administered by CIDI and farmers worried about the continuation of this service if the CIDI project closes. One way of addressing this has been the introduction of a new thermostable vaccine, which is currently being tested in the area. Interestingly, this was the only project area where farmers expressed a need to continue to access improved expertise, mainly on poultry management and livestock treatment. Access to markets, while not a current problem, was raised by farmers in terms of maintaining future demand. Theft of produce, as with the AIV and cassava projects, was also raised as a concern.

An input shop manager restocks her shelves (note the sacks of poultry feed ingredients, including premix, cotton and sunflower seed meal, maize bran and lime/shells)

Figure 8. Challenges faced by poultry farmers



3. Qualitative impact

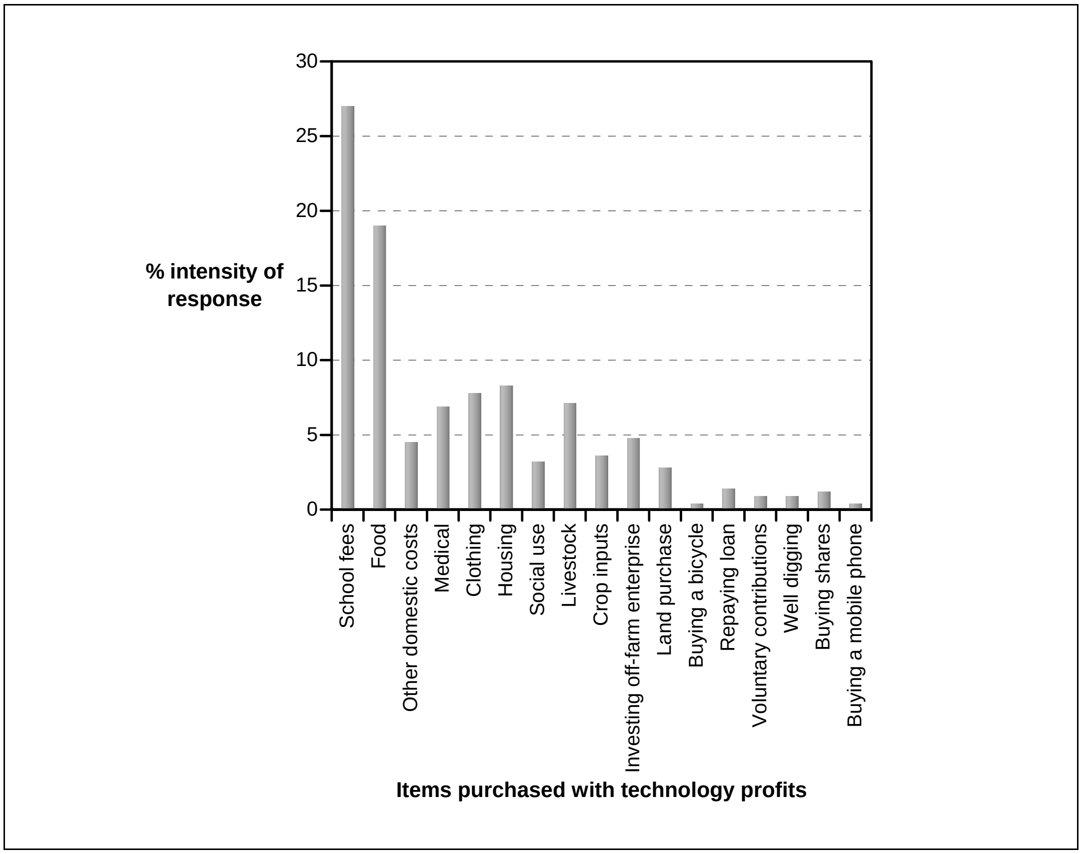
3.1 Use of income

Farmers use of income varied between the four projects (see Appendix 2 Tables 1 to 4). Overall, school fees were highlighted as the most important use of expenditure in all projects, with AIV farmers in Kenya also funding their children through tertiary education courses, such as computer studies. In Tanzania, banana farmers put particular priority on school fees and food purchases above all other uses, with domestic running costs, medical costs and loan repayments also priorities. In Kenya, AIV farmers also listed school fees and food purchases as first and second most important uses, but livestock purchase and improvements to housing were also highlighted. Groups have also purchased shares on the local stock market as a way of investing savings to achieve potentially higher returns than bank savings accounts. Cassava farmers in Uganda listed clothing purchases as their second most important purchase with food purchases and medical costs third and fourth respectively, while poultry farmers highlighted food purchases, housing renovation, livestock purchases, medical costs, investing in other businesses and land purchase as important other uses for their profits.

Aggregating the results for all four sites (see Figure 9) demonstrates the impact on education[21] of the improved technologies, as well as the use of income for housing, medical and clothing costs and the diversification of the farm enterprise through livestock purchase, investment in off-farm enterprises and even purchase of land.

[21] All three countries have universal primary education and fees are not charged at this level but funds are required for secondary school fees and other charges, such as uniforms, books, school maintenance fund, etc.

Figure 9. Use of profits from technology adoption



The overall impact on food security should be viewed from both the direct and indirect perspectives. With profits being used to purchase household food supplies – the second most important use of income at 19 per cent – the technologies are clearly enabling families to access food supplies not grown on the farm. All farmers also reported that a significant amount of production of the bananas, AIVs, cassava and chickens were consumed at home (see Table 7), thereby directly contributing to household food security.

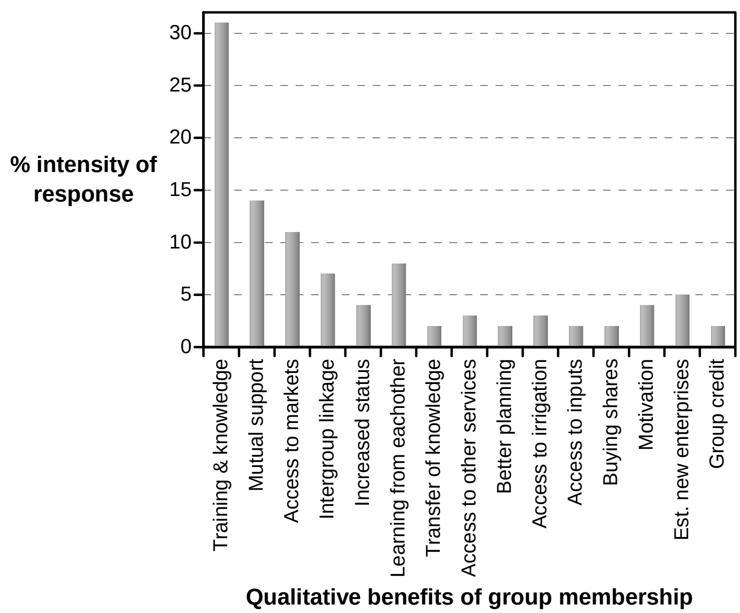
Table 7. Home consumption	
Project	**% produce consumed at home (by value)**
TC bananas in Arumeru	12
AIVs in Kiambu	5
Cassava in Nakasongola	29
Poultry products in Rakai	7

The importance of increased cassava production to household food security is related to its status as the main staple food crop in Nakasongola, with bananas also partially occupying the staple crop role in Arumeru (to the extent that savoury banana varieties are cultivated). Differentiation of results between men and women shows that whilst men and women (see Appendix 2 Figure 5) emphasise education equally and above all other uses, women place twice as much importance on food purchases and scored both medical and domestic running costs higher than men. Men particularly emphasised housing construction/refurbishment and purchase of livestock.

3.2 Other benefits of group membership

When asked about the other benefits of group membership apart from the economic impact of establishing a new or improved enterprise, many of those listed were closely associated with the technology adopted. Farmers rated the training and knowledge they received as the primary benefit, with seven of the other benefits also related to the technology they have adopted. These included accessing new markets, exchanging information with other groups and learning from one another. Altogether, 64 per cent of the response was technology related. However, other factors were also considered important by farmers, particularly the aspect of mutual support through being in a group, which was the second most important other benefit (see Figure 10). Others cited increased motivation and status through working as a group and the transfer of knowledge to and establishment of other enterprises (both individual and group-managed). The group management training in particular was mentioned by several farmers as being replicable to other businesses. This triangulates with use of income responses listing investment in other enterprises as a destination for the profits realised from improved technology adoption.

Figure 10. Qualitative benefits of group membership



Variation between projects (see Appendix 3 Figures 1 to 4) was mainly related to particular aspects of the technology, so banana farmers in Tanzania rated access to inputs (irrigation) as their fourth most important other benefit, largely due to the improved access given by the Pangani River Basin Authority to groups over individuals for irrigation water. AIV farmers in Kenya, with access to the most formal outlets (e.g. through supermarkets), listed market access as their third most important other benefit at 20 per cent, nearly twice the all group average.

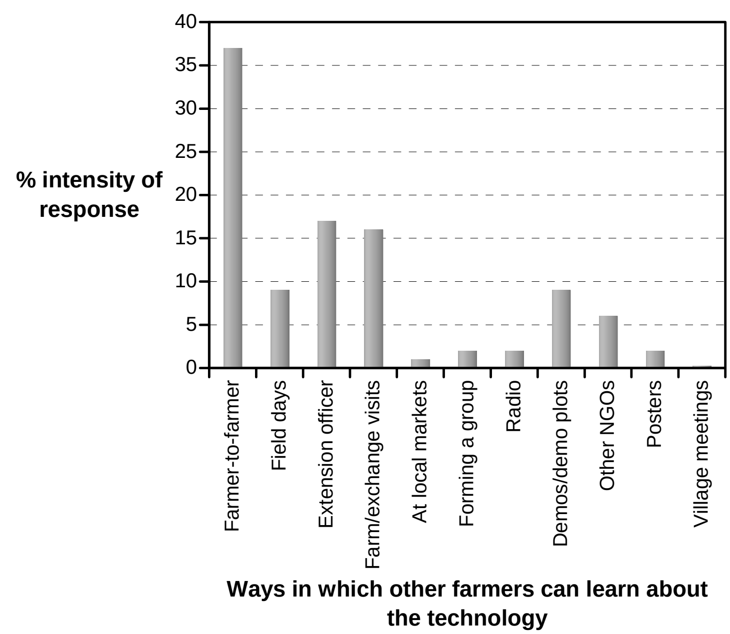
Interviewing cassava farmers in Nakasongola

In Nakasongola, where farmers had no access to formal extension advice, training and knowledge received the highest rating (41 per cent), demonstrating the demand for quality advisory services. Chicken farmers in Rakai gave the highest response for increased status (16 per cent). Disaggregating responses from men and women showed a similar pattern for both with two main exceptions (see Appendix 3 Figure 5). More women than men mentioned learning from each other and motivation through being in a group, whereas men's responses suggested that they valued transfer of knowledge to other enterprises and better collective planning more than women.

3.3 Dissemination of knowledge

When farmers were asked what the best way was for other farmers in their area to gain the information necessary to use the new technology, the overwhelming response was through farmer-to-farmer contact (see Figure 11). The one exception to this was in Rakai, where chicken farmers preferred farm/exchange visits and demonstrations. This was possibly due to the very different nature of programme breeding and upgrading, and the importance of actually seeing the poultry unit and housing as compared to traditional local poultry production methods.

Figure 11. How other farmers learn about the technology



In terms of types of responses, two-thirds involved some sort of communication that linked farmers directly to farmers without necessarily the involvement of a third party, a further 17 per cent suggesting a third party such as another NGO or radio station and only 17 per cent suggested using the government extension system. In Uganda, the use of the extension system as a useful way for other farmers to learn was hardly mentioned by cassava farmers. Only 8 per cent of the response of chicken farmers in Rakai related to the extension service, mainly due to the district veterinary staff involvement in vaccination. Even in Tanzania, where village extension officers are active, banana farmers mentioned farmer-to-farmer methods of learning twice as often as those involving an extension agent.

4. Conclusions

All four examples examined were initiated between 2½ and 3½ years[22] ago and are now either in a post-MATF funding phase or reaching the end of extension periods negotiated to strengthen sustainability of the technology introduced. Given the relatively short duration of the MATF-funded period, it is inevitable that the significant economic impact only becomes apparent after the project is completed. This strengthens the case for allocation of management resources to ex-post economic assessment a year or so after project completion that builds on the monitoring and evaluation of the implementing process carried out during the lives of the projects. This has the added benefit of obtaining an assessment of sustainability after MATF-funded period has been completed. Given the extensive process of monitoring work already carried out by MATF staff and external evaluations, such as the 2006 external evaluation, consideration could be given to re-orienting the round evaluations to perform this function.

Focusing more specifically on the introduction of the four technologies examined, they have clearly generated economic benefits to the farmers adopting them. Gross margins have improved with improved technology generating margins twice, four times and 44 times the local variety for TC bananas, African indigenous vegetables and cassava mosaic virus-tolerant cassava respectively. Upgrading local poultry production in Rakai has taken what was an informal enterprise with a handful of birds per farmer and transformed it into a net addition to the farming enterprise with no significant land area being taken out of production to accommodate the enterprise. These enterprises have increased food security directly through the home consumption and indirectly through marketing of products and hence increasing purchasing power to buy other essential food products.

Whereas in both Arumeru and Kiambu, TC bananas and indigenous vegetables have enhanced the on-farm enterprises of small-scale farmers, the most striking change in crop performance has been in Nakasongola where a district that has for many years survived on food aid has been transformed into a cassava-marketing area. Two processing plants have been established to further add value locally through the production of cassava chips and

[22] This is the period from actual implementation of the technology by farmers and does not include the start-up and introductory training stages of a project that are required before the technology is introduced.

flour. This successful increase in production does however raise the issue of maintaining soil fertility in cassava growing areas, as most farmers are relying on opening up previously uncultivated areas and rotating cassava plots. Without external inputs of nutrients, decline in soil fertility is inevitable. Better integration with cattle herders in the area to access local supplies of manure needs urgent attention; alternatively inorganic fertilisers will need to be used.[23]

Marketing remains a challenge for farmers, with TC banana and improved poultry farmers continuing to rely largely on local markets and farmgate sales, although the latter have recognised the need for diversification with the formation of the Rakai Local Chicken Breeders Association. Indigenous vegetable farmers have shown the highest levels of sophistication in their marketing strategy, successfully penetrating supermarkets and groceries in Nairobi and implementing highly organised planting, harvesting and product delivery schedules in order to meet the supply standards of these more formal urban outlets.

In terms of the inputs needed, farmers in all projects have relied on or developed a degree of local supply. For both banana and indigenous vegetable growers, the demand for animal manure demonstrates the importance of integrating livestock into the farm enterprise or being able to access manure from nearby livestock keepers. The importance chicken farmers in Rakai place on their own manure for use in their banana orchards further emphasises this. Both indigenous vegetable and cassava growers have added seed/planting material to their output markets, which in turn has facilitated uptake by other farmers in their locality. The introduction of AIVs to farmers in Kiambu has halved their chemical fertiliser costs and reduced pesticide costs by a third, a factor which farmers have welcomed given concern over the effect of chemical fertiliser on soil quality, increasing number of pesticide applications needed with conventional vegetables and local pests and diseases developing a resistance. The introduction of the poultry project in Rakai has stimulated the establishment of three input shops retailing veterinary treatments and poultry feed.

Applying cost-benefit analysis to add fixed costs into the economic equation and extending the analysis from the three years of actual experience so far to 10-years of improved

[23] Project monitoring visits to TC banana projects in both Kenya and Tanzania observed that soil fertility was steadily decreasing on most farms after three to four harvesting cycles of TC bananas. Farmers were harvesting smaller bunches, often half the size, compared to the first harvest. In places where banana is the dominant crop and livestock numbers are low, the option of replenishing soil nutrients through manure is a challenge to growers. Up to one-third of the total arable area would need to be converted to livestock farming, which would have important implications - technical, financial and cultural - on the TC banana model.

technology operation give net present values of US$ 2,117 – 7,277 for the four enterprises. Deducting the equivalent NPV of the local variety, replaced to give the net NPV of introducing the improved technology, and comparing this with the grants provided by the MATF to facilitate the acquisition of improved technology gives returns of US$ 2.8 – 24.3 for every MATF dollar spent.

The use of cost-benefit analysis to measure the cost-effectiveness of MATF grants should, however, be qualified. There are a number of factors that suggest the full economic impact of the technologies introduced is likely to be larger:

- Firstly the comparative cost-benefit analyses assume that the area of land or size of enterprise will remain constant which given is unlikely e.g. the 65 per cent increase in area of TC bananas since their introduction in 2004. Several banana growers indicated an intention to either continue to expand their area of irrigated orchards (in the lowland areas) or continue replacing local variety orchards with TC bananas (in the upland areas around Mt Meru). Other technologies have seen even higher rates of expansion on the farms of direct beneficiaries. It is likely therefore that the average size of enterprise will continue to increase but reach a plateau depending on the holding size of farmers.
- Secondly, for each farmer directly supported by the project, farmers estimate an average of six to 22 further farmers in their areas accessing the improved technology. Further research would be able to reveal the productivity increases that these replicating farmers are achieving, an indirect impact of the project. In addition to this, there are farmers accessing technologies – particularly the CMV-tolerant cassava and improved chickens – through other NGOs or from further afield. These have not been measured by the study.
- Finally there is still some potential for average yields achieved by farmers to increase further as management practices continue to improve (the CBA assumes yields will not increase). For example, the average of 1.38 banana bunches per plant per year recorded can be significantly increased to two or even three bunches per annum under well-managed irrigated production.
- Separating use of most fixed costs items from other farm enterprises was not possible.

Conversely, a number of factors may suggest a more limited degree of economic impact:

- Results are largely dependent on the latest season's performance, which has been relatively benign in three of the four project areas over the last year. The main exception has been the central Kenya area, which saw extensive flooding of valley floor early in the year, affecting AIV farmers. Drought or flood years will inevitably affect the economic performance of enterprises in future.

- Inflation rates are historically low and may increase in future.
- Prices of crop and livestock produce may decline faster in real terms than assumed in the analysis as supply increases.
- There are costs specifically not covered by the MATF grant (such as implementer salary and reporting costs).
- Difficulties in obtaining reliable areas cultivated, especially in the case of AIVs, may lead to an underestimation of the area cultivated and consequently higher returns per acre than is actually the case.
- Retrospective assessment in the absence of baseline studies or recorded farm accounts may have introduced inaccuracies into the analysis.
- Based on discussions with farmers, there is an assumption that fixed cost items are not replaced in the 10-year period of the analysis – this may not always be the case with all items.

Furthermore, in relating the impact of these four projects to the MATF portfolio more generally, the projects selected were generally viewed as the better performing examples of technology transfer.

Farmers were clear about the indirect or qualitative benefits of technology adoption. The high degree of emphasis placed on the use of profits for paying school fees and related costs reveals the importance of the projects to access education, with over a quarter of the response indicating this as the profit destination. The impact on a range of other livelihood factors, such as health, housing and clothing was also clear, further emphasising the importance of sustainable agricultural enterprise development in enabling rural communities to access these essential services. Impact on empowerment is evident from the responses farmers gave when asked about the benefits of group membership, in terms of learning from each other, mutual support and access to markets.

Appendix 1. Cost benefit analysis

Table 1. TC banana cost benefit analysis (CBA) for 10-years for a 0.54 acre orchard

Year		**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Fixed Costs											
	Land clearing	20,020									
Plants	TC plantlets	200,722									
	Interest on loan (15%)	22,079	8,029								
	Digging hole	53,420									
	Planting	23,707									
Tools	Hoe	4,807									
	Panga	4,280									
	Spade	4,873									
	Wheelbarrow	29,898									
	Digger	8,166									
	Rake	4,412									
	Supports	13,171									
	Misc equip	2,529									
Variable costs (VC)	Manure	7,800									
	Manure re-applic.				9,029			10,453			
Other VCs	Weeding	34,507	36,233	38,044	39,947	41,944	44,041	46,243	48,555	50,983	53,532
	Pesticide	659	691	726	762	800	840	883	927	973	1,022
	Irrigation	5,782	6,071	6,375	6,693	7,028	7,379	7,748	8,136	8,543	8,970
	De-suckering	27,342	28,710	30,145	31,652	33,235	34,897	36,641	38,474	40,397	42,417
	Transport for market	21,705	22,791	23,930	25,127	26,383	27,702	29,087	30,542	32,069	33,672
Total costs		**489,880**	**102,524**	**99,220**	**113,211**	**109,390**	**114,860**	**131,055**	**126,633**	**132,965**	**139,613**
Benefits	Bunches/year		238	302	302	302	302	302	302	302	302
	Market price		2,650	2,650	2,650	2,650	2,650	2,650	2,650	2,650	2,650
Total benefits			**629,989**	**800,300**	**800,300**	**800,300**	**800,300**	**800,300**	**800,300**	**800,300**	**800,300**

Net benefits		**-489,880**	**527,465**	**701,080**	**687,089**	**690,910**	**685,440**	**669,245**	**673,667**	**667,335**	**660,687**
Discounted benefits		**-489,880**	**462,688**	**539,458**	**463,766**	**409,074**	**355,996**	**304,899**	**269,223**	**233,941**	**203,167**
Discount rate	14%	(Tanzania Central Bank rate)									
Inflation rate	5%	(Official annual inflation rate)									
NPV	2,752,331										
NPV US$	2,117.18	TSh 1,300 = US$1									
IRR	123%										
NPV of TC bananas (US$)	677,497	Average NPV for an individual farmer x 320 (no. of farmers in project)									
NPV of local bananas (US$)	360,401	Average NPV for same no. of farmers growing 0.54 acres of local bananas									
Net gain by introducing TC bananas (US$)	**317,096**										
Investment (US$)	114,000	Two year MATF grant (£60,000)									
No. of US$ direct benefit generated by US$1 MATF investment	2.8	Net gain in NPV divided by the grant									

Note: Costs are inflated at 5 per cent per annum but market price (benefits) is not on the assumption that increased supply will have some downward influence on market prices

Table 2. AIV CBA for 10-years for 0.263 acre holding

Year		0	1	2	3	4	5	6	7	8	9
Fixed Costs	Hoe (big)	1,554									
	Hoe (small)	657									
	Harrow	371									
	Panga	500									
	Spade	117									
	Wheelbarrow	2,314									
	Watering can	463									
	Sprayer	3,593									
	Pipes	959									
	Motor pump	26,143									
	Raincoat	71									
Variable costs	Seeds	3,711	3,897	4,092	4,296	4,511	4,737	4,974	5,222	5,484	5,758
	Manure	5,358	5,626	5,907	6,202	6,512	6,838	7,180	7,539	7,916	8,311
	Preparation	1,085	1,139	1,196	1,256	1,319	1,385	1,454	1,527	1,603	1,683
	Sowing	1,171	1,229	1,291	1,355	1,423	1,494	1,569	1,647	1,729	1,816
	Weeding	722	758	796	836	878	922	968	1,016	1,067	1,121
	Pesticide	2,337	2,453	2,576	2,705	2,840	2,982	3,131	3,288	3,452	3,625
	Spraying	357	375	393	413	434	455	478	502	527	554
	Fertiliser	1,389	1,458	1,531	1,608	1,688	1,772	1,861	1,954	2,052	2,154
	Irrigation	1,379	1,448	1,520	1,596	1,676	1,760	1,848	1,940	2,037	2,139
	Electricity (irrig.)	2,101	2,206	2,317	2,432	2,554	2,682	2,816	2,957	3,105	3,260
	Harvesting	3,614	3,795	3,985	4,184	4,393	4,613	4,844	5,086	5,340	5,607
	Marketing	2,855	2,998	3,148	3,305	3,470	3,644	3,826	4,017	4,218	4,429
	Group fees	900	945	992	1,042	1,094	1,149	1,206	1,266	1,330	1,396
Total costs		**63,721**	**28,327**	**29,744**	**31,231**	**32,792**	**34,432**	**36,154**	**37,961**	**39,859**	**41,852**
Benefits	African Nightshade	67,446	67,446	67,446	67,446	67,446	67,446	67,446	67,446	67,446	67,446
	Amaranthus	28,938	28,938	28,938	28,938	28,938	28,938	28,938	28,938	28,938	28,938
	Spider plant	19,985	19,985	19,985	19,985	19,985	19,985	19,985	19,985	19,985	19,985

	Cowpeas	1,553	1,553	1,553	1,553	1,553	1,553	1,553	1,553	1,553	1,553
	Value of home consumption	6,145	6,145	6,145	6,145	6,145	6,145	6,145	6,145	6,145	6,145
Total benefits		**124,066**	**124,066**	**124,066**	**124,066**	**124,066**	**124,066**	**124,066**	**124,066**	**124,066**	**124,066**
Net benefits		**60,345**	**95,739**	**94,323**	**92,835**	**91,274**	**89,634**	**87,913**	**86,105**	**84,207**	**82,214**
Discounted benefits		**60,345**	**83,982**	**72,578**	**62,661**	**54,041**	**46,553**	**40,052**	**34,411**	**29,519**	**25,281**
Discount rate	14%										
Inflation rate	5%										
NPV	509,424										
NPV US$	7,277.49	KSh 70 = US$ 1									
NPV of project (US$)	3,638,744	Average NPV for an individual farmer x 500 (no. of farmers in project)									
NPV of conv. veg (US$)	870,584	Average NPV for same no. of farmers growing 0.263 acres of conventional vegetables									
Net gain by introducing AIVs US$	**2,768,159**										
Investment (US$)	114,000	Two year MATF grant (£60,000)									
No. of US$ direct benefit generated by US$1 MATF investment	24.3	Net gain in NPV divided by the grant									

Note: Costs are inflated at 5 per cent per annum but market price (benefits) is not on the assumption that increased supply will have some downward influence on market prices
Same discount rate used as in TC bananas to facilitate comparison

Table 3. Cassava CBA for 10-years for 4.6 acre holding

Year		**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Fixed Costs	Hoes	16,300									
	Pangas	7,100									
	Axe	15,050									
	Plough	73,500									
	Bags	1,200									
	Baskets	600									
	Sisal twine	700									
	Conservation structures	14,000									
Variable costs	Stems	239,908	251,903	264,498	277,723	291,609	306,190	321,499	337,574	354,453	372,176
	Clearing land	67,231	70,592	74,122	77,828	81,719	85,805	90,096	94,600	99,330	104,297
	Ploughing	107,923	113,319	118,985	124,934	131,181	137,740	144,627	151,859	159,452	167,424
	Planting	48,654	51,087	53,641	56,323	59,139	62,096	65,201	68,461	71,884	75,478
	Weeding	138,708	145,643	152,925	160,571	168,600	177,030	185,882	195,176	204,934	215,181
	Harvesting	120,308	126,323	132,639	139,271	146,235	153,546	161,224	169,285	177,749	186,637
	Other labour	8,846	9,288	9,753	10,241	10,753	11,290	11,855	12,447	13,070	13,723
	Transport	150,031	157,532	165,409	173,679	182,363	191,482	201,056	211,108	221,664	232,747
	Peeling	62,985	66,134	69,441	72,913	76,558	80,386	84,405	88,626	93,057	97,710
Total costs		**1,073,042**	**991,822**	**1,041,413**	**1,093,484**	**1,148,158**	**1,205,566**	**1,265,844**	**1,329,136**	**1,395,593**	**1,465,373**
Benefits	Tubers		1,822,055	1,822,055	1,822,055	1,822,055	1,822,055	1,822,055	1,822,055	1,822,055	1,822,055
	Stems		524,223	524,223	524,223	524,223	524,223	524,223	524,223	524,223	524,223
	Dried chips		171,262	171,262	171,262	171,262	171,262	171,262	171,262	171,262	171,262
	Home consumption		1,029,945	1,029,945	1,029,945	1,029,945	1,029,945	1,029,945	1,029,945	1,029,945	1,029,945
Total benefits			**3,547,485**	**3,547,485**	**3,547,485**	**3,547,485**	**3,547,485**	**3,547,485**	**3,547,485**	**3,547,485**	**3,547,485**
Net benefits		**-1,073,042**	**2,555,663**	**2,506,072**	**2,454,001**	**2,399,327**	**2,341,919**	**2,281,641**	**2,218,348**	**2,151,892**	**2,082,112**
Discounted benefits		**-1,073,042**	**2,241,809**	**1,928,341**	**1,656,381**	**1,420,594**	**1,216,319**	**1,039,485**	**886,535**	**754,365**	**640,266**
Discount rate	14%										
Inflation rate	5%										

NPV	10,711,052	
NPV (US$)	6,694.41	USh 1,600 = US$1
IRR	236%	
NPV of project (US$)	3,347,204	Average NPV for an individual farmer x 500 (no. of farmers in project)
NPV of local cassava (US$)	93,244	Average NPV for same no. of farmers growing local cassava varieties
Net gain by introducing CMV	**3,253,960**	
Investment	171,000	Three year MATF grant (£90,000)
No. of US$ direct benefit generated	19.0	

Note: Costs are inflated at 5 per cent per annum but market price (benefits) is not on the assumption that increased supply will have some downward influence on market prices
Same discount rate used as in TC bananas to facilitate comparison

Table 4. Chicken CBA for 10-years for 40 birds

Year		**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Fixed Costs											
House	Chicken house	190,850									
	Wire mesh	32,760									
	Plastic sheet	18,700									
	Roofing	16,900									
	Construction labour	23,000									
Tools &	Feeders	17,000									
equip.	Drinkers	13,100									
	Lanterns	2,980									
	Jerry cans	2,000									
	Forked hoe/rake	1,200									
	Wheelbarrow	15,700									
	Spade	5,700									
	Hoe	1,800									
	Panga	900									
Variable	Feed (ready mix)	374,000	392,700	412,335	432,952	454,599	477,329	501,196	526,256	552,568	580,197
Costs	Drugs & treatments	52,800	55,440	58,212	61,123	64,179	67,388	70,757	74,295	78,010	81,910
	Vaccines	49,431	51,903	54,498	57,223	60,084	63,088	66,242	69,555	73,032	76,684
	Bedding	35,600	37,380	39,249	41,211	43,272	45,436	47,707	50,093	52,597	55,227
	Labour	65,950	69,248	72,710	76,345	80,163	84,171	88,379	92,798	97,438	102,310
	Brooding pots	1,810	1,901	1,996	2,095	2,200	2,310	2,426	2,547	2,674	2,808
	Charcoal (for brooding)	51,100	53,655	56,338	59,155	62,112	65,218	68,479	71,903	75,498	79,273
	Paraffin (for lamps)	41,867	43,960	46,158	48,466	50,889	53,434	56,105	58,911	61,856	64,949
	Water	10,950	11,498	12,072	12,676	13,310	13,975	14,674	15,408	16,178	16,987
	Pesticide (for house cleaning)	3,600	3,780	3,969	4,167	4,376	4,595	4,824	5,066	5,319	5,585
	Transport	7,200	7,560	7,938	8,335	8,752	9,189	9,649	10,131	10,638	11,170
	Start-up hens	46,000	48,300	50,715	53,251	55,913	58,709	61,644	64,727	67,963	71,361
	Start-up cocks	7,000	7,350	7,718	8,103	8,509	8,934	9,381	9,850	10,342	10,859

	Replacement hens	11,000	11,550	12,128	12,734	13,371	14,039	14,741	15,478	16,252	17,065
	Replacement cocks	7,000	7,350	7,718	8,103	8,509	8,934	9,381	9,850	10,342	10,859
Total costs		**1,107,898**	**803,573**	**843,752**	**885,939**	**930,236**	**976,748**	**1,025,586**	**1,076,865**	**1,130,708**	**1,187,244**
Benefits	Chicks (1 day)	57,857	92,571	92,571	92,571	92,571	92,571	92,571	92,571	92,571	92,571
	Chicks (1 week)	165,000	264,000	264,000	264,000	264,000	264,000	264,000	264,000	264,000	264,000
	Chicks (1 month)	303,094	484,950	484,950	484,950	484,950	484,950	484,950	484,950	484,950	484,950
	Chicks (2-3 months)	111,938	298,500	298,500	298,500	298,500	298,500	298,500	298,500	298,500	298,500
	Eggs (for eating)	20,475	37,800	37,800	37,800	37,800	37,800	37,800	37,800	37,800	37,800
	Eggs (fertilised)	223,221	412,100	412,100	412,100	412,100	412,100	412,100	412,100	412,100	412,100
	Old layers		359,100	359,100	359,100	359,100	359,100	359,100	359,100	359,100	359,100
	Old cocks		59,000	59,000	59,000	59,000	59,000	59,000	59,000	59,000	59,000
	Cocks (4-6 months)		208,000	208,000	208,000	208,000	208,000	208,000	208,000	208,000	208,000
	Manure	37,583	60,133	60,133	60,133	60,133	60,133	60,133	60,133	60,133	60,133
	Home consumed eggs	43,476	80,263	80,263	80,263	80,263	80,263	80,263	80,263	80,263	80,263
	Home consumed birds		88,704	88,704	88,704	88,704	88,704	88,704	88,704	88,704	88,704
Total benefits		**962,644**	**2,445,122**	**2,445,122**	**2,445,122**	**2,445,122**	**2,445,122**	**2,445,122**	**2,445,122**	**2,445,122**	**2,445,122**
Net benefits		**-145,254**	**1,641,549**	**1,601,370**	**1,559,183**	**1,514,886**	**1,468,374**	**1,419,536**	**1,368,257**	**1,314,414**	**1,257,879**
Discount rate	**14%**										
Inflation rate	5%										
NPV	7,279,984										
NPV (US$)	4,549.99										
IRR	1,128%										

Net gain by introducing CMV (US$)	**1,819,996**	**Average NPV for an individual farmer x 400 (no. of farmers in project)**
Investment (US$)	114,000	Two year MATF grant (£60,000)
No. of US$ direct benefit generated by US$1 MATF investment	16.0	Net gain in NPV divided by the grant

Note: Costs are inflated at 5 per cent per annum but market price (benefits) is not on the assumption that increased supply will have some downward influence on market prices
Same discount rate used as in TC bananas to facilitate comparison. There is no equivalent technology that has been replaced by the project and no significant land has been transferred from original use into poultry production

Appendix 2. Use of income

Figure 1. TC banana farmers in Arumeru (Tanzania)

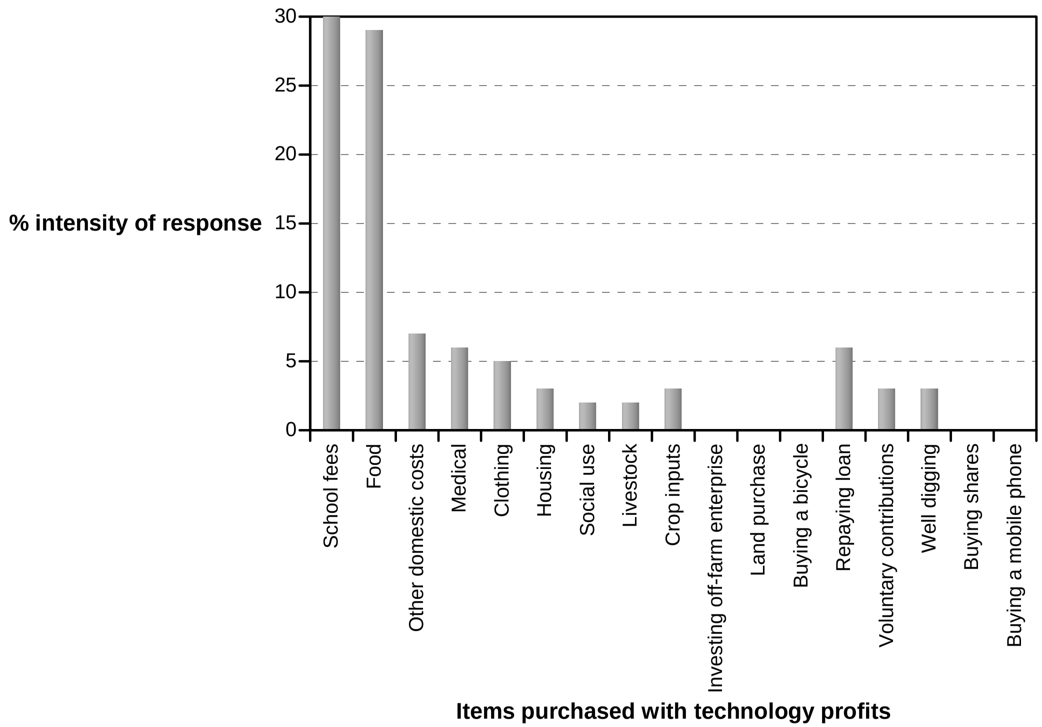


Figure 2. African Indigenous Vegetable farmers in Kiambu (Kenya)

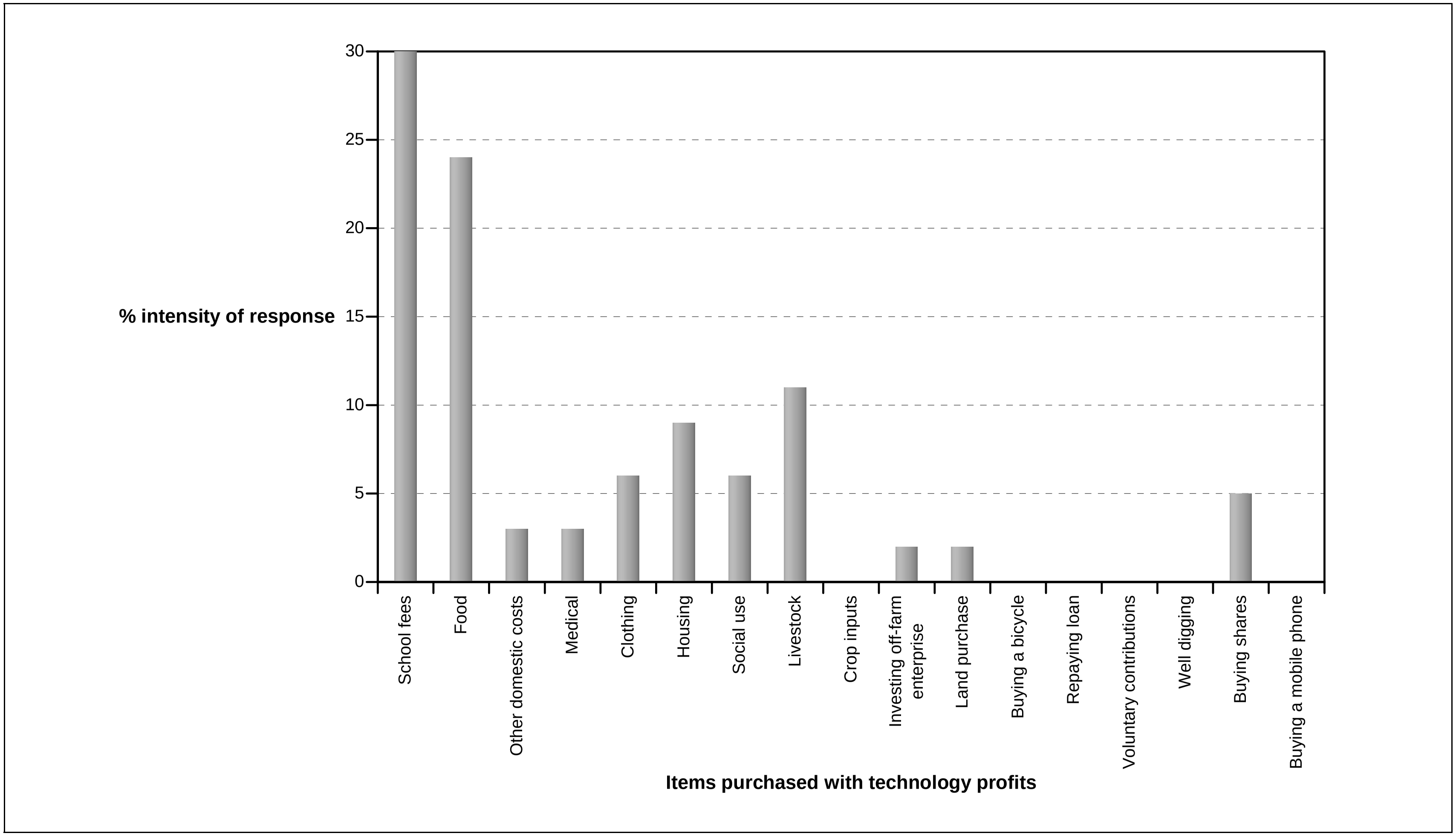


Figure 3. Cassava farmers in Nakasongola (Uganda)

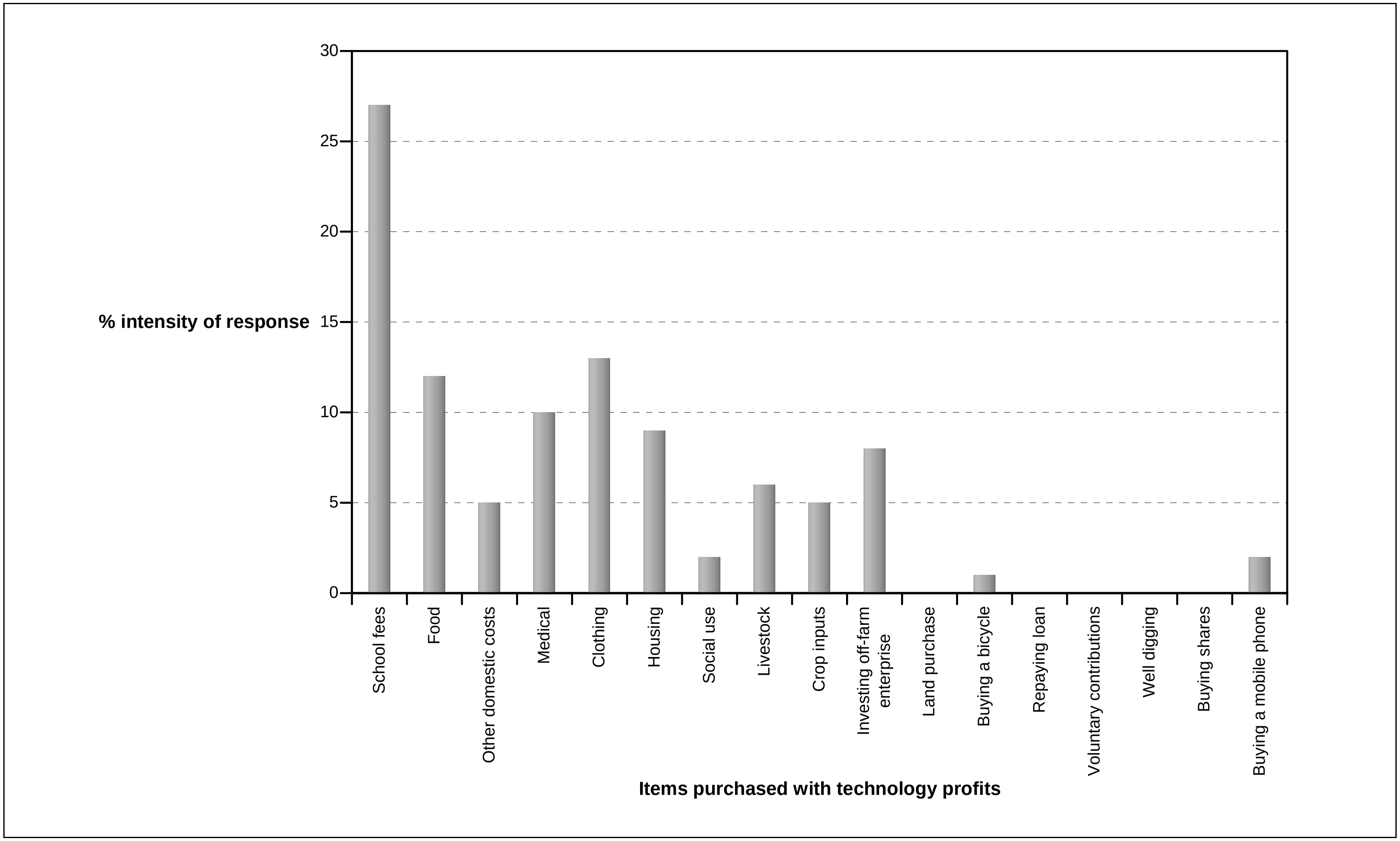


Figure 4. Chicken farmers in Rakai (Uganda)

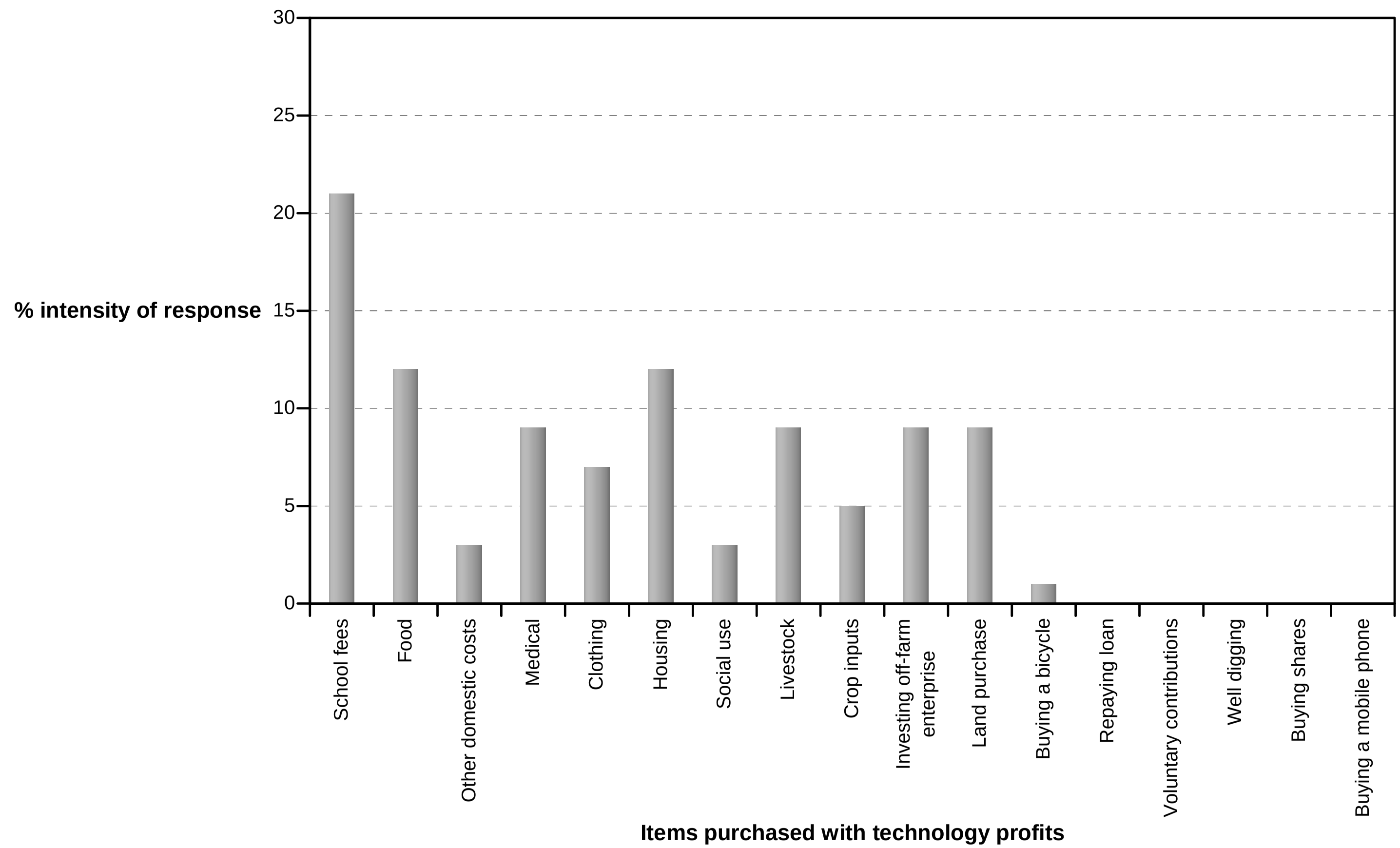
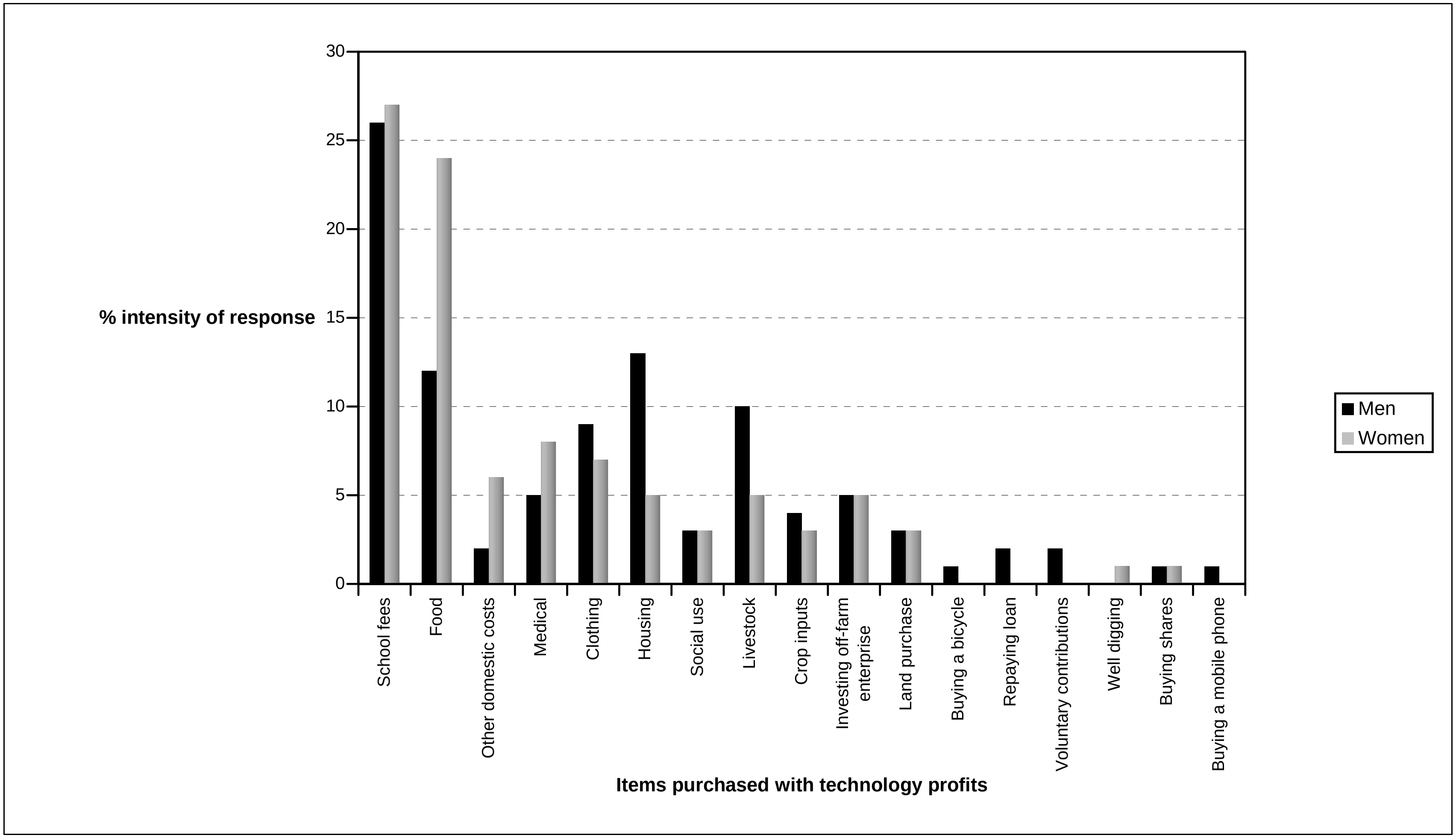


Figure 5. Use of income – men versus women



Appendix 3. Benefits of group membership (other than accessing a new technology)

Figure 1. TC banana farmers in Arumeru (Tanzania

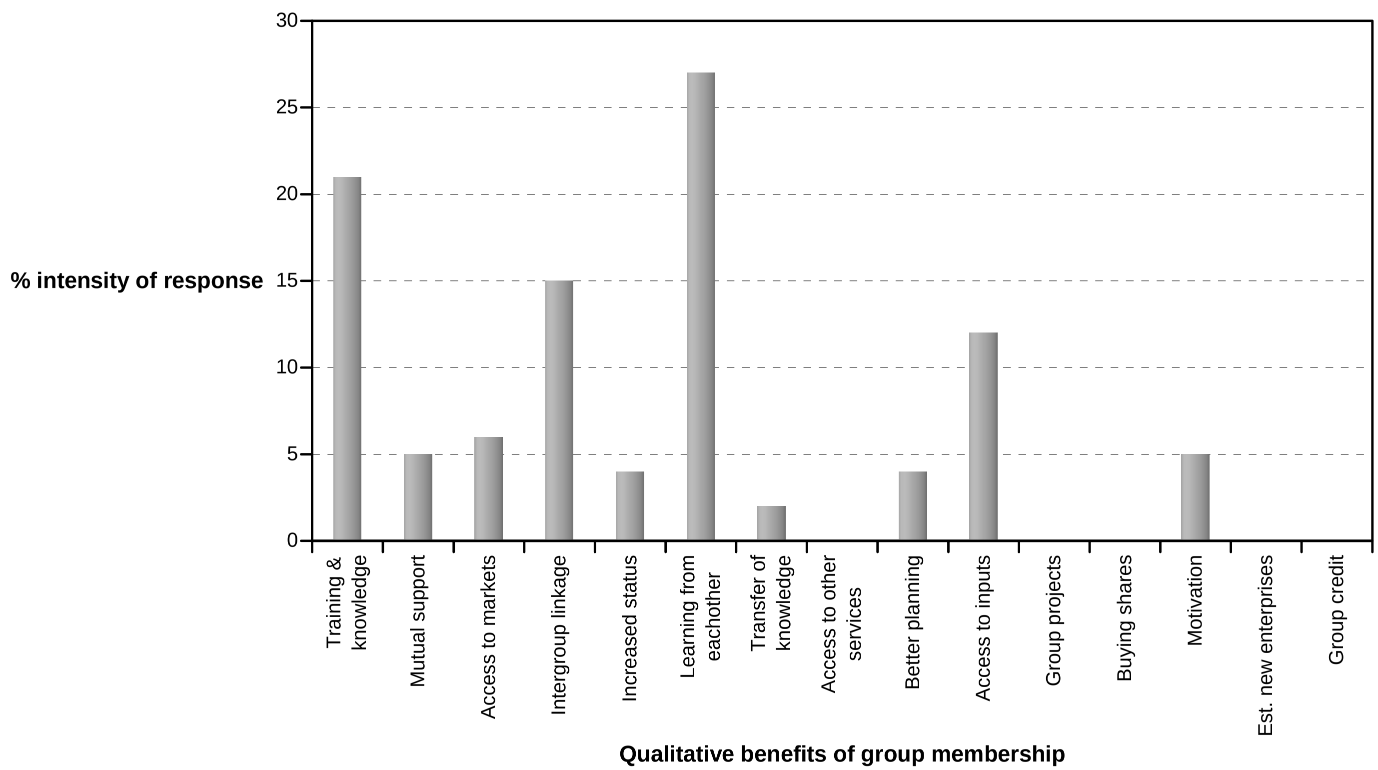


Figure 2. African indigenous vegetable farmers in Kiambu (Kenya)

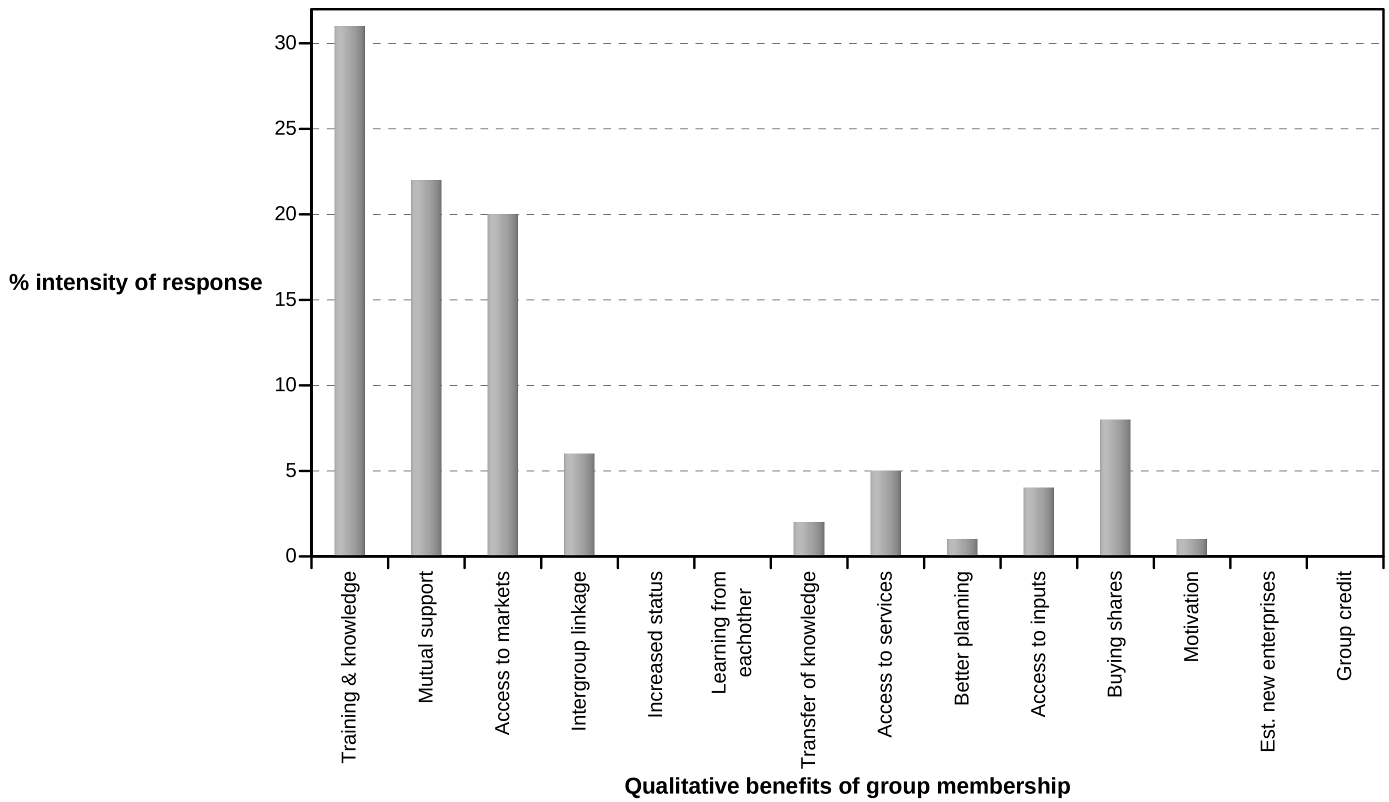


Figure 3. Cassava farmers in Nakasongola (Uganda)

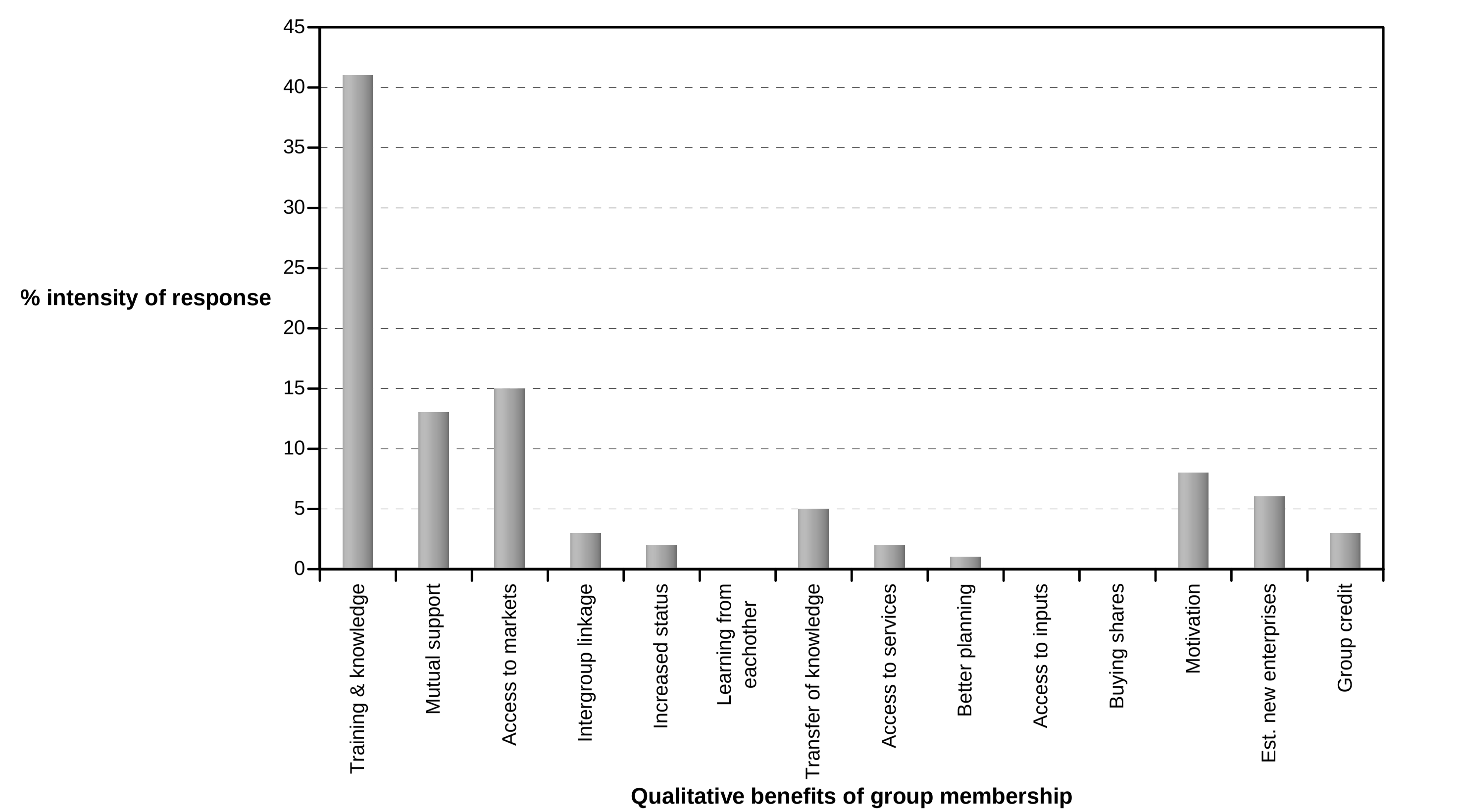


Figure 4. Chicken farmers in Rakai (Uganda)

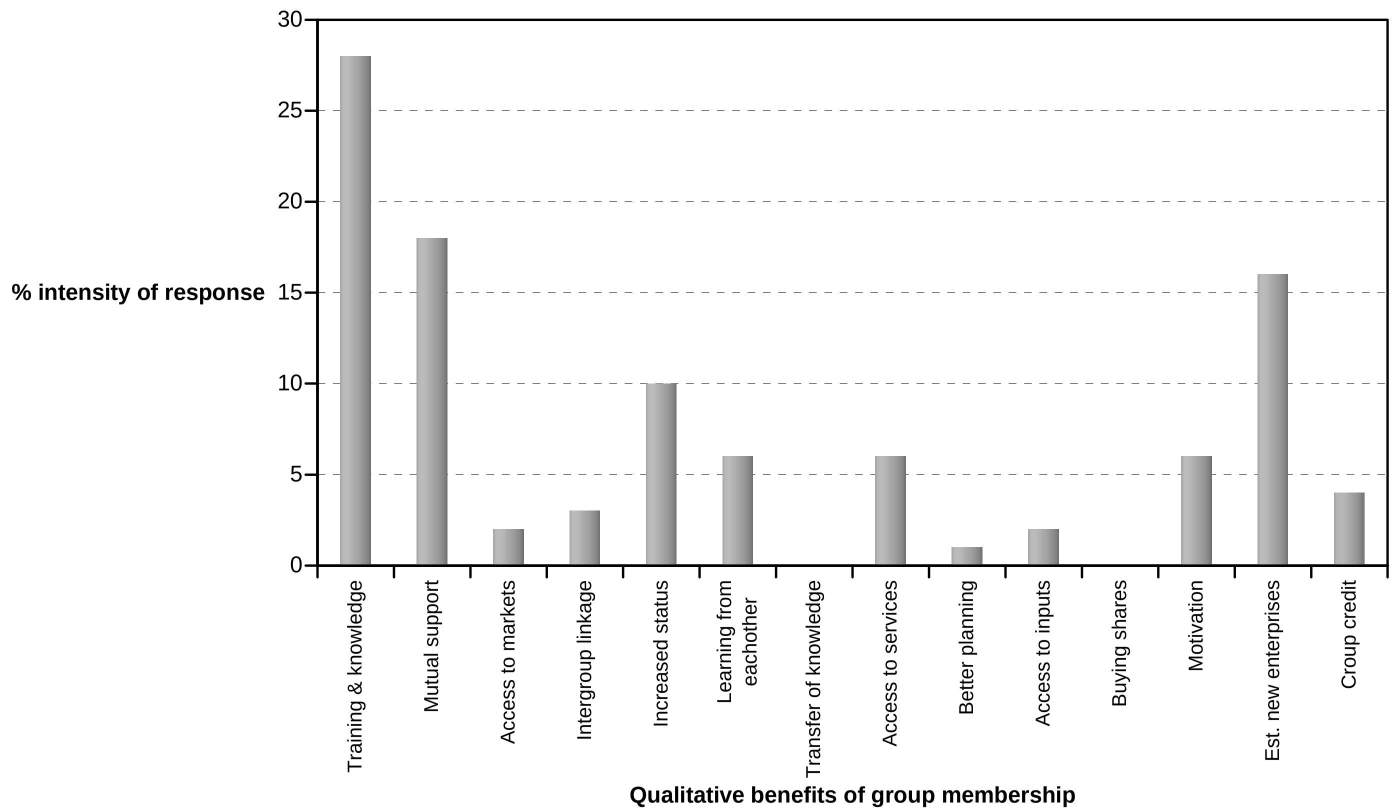
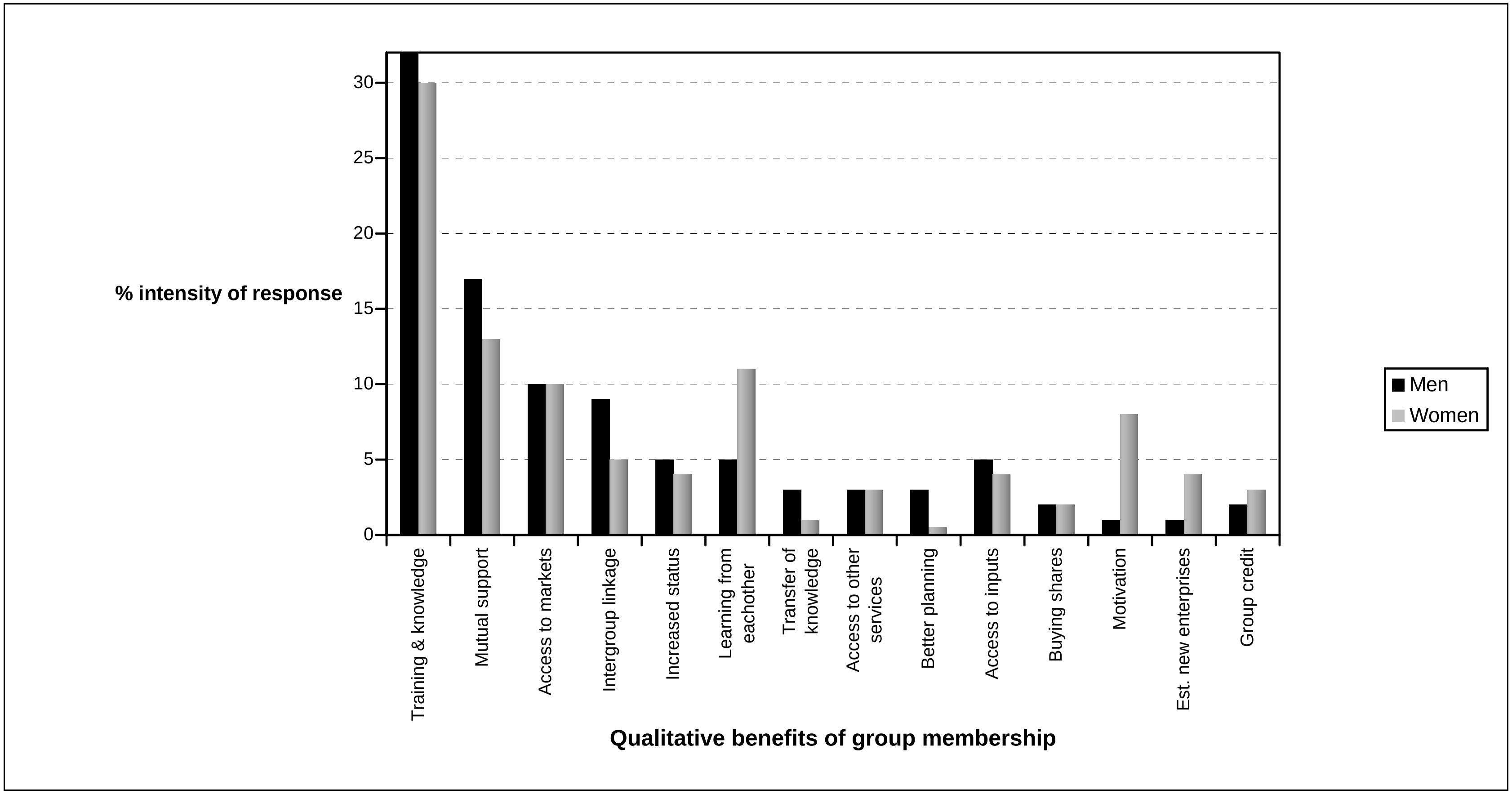


Figure 5. Benefits of group membership



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