Crop Protection Programme

Socio-Economic Study of the Uptake of Herbicide Technology In Maize Based Cropping Systems

R7404 (ZA0301)

Final Technical Report

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Contents

Executive Summary

The smallholder markets for herbicides on food crops in Kenya and Uganda are thought to be very small at the current time. Survey evidence from this project suggests that just over 3 per cent of households (n=240) were using herbicides as a means of controlling weeds in their maize plots. The small number of farmers who were using herbicides were generally found to be better educated, cultivating more land, producing and selling more maize and sending a greater proportion of their children to school than farmers who did not.

Evidence from the on-farm participatory trials would indicate that herbicides can increase the net benefits of cultivating maize to farmers by up to 80 per cent in the case of those practising intercropping with beans. When this is combined with their ability to alleviate seasonal (and gender) based labour constraints their potential contribution to a more successful and economically sustainable farming system is highlighted. These benefits are derived from yield increases (of over 30 per cent) associated with more effective weed control during the critical period of crop growth/competition, and the cost savings from massive reductions in labour requirements. This fell from 39.2 to 1.3 person days per hectare equivalent (based on plots of 500 square metres).

Estimations of the net benefits to farmers does not complete the whole story due to the potential impact on labour usage patterns. The very change that produces the largest benefit for farmers – the reduction in labour time and cost – could produce negative problems for other members of the communities. Whether this is the case is dependent on if households are actually hiring labour to conduct weeding activities. More than half of households surveyed did hire labour to conduct weeding activities, with this been more prevalent in Kenya than Uganda. However in many cases labour is often not available at weeding time with a large proportion of households reporting this to be the case. In addition it is important to note that virtually all the labour that is hired comes either from the village in which farmers are based or a closely neighbouring one. In general terms there are not large groups of migrant workers who would be adversely affected by the widespread introduction of herbicides but the potential labour displacement may still be of concern.

Household incomes are low - at around £50 per annum (per capita) - clearly indicating that there is little room for the introduction of new expenditure items such as herbicides. Low household incomes become a binding constraint to the adoption of herbicides because of poor access to credit and the application equipment (sprayers). Overall financial constraints are deepened by temporal cash flow issues (and household spending priorities). School fees are the expenditure area that households spend most of their income (after food), and on which the greatest priority is placed. This creates temporal concerns because school fees are due at exactly the same time that herbicides would be required and there is simply not enough available income to pay for both at the same time.

The current burden of weeding activities are not distributed evenly within the household with the majority falling on women, and to a lesser extent on children. Women generally have the responsibility for making decisions on weeding (and generally carrying through weeding activities) but not for maize selling which is a male dominated – indicating male control of this income flow (this is also the case more broadly within households concerning incomes). In terms of herbicide uptake the important issue is that the major beneficiaries of the reduced labour burden would be women, but they have much more limited access to the funds that would be required to buy herbicides, compared to men. The opportunity cost of women's labour time by men may not be valued highly enough to promote herbicide use.

Background

1. In sub-Saharan Africa weeds are a major obstacle to crop production (Marnotte, 1997). Traditional weed control is very labour intensive (almost totally by hand) and herbicides, as part of an overall crop management strategy, can reduce this labour requirement and generally improve yields over more traditional methods (Deat, 1973 and 1986; Marnotte, 1997). Most resource-poor farming households in East Africa face an effective labour constraint which is seasonal, gender-based and in some areas may be related to the downstream impact of HIV/AIDS. This constraint affects the timeliness of weed control practices, particularly during initial crop growth stages, reducing yields and providing secondary hosts for insect crop pests. Herbicide spraying treatments require much less labour: i.e. 1 person day/ha compared to 10-20 person days/hectare for manual treatment[1] (Marnotte, 1997). Despite these potential labour savings there has not been widespread adoption of herbicide technology in maize-based farming systems; additionally there has been no critical assessment of the overall benefits of herbicides to rural communities and this is urgently required.

2. The research in this project is closely related to the research that has been conducted on technology uptake in maize farming systems in East Africa (and more widely). The body of literature has concluded that technology adoption levels are a function of a wide range of factors: availability of capital; farm size; attitudes to risk; ability to mobilize sufficient labour supplies (at appropriate times); output and input prices (influence of pricing policy); multiple and conflicting objectives at household and intrahousehold level; credit availability; amount and quality of extension contact; input availability; quality of delivery systems; infrastructure, particularly in relation to ease of marketing; education levels; farmer age; membership of social organisations; farm household knowledge systems (Shields et al, 1993; Holden, 1993; Ongaro, 1990; Stanning, 1989; Ezeh and Unamma, 1989; Albert and Runge-Metzger, 1995). This long list reveals the complex interaction of economic, social and institutional arrangements affecting technology uptake. Very little work has focused on the uptake of herbicide technology in maize-based systems and the economic incentive that is generated by household labour constraints (particularly female labour for timely weed control); and the further constriction of this related to reduced labour availability due to the impact of HIV/AIDS[2].

3. Many studies have demonstrated the much longer working hours of women in farm households in developing countries (McSweeney, 1979; Evenson et al, 1979; Acharya and Bennett, 1982; Hanger, 1973; Cain et al, 1979; Hart 1980; Barnum and Squire, 1979; Deere, 1982; Overfield, 1995), the impact of these patterns on the technical efficiency of household cash cropping (Overfield and Fleming, in prep) and production levels in general (Overfield, 1998). It is also generally recognised that women usually have much lower rates of access to on-farm capital (and technical knowledge) and receive lower labour returns than men which dramatically alters the relative economic incentives they face to adopt new technologies; this issue has not been investigated with respect to herbicides. Herbicides *may* provide a solution to the economic impact of weeds on crop yields that are closely associated with the evolving pattern of labour constraints in East African maize-based farming systems.

4. Demand for the outputs of this research were generated by the programme managers of the Crop Protection Programme. This demand was generated by the need for a timely piece of strategic research to assess the overall benefits of herbicide technology to resource poor farming households in Kenya and Uganda (and more generally) and to identify the factors which affect its adoption. There have been many studies on the factors that influence the adoption of new agricultural technologies in general, but no studies appear to have focused on herbicide technology specifically, or used on-farm participatory trials to evaluate the potential economic benefits.

[1] These data can vary markedly, depending on the growth stage of the crop and the extent of weed infestation.
[2] This is a matter of some debate and there is not space to consider the issues here; it is the subject of many on-going studies.

Project Purpose

HP104: Improved Methods for the Management of Weeds in Non-Rice Cropping Systems:

5. This project is concerned with reducing the economic impact of weeds on resource-poor farming households in east Africa (and more generally). The research objectives are to provide an overall assessment of the benefits of herbicide technology to rural communities within overall crop management strategies and identify those factors which lead to different usage patterns. These objectives will impact on the project purpose by identifying those factors which influence the uptake of improved weed control practices.

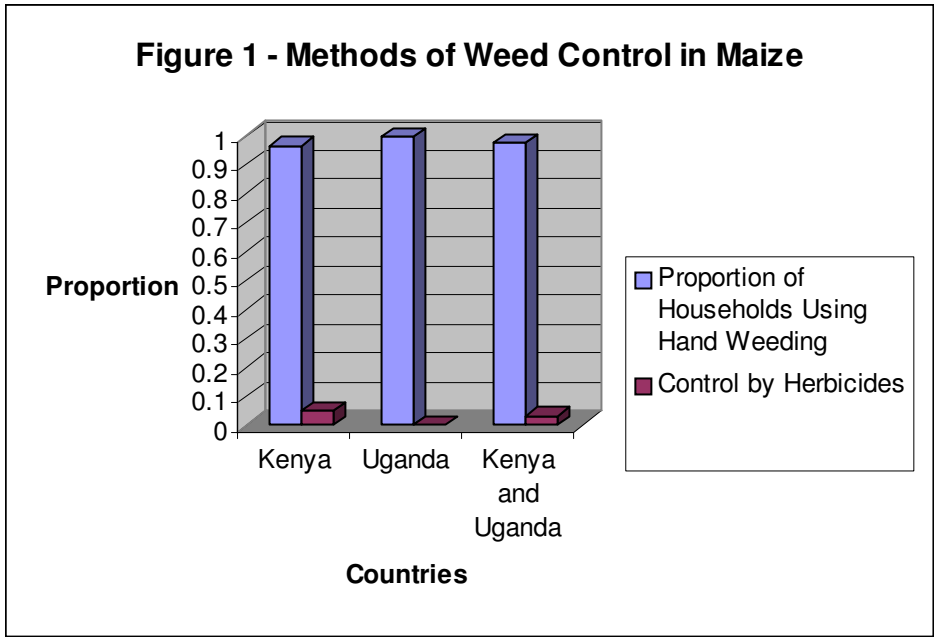
Research Activities

6. In order to identify the factors influencing the adoption of herbicides, and provide a critical assessment of the potential net benefits to rural communities, it was necessary to study a number of different farming systems in different locations across Kenya and Uganda. Specific project activities included:

- Literature review;
- Initial RRA and stakeholder workshop to identify key issues and finalise geographic areas in which project activities will be based;
- Detailed PRAs of rural communities in selected areas representing different maize production areas (7 major production areas – 4 in Kenya; 3 in Uganda);
- Formal survey (using structured questionnaire) of herbicide usage and related factors (based on findings of PRA study) in different maize production areas (240 households).

Output 1: Analysis of Trends in Herbicide Usage in Smallholder Maize Production in Kenya and Uganda

7. In global terms herbicides account for over 70 per cent of all agrochemical use on maize with over 70 per cent of all herbicides (all crops) used in the USA and Europe (Terry, 1999). Another 23 per cent is accounted for by the markets in Asia (15 per cent) and Latin America (8 per cent) leaving only 7 per cent for the rest of the world including Africa (After Oerke et al, 1994 in Terry, 1999). The market for herbicides is so small and scattered in sub-Saharan Africa it is impossible to find any reliable consumption figures. The markets within Kenya and Uganda are thought to be very insignificant at the current time in the smallholder sectors for both maize and food crops in general. Survey evidence on usage incidence was non-existent until survey work commissioned by this project was completed in 1999/2000. This indicated that just over 3 per cent of households were using herbicides as a means of controlling weeds in their maize plots and this is illustrated in figure 1 below.



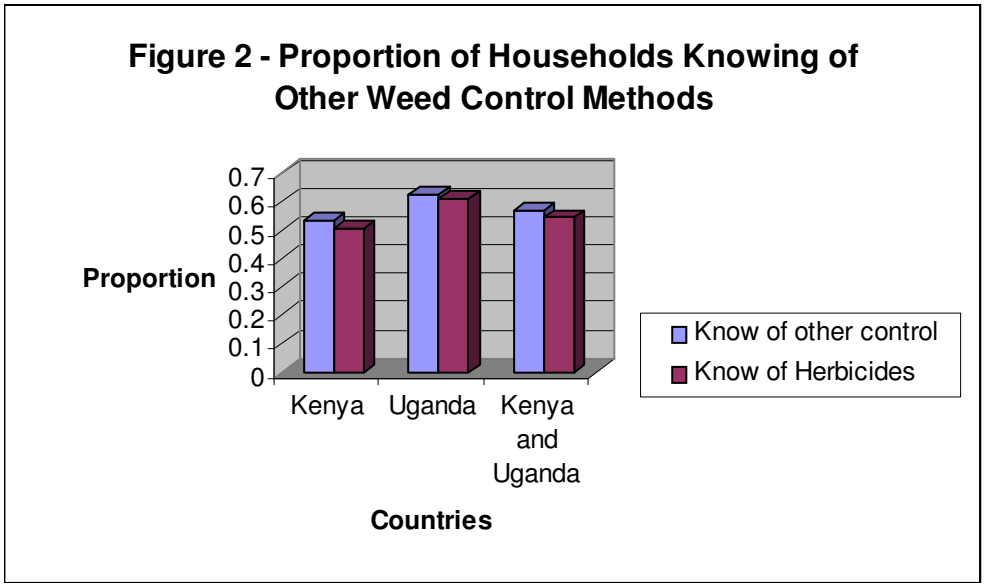
8. It is apparent from figure 1 that herbicides are only used by a very small proportion of smallholder farm households[3] (the data collection unit) use herbicides for weed control; hand control predominates and no instances of herbicide use were found in Uganda at all. Of 241 households surveyed only 8 were found to be using herbicides . Because of this small (positive) number it is difficult to establish statistically the determinants of herbicide use[4] but it would appear that the small number of farmers who use herbicides are generally better educated, cultivate more land, produce and sell more maize and send a higher proportion of their children to school (see appendix 2 for more details).

9. When explaining low usage of herbicides usage in developing countries many commentators refer to lack of knowledge as the principal explanation; figure 2 summarises the information from the survey. It would appear that about half of all households are aware[5] of herbicides for use in maize across Kenya and Uganda indicating substantial gaps in basic awareness and current levels of potential adoption i.e. other factors are acting as a significant constraint on use.

[3] Survey based on 240 households using representative sampling methods (combining formal and informal methods) – see appendix 1 for more details. There 151 households in Kenya and 90 in Uganda covering all major production areas.

[4] Using a binary logistic or other appropriate econometric model .

[5] Meaning they can identify a product, explain what it does, and its potential benefits.



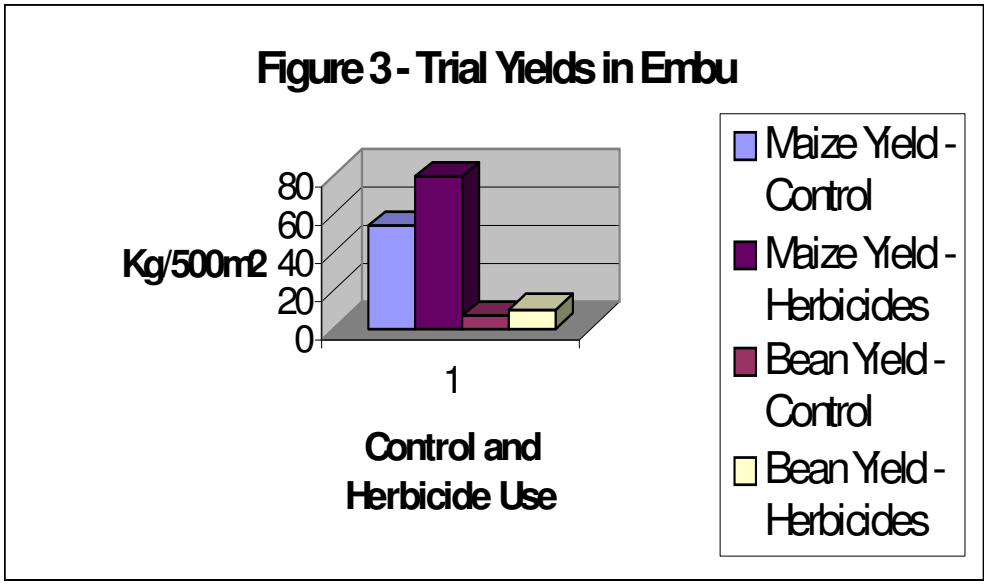
10. There has been little discernable movement to the use of herbicides in smallholder maize production in Kenya and Uganda for weed control. A significant proportion of households are aware of herbicides and their potential benefits, but still choose not to use them. It is critical to gain an understanding of the factors that are leading to these low adoption levels which requires a deeper analysis of the farming and livelihood system operating in the major production areas on which output 3 (pages 12-14) will concentrate. Before this the next section turns to concerns over the size of potential net benefits to rural areas – both farmers and the broader community.

Output 2: Critical Analysis of the Potential Net Benefits

Economic Returns to Farmers

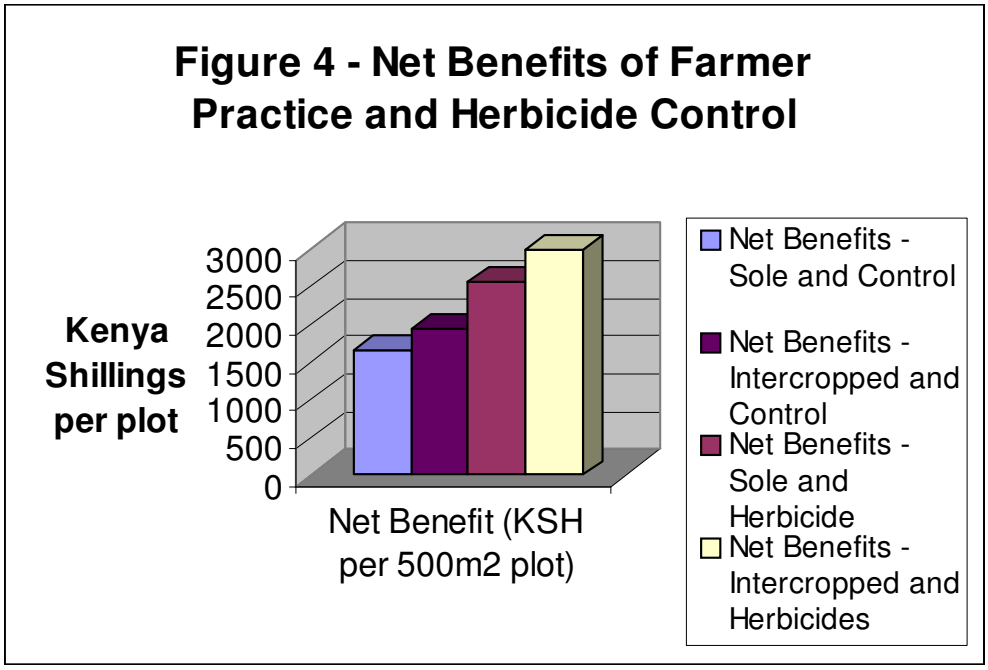
11. Figures 3 and 4 summarise the results of on-farm participatory trials held in Embu during the short rains in 1999/2000[6]. These clearly indicate that herbicides can have a highly positive impact on the net benefits accruing to farmers for two main reasons. The first concerns the factors underlying yield increases – more effective weed control during the critical period of crop growth and competition (particularly in relation to seasonal labour shortages). The alleviation of this constraint by herbicides contributed to yield increases of over 30 per cent for both maize and beans and consequent increases in the value of production (and hence to net benefits). The second reason concerns the overall reduction in production costs associated with herbicides caused by a massive reduction in the labour required for weeding, from 39.2 to 1.3 person days per hectare (equivalent based on plots of 500 square metres).

12. The combination of reduced competition (and hence increased yields) and reduced production costs gives the net benefits presented in figure 4. This shows that herbicides produce net benefits that are between 55 and 82 per cent higher compared to farmers normal practice in this area. These should be regarded as initial indications only as they relate to one season and one area – results from three areas and three seasons should be available by the completion of sister project (R7405 (ZA0302)). In addition they overstate the level of benefits because they do not take into account the additional labour costs that would be associated with increased yields (harvesting and processing), the costs of a sprayer or the true herbicide cost to farmers[7].



[6] Due to the drought conditions through most of 2000 in East Africa these are the only trial results currently available. However trials are on-going under sister project R7405 (ZA0302) and will be reported by that project)

[7] For a sprayer these could be as high as Ksh 1100 per season for a sprayer (assuming they last five years and there are two seasons per year). However some households already have access to sprayers, some could share and they can be used across a number of crops. A more reliable estimate may indicate the net benefits to maize (of herbicide use) would be reduced by 2-300 Ksh per plot – which represents about 15 per cent in the net gain due to herbicides. Labour costs would also contribute to further reductions in the improvement of net benefits – but these are expected to be relatively small (a fraction of the 30 per cent yield and production increase) – still leaving substantial benefits to be gained by farmers. Net benefits were also calculated using the actual amount of herbicide used; currently farmers would have to buy a 5 litre tin (costing around £30) when a 1 litre tin would be more appropriate (and cost around £6.60) – this again would reduce the size of potential net benefits. The exact price facing smallholders is difficult to estimate at the 'farm gate' given the small market i.e. not really observable. Prices are based on those currently prevailing in urban/peri-urban areas – which is the best guide.



Other Economic Concerns

13. The very change that produces the benefits for farmers – the reduction in labour time and cost could produce negative problems for other members of the communities. Whether this is the case is dependent on the extent to which household's hire labour to conduct weeding activities. It is also dependent on who the labourers and if they are available during the critical weeding period. Figure 5 summarises the survey evidence and indicates that more than half of households do hire labour to conduct weeding activities, with this more common in Kenya than Uganda. However in many cases (about 50 per cent) labour is often not available and figure 8 indicates that this is most frequently reported during crop weeding periods. It is important to note that virtually all the labour that is hired comes either from the village (i.e. from other farm households) in which they are based or closely neighbouring one (also from farm households). In general terms there are not large groups of migrant workers who would be adversely affected by the widespread introduction of herbicides in these systems. However localised labour displacement may still be of concern and does warrant some further investigation[8].

14. Responsibilities for weeding maize (and other plots) are not equally distributed within the household, with over a third of households reporting than women are solely responsible; however in most cases both men and women are responsible (but with women generally bearing most of the burden). Children are also involved in weeding in more than half of households which may be directing their attention away from education as figure 7 provides some indication – though this is difficult to be conclusive without detailed intrahousehold time allocation data. This *may* identify other positive livelihood spin-offs from the introduction of herbicides into these farming systems.

[8] This would depend on the extent to which individual households were dependent on casual labouring on neighbouring farms compared to their agricultural production and sales and hence the loss of the former against the benefit of the latter. This requires a detailed household analysis of individual income/production data with a particular focus on casual labouring incomes – difficult from this data set, and really requires detailed household monitoring.

Figure 5 - Proportion of Households Hiring Labour for Weeding and Availability

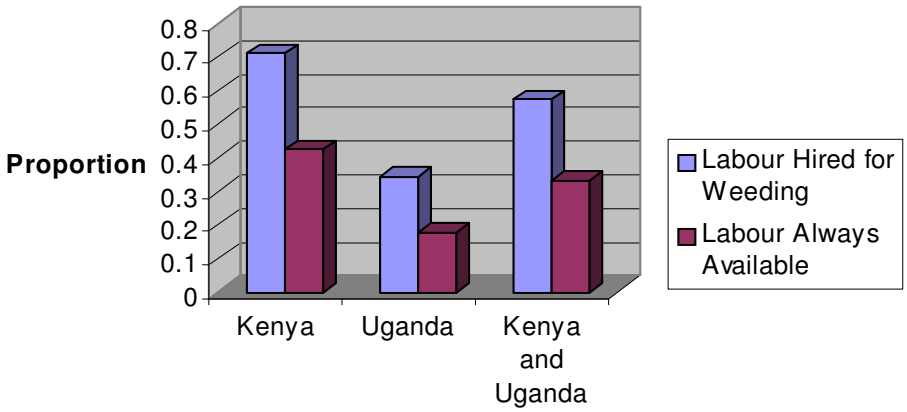
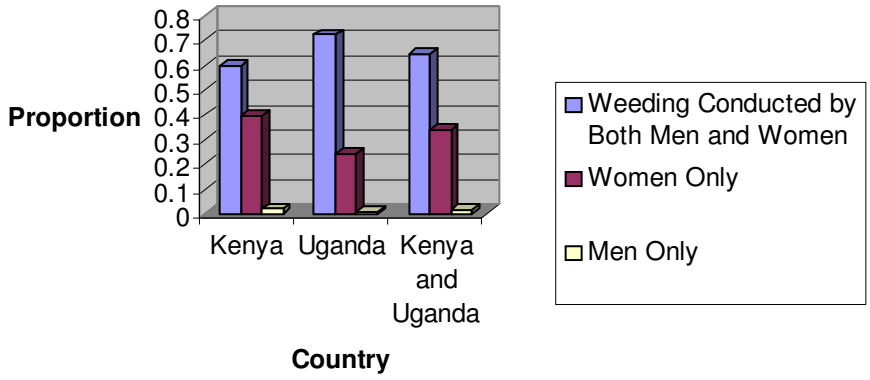
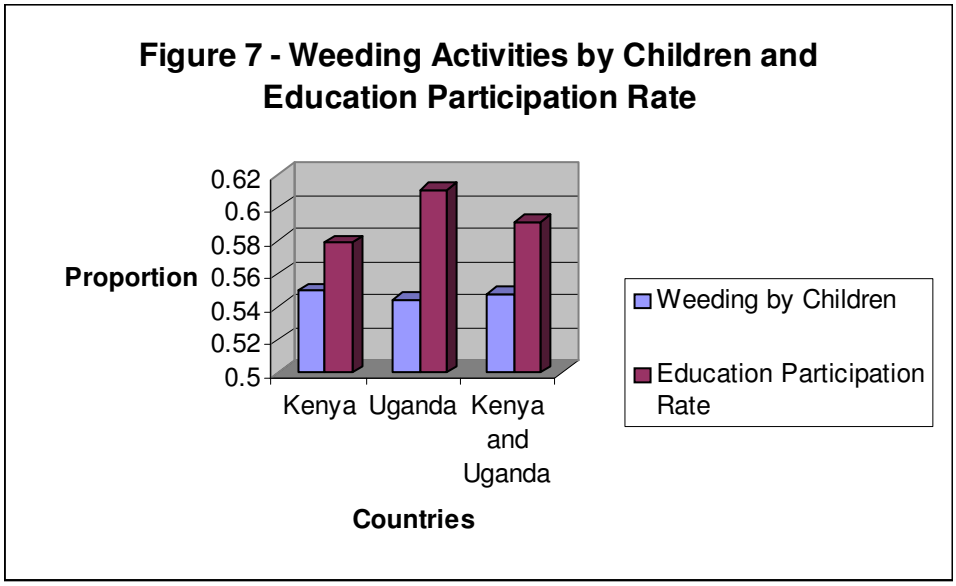
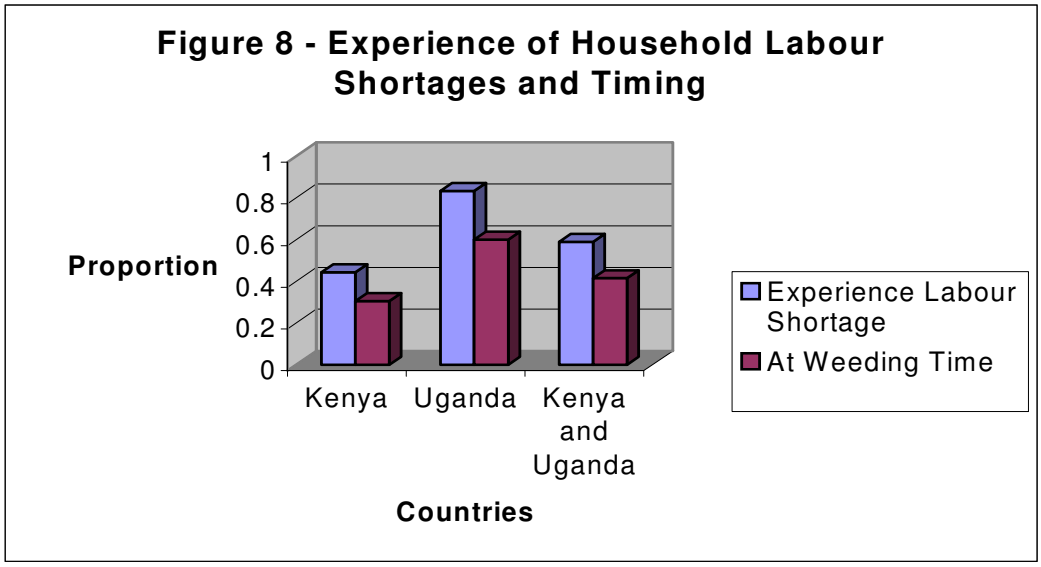


Figure 6 - Use of Household Labour for Weeding





15. Figure 8 indicates that a majority of the surveyed households experienced labour constraints with most bearing this during crop weeding periods (harvesting representing the other major period of constraint). When this information is combined with that in figure 6 it is clear that herbicides could produce positive benefits in terms of alleviating labour constraints. In particular it will release a lot of female labour time within the household, and the current labour demands on children in this area. It would appear that the negative effect on employment opportunities would be small for two reasons: firstly, the labour is often not available at the appropriate time; secondly, it is often neighbours that are hired and so most should amount to transfer benefits – however this is still an issue and is covered under footnote number 8.



Conclusions on Overall Economic Benefits

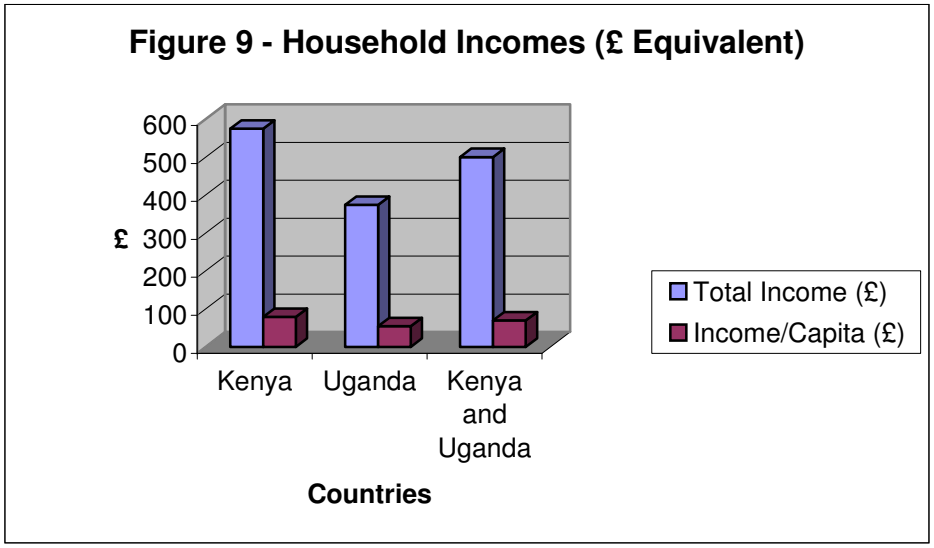
16. Evidence from the on-farm participatory trials would indicate that herbicides can increase the net benefits of maize cultivation to farmers by up to 80 per cent. When this is combined with their ability to alleviate seasonal (and gender) based labour constraints their potential contribution to a more

successful and economically sustainable farming system is highlighted. Negative employment effects for casual labourers are still of some concern and it is difficult to make meaningful conclusions based on the information collected by this project. Herbicides will certainly benefit farmers economically, but is clear that households do not just farm and hiring out labour is often an important element of household livelihood strategies; it is the exact balance between these that will determine the overall level of net benefit. Further work is required on this issue. There are of course other potential costs relating to health (particularly of spray operators) and the environment which could result, mainly from inappropriate use of herbicides. This represents a substantial risk where a new product is being introduced into communities such as these.

Output 3: Identification and Analysis of Factors Influencing Herbicide Adoption Levels

Household Incomes and Poverty

17. The adoption gap (or difference between awareness and actual adoption) highlighted earlier in this report has a number of explanations most of which are founded in poverty, temporal cash flow issues and the undervaluing of the opportunity cost of labour. Low levels of adoption are also related to a lack of knowledge for many households – itself a function of the agricultural knowledge information system (AKIS) in these areas. However the largest overarching constraint to the adoption of herbicides would appear to be household income levels and the poverty they imply. Figure 9 summarises the survey information with respect to annual household incomes and clearly indicates that these households are very with per capita incomes around £50 (equivalent)[9] per year allowing little room for the introduction of new expenditure items into household budgets.



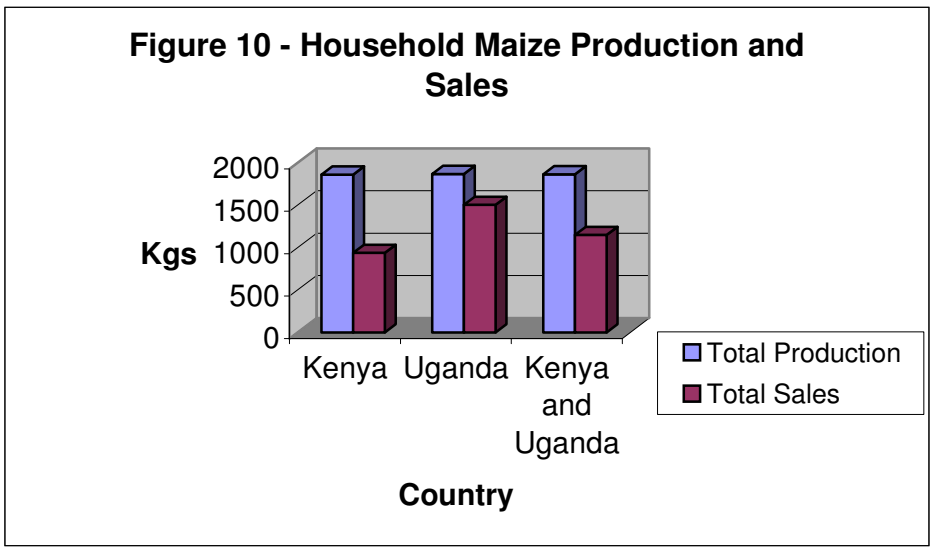
18. Figures 10, 11 and 12 look at the contribution of maize to household budgets and it is clear that it makes up a significant proportion of farm income (over 40 %) but a much smaller proportion of total household income[10]. Maize has an important contribution to make to home consumption but large proportions are clearly sold – particularly in Uganda. Maize sales generate an average income of £105 in Kenya and £65 in Uganda[11]. Maize only generates a small income (in the general context of

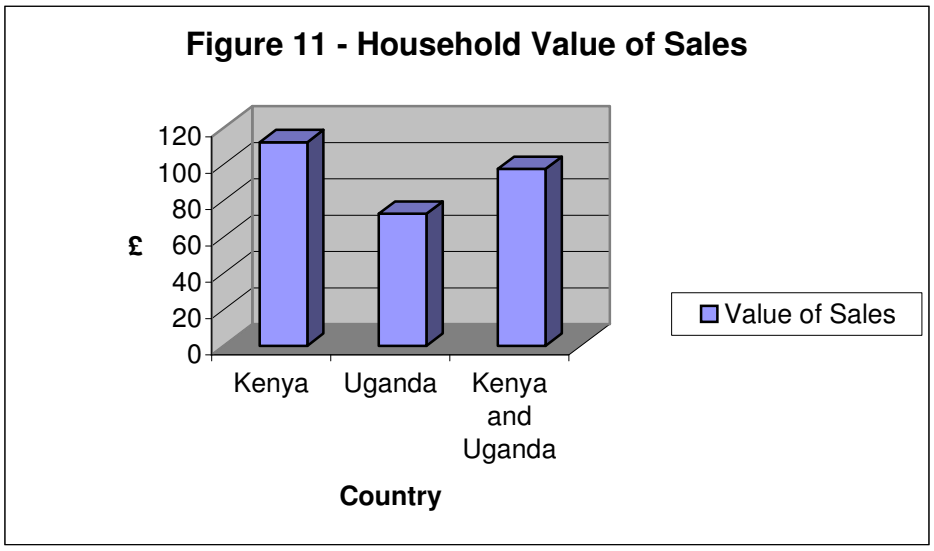
[9] Calculated at £1=110 Kenyan Shillings (Ksh) and £1=2400 Ugandan Shillings (Ush)

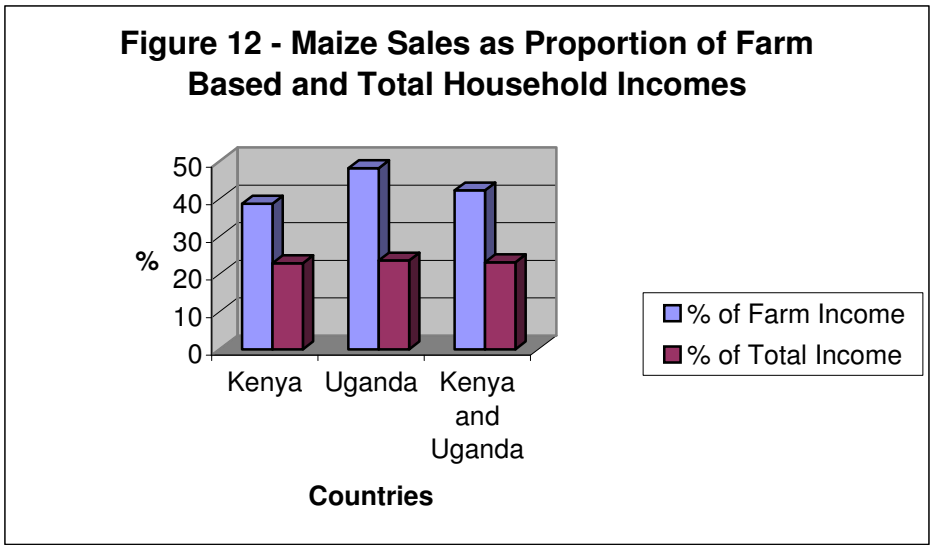
[10] However some non-farm income is derived from casual labouring on neighbouring farms often on maize. There is also considerable variation within the sample.

[11] Based on an exchange rate of £1=110Ksh and 2400Ush. There is considerable variation between the different areas.

low household incomes) providing little space for investment in productivity enhancing technologies targeted at maize such as herbicides.

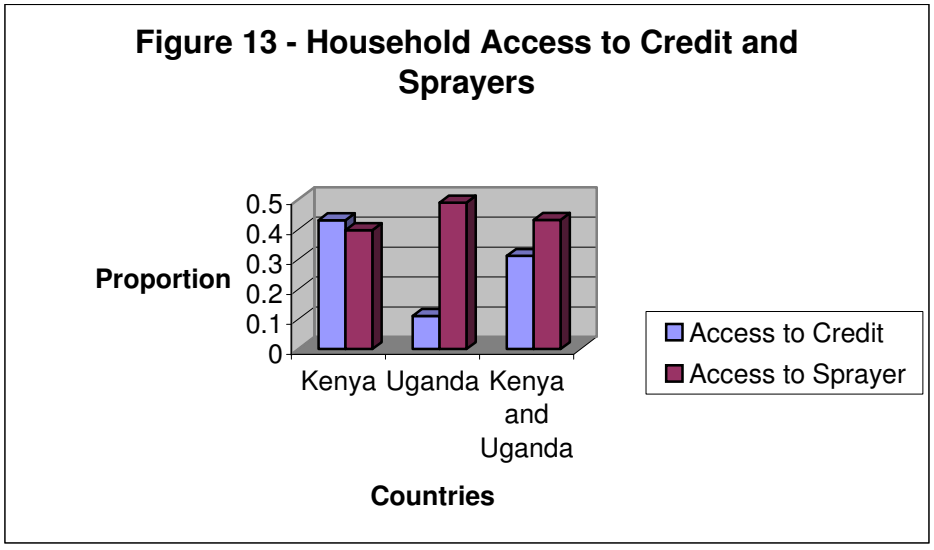






Access to Credit and Sprayers

19. Low household incomes would not form such a binding constraint if households had access to both credit and the sprayers that are required to apply herbicides. Figure 13 reveals that the majority of households do not have access to credit with this proportion falling to less than 10 per cent in Uganda. Access to Sprayers is greater than credit but most households still do not have access to a sprayer (even on a shared basis). This provides a double hurdle for many farmers to jump – which is probably too high. For instance a sprayer will cost in the region of £70 (an up front payment) in most rural areas in Uganda and Kenya – which is most of the income earned from maize. Add to this the cost of applying herbicide to average size maize plot at – approximately £30 per season[12] (another up front payment) for the 'average' sized farm and the prospects for uptake, without provision for credit, do not look high.

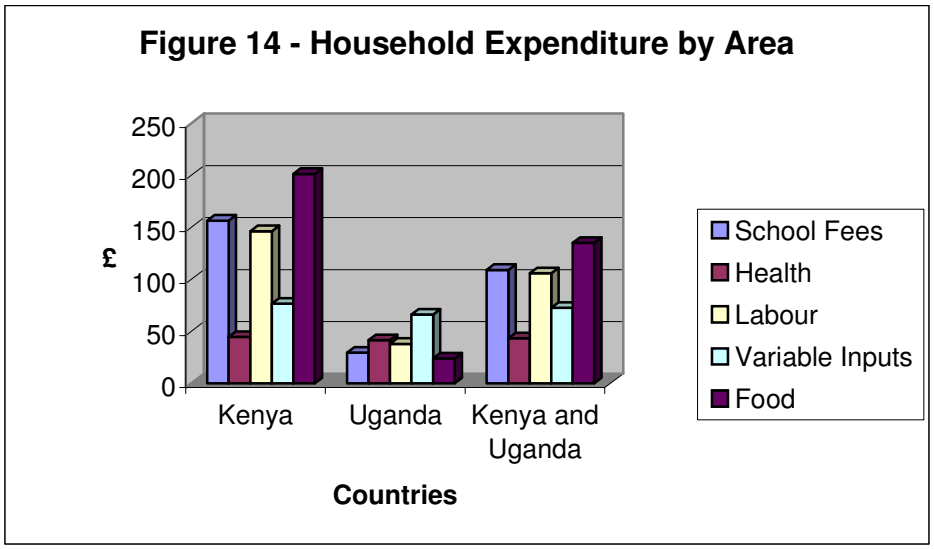


[12] Mainly because herbicides currently have to be purchased in five litre tins. One litre would be more appropriate for smallholders at an approximate cost of £6.60.

Temporal Cash Flow Issues

20. General household budget constraints are further compounded by temporal cash flow concerns and household spending priorities (identified in the detailed PRA reports for each of the producing areas). Figure 14 reveals that education (school fees) is the area that most households spend most of their income (after food) and this is the expenditure area with the highest priority (Muruthi et al, 2000; Kamidi et al, 2000; Odendo et al, 2000; Maina et al, 2000; Birungi and Overfield, 2000). This creates temporal concerns because school fees are due at exactly the same time that herbicides would be required (September and January) and there is simply not enough available income to pay for both at this time.

21. Herbicides could ease this temporal constraint by reducing labour expenditure but require up front payments for both the herbicides and the sprayer; labour payments are generally on a day by day basis (and often in kind). Compounding this still further is that herbicides are generally only available in large quantities (generally 5 litre tins) with 'average' farmers requiring less than 1 litre per season. In many areas the appropriate herbicides for maize (particularly for intercropping systems) are also not available.



Intrahousehold Issues and the Opportunity Cost of Labour

22. It has been noted elsewhere in this report that the burden of weeding activities were not distributed evenly within the household with the majority of burden falling on women and to a lesser extent children. Figures 15 and 16 indicate that women generally have the responsibility for making decisions on weeding (and generally carrying out the activity) but not for maize selling which is a male preserve – indicating male control of this income flow. Figures 17 and 18 reveal a more gender balanced picture for farm incomes in Kenya (but not in Uganda) but male dominance in other non-farm income flows across both countries. In terms of herbicide adoption the important issue here is that the major beneficiaries of the reduced labour burden would be women, but they have much more limited access to the funds that would be required for adoption compared to men. Men on the other hand may 'undervalue' the opportunity cost of women's labour time when making investment and expenditure decisions such as those concerning herbicides.

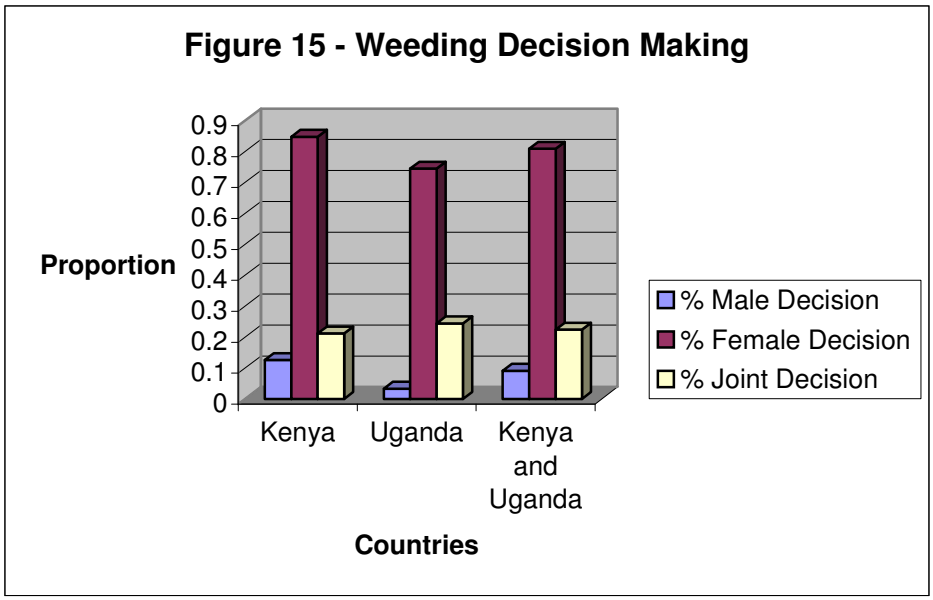


Figure 15 - Weeding Decision Making
Proportion
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Kenya
Uganda
Kenya and Uganda
Countries
% Male Decision
% Female Decision
% Joint Decision

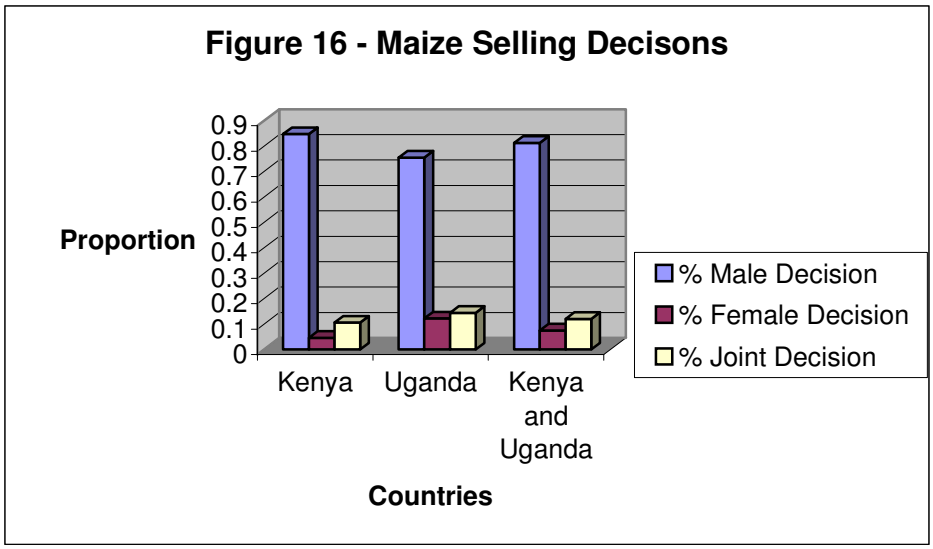
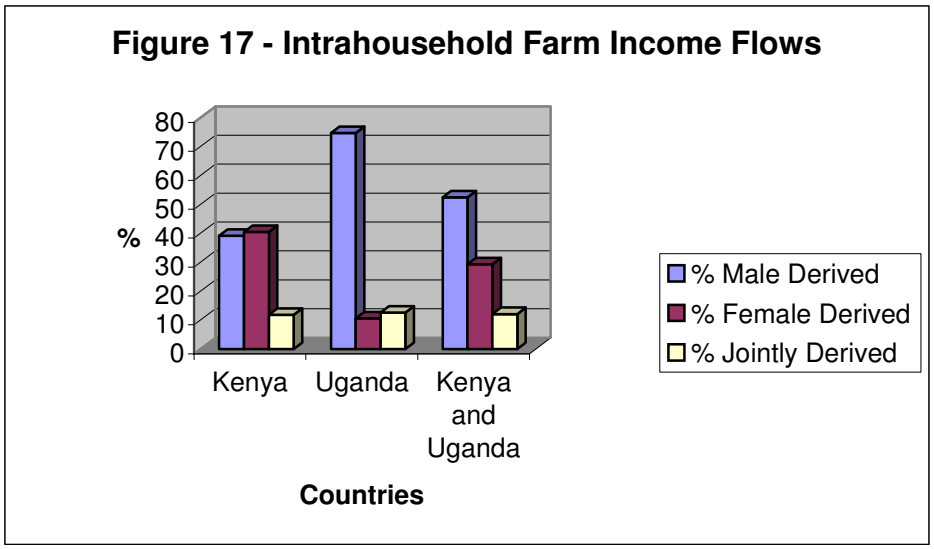
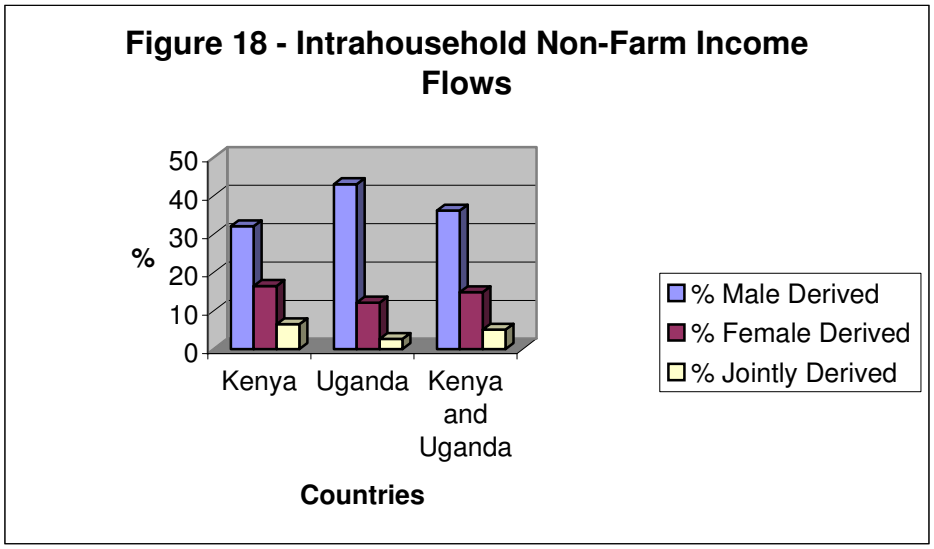


Figure 16 - Maize Selling Decisons
Proportion
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Kenya
Uganda
Kenya and Uganda
Countries
% Male Decision
% Female Decision
% Joint Decision

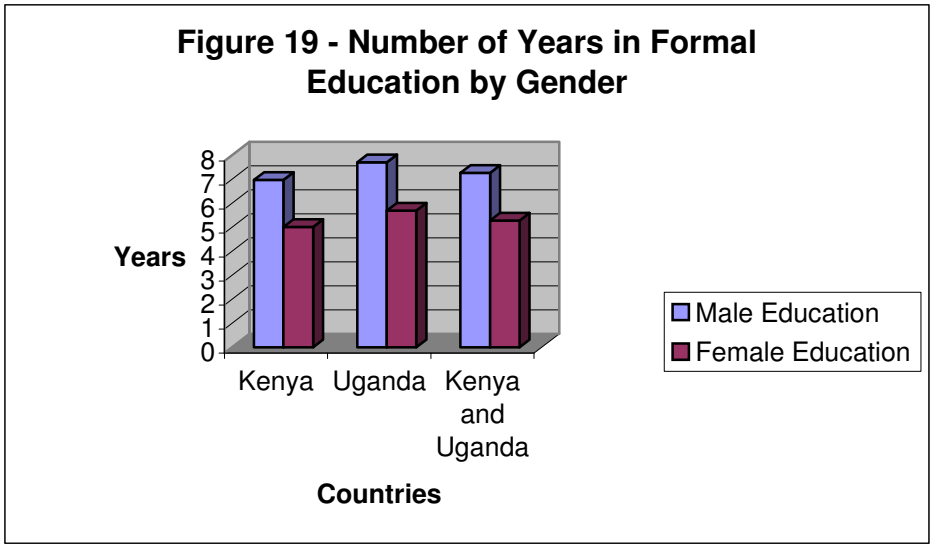




23. Women have significantly less formal education than men – a gap of approximately two years (on average). - which may well reduce agricultural productivity in this system and the potential for adoption of new technologies. This is particularly critical at these levels of education because recent studies have indicated that it is post elementary or primary schooling that has the greatest influence on the adoption of new techniques and crop varieties. Formal education over 4 years begins to assert a positive influence; 4 years or less was found to be statistically insignificant[13]. This figure would

[13] The impact of education on agricultural productivity is complex and there is not space to adequately consider this within this report. However recent evidence suggests that the influence of education on agricultural productivity suggests that schooling only becomes important in the face of new crop varieties, when these render redundant knowledge historically imbedded in relevant cultural practices learned over generations (Azhar, 1991: 658-661). In Azhar's study the coefficient of schooling variable became significant only in the case of Green Revolution crop varieties, namely, Mexipak (wheat) and IRRI rice; for two traditional varieties these were not significantly different from zero at 90% level of confidence. For the modern varieties, an extra year of schooling increases output by 1.28 %(wheat) and 1.52%(Rice). These are better than those found by

appear to be critical as women, in this sample, have an average number of years in education in the region of four not enough, on the basis of international literature, to contribute to farm productivity levels and adoption patterns.



Knowledge Systems, Dissemination and Extension Issues

24. Figure 2 and paragraphs 9 and 10 indicated the proportion of households aware of herbicides and the potential information gap. In this context it is important to know from where farmers are obtaining information regarding agricultural practices and of the biases that may operate within this system. Hassan (1998) concluded, in this extensive Kenyan study (n=1300), that most farmers acquired information about new maize varieties from extension sources, followed by learning from other farmers (possibly because of increased use of contact farmers and farmer groups under the train and visit (T&V) system) Despite the introduction of the T&V system[14] bias against female farmers remained (though other biases appeared to be addressed). Input supply systems only had minimal influence in dissemination (all areas). The major constraint to adoption of improved varieties and pest control methods was found to be lack of information, particularly in the lowland tropics. The major

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Pudasaini (1976) for Nepal (1.3%) and Wu (1971) for Taiwan (0.7%) – all based on years of schooling of farm operator. However against this Nelson-Phelps-Schultz hypothesis effect (quoted in Azhar, 1991) that the impact of education tapers off over time because of learning by doing – a demonstration effect. From further accumulated evidence it appears that elementary education (4-5 years of schooling) does not have much effect on agricultural productivity (Lockheed et al, 1980). When Azhar re-ran his model with two dummy variables (1-4 years and more than 4 years schooling) the first was found not to be significant but the second was for both modern varieties. Further results estimated by Azhar show that completion of education beyond elementary level leads to a 9.5% increase in farm productivity for wheat, while in the case of rice this is almost 20%. These gains are twice those of 7.4% for corresponding gains in other countries as estimated by Lockheed et al (1980).

[14] T and V system in Kenya made use of frontline extension workers, contact farmers, farmers groups, subject matter specialists, and research scientists. Provided training every two weeks to frontline extension workers by SMS and every month to SMS by research scientist. There were fixed work programs and regular visits (usually fortnightly) by extension workers to contact farmers or farmer groups; it was considered so successful in Kenya was used to make the case for T and V elsewhere in Africa (World Bank 1990, 1993).

barrier to increased adoption of fertiliser was found to be its high cost (a similar situation to that of herbicides where the costs are even higher). In this study it is interesting to note that there was little variation in the factors that influenced the uptake, or non-adoption, of recommended maize production practices - whether these be improved varieties, fertiliser use or pest control measures.

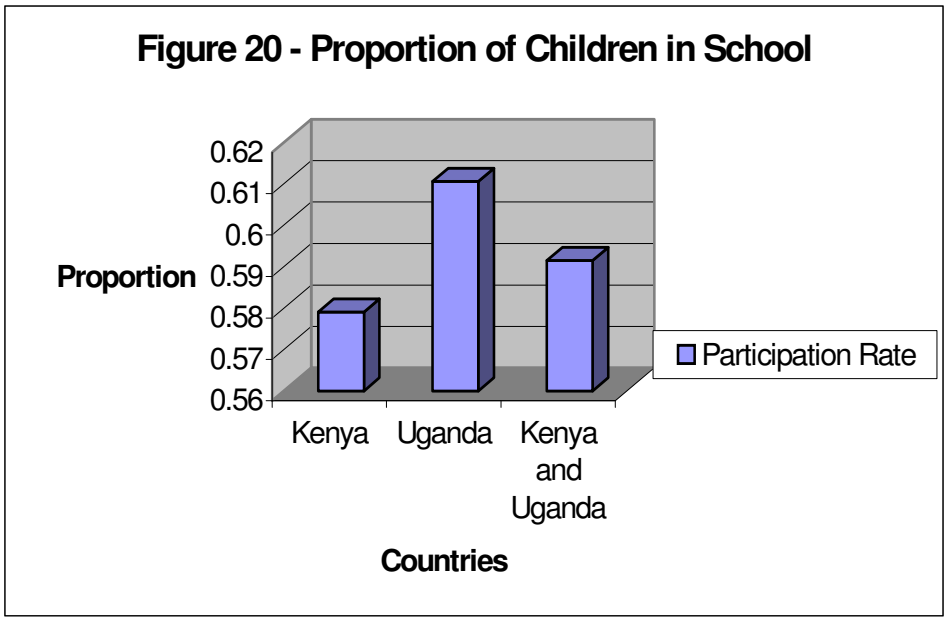
25. In their 1997 Ugandan study Mulhall and Garforth identified wide variation between four parishes, indicating overall that other farmers were the most common information source to farm households. Men had more overall access to information than women; men also obtained agricultural information via the radio and dealers, with women expressing that NGOs were more important - particularly through the women's groups in which they were involved. These two studies indicate that farmers have multiple sources of information and that farmers are a very important information agent in addition to their role as adapters and integrators of new technologies.

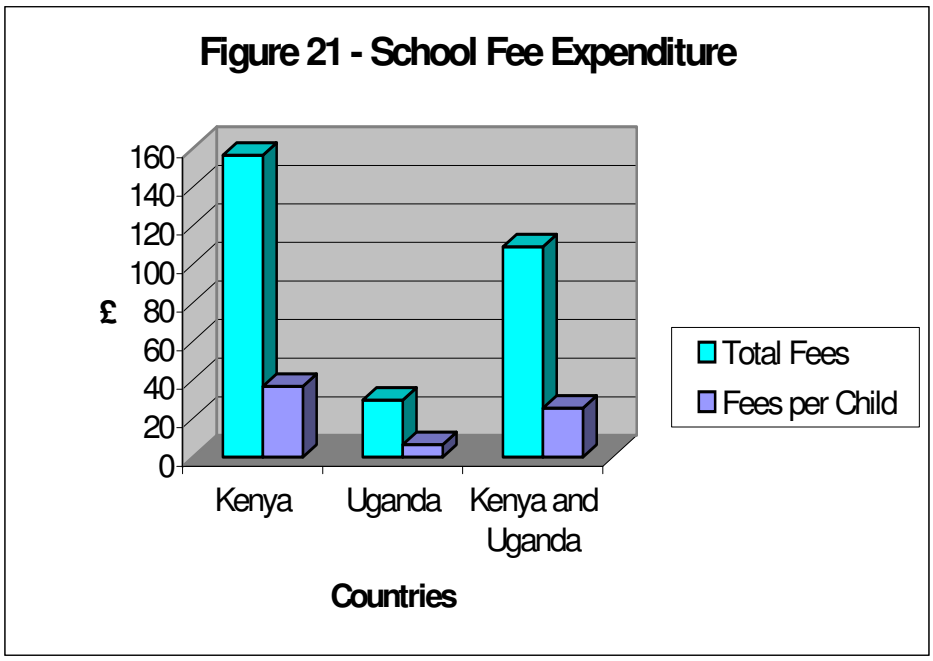
26. The survey information collected by this study was in general agreement with both of the studies summarised in this sub-section. Farmers where found to have multiple sources of information, and different information sources for different topics. The two primary sources of information were extension services, other farmers (including neighbours and parents) – both of these being of equal importance. Other significant sources of information included stockists (particularly for agro-chemicals), NGOs (particularly in Uganda) and CBOs. The bias against women identified in both of these studies could not be confirmed by this study (due to the way information was collected) but is clearly a major issue concerning adoption.

Output 4: Policy Recommendations

Education – Temporal Cash Flows, Productivity and Gender

27. The analysis in paragraph 23 (and figure 19) highlighted the gender concerns associated with the likelihood of adoption of new agricultural technologies and the critical number of years in education that are required to have a positive impact. Added to this were issues brought up concerning temporal cash flows and the negative impact that school fee expenditure was likely to have on the adoption of herbicides. Because there are major policy differences between Uganda and Kenya on this matter (mainly because Uganda has free primary school education) it is possible to make some meaningful comparisons between the two countries. It can be seen from figure 20 that Uganda has a higher education participation rate than Kenya and that (from figure 21) and that school fee expenditure is lower, and much lower in terms of fees per child. The implication is that alleviation of this burden at primary level may lead to overall higher participation with potential further positive downstream effects, and the creation of an enabling environment for the adoption of new technologies such as herbicides. Current patterns may indicate that despite greater poverty (in terms of income levels) in Uganda herbicides may have a higher probability of uptake than in Kenya, particularly in the medium-long term. The obvious policy implication is that education needs to be subsidised, or at least be available on credit (a removal of the current termly payment structure which clashes with the agricultural seasons would help) if a more supportive environment for the widespread adoption of herbicides is to be created.





Knowledge and Promotion Issues

28. Paragraphs 24-26 considered AKIS issues and the diversity of information sources that farm households have. There are key avenues that need to be targeted in the promotion of herbicides within the system especially given that a major proportion of smallholder households are not aware of the existence of herbicides for use in maize. These are: formal extension services; agri-business (companies and stockists); NGOs and church organisations; maximizing farmer to farmer links (as part of the on-farm trials/demonstrations); networking with other organisations/donors who are concerned with package delivery to farmers (CG Centres, ASARECA etc.). Maximizing the value of existing links between organisations is also clearly very important but there are problems in this area

with many of these being weak, and the weaker the closer to farmer delivery they get (Rees et al, 1999; Mulhall and Garforth, 200; Hassen, 1998). There is a need for increased use of networking and pluralism in provision of research and extension services to increase cost-effectiveness, equity and efficiency of agricultural development. It is important to note that these problems are currently being addressed directly by donors in both Kenya and Uganda: there are two specific new initiatives which provide opportunities for the promotion of herbicides in smallholder farming systems:

1. ***Uganda: The Programme for Modernisation of Agriculture/National Agricultural Advisory Service (NAADS) (multi-donor).*** Combination of bottom-up planning and competitive tendering for extension at District Level; priorities will be determined by new, local, civil society institutions and a national secretariat. The NAADS secretariat will work closely with the local governments which have the mandate for delivery of agricultural advisory services. Agricultural Development Centres (ADCs) will be set up in each district to provide demonstration and capacity building for the Technology Development Sites (TDSs) at sub-county level[15]. All three levels will represent important dissemination entry points for all CPP outputs in Uganda.

2. ***Kenya: Agricultural Technology and Information Response Initiative (World Bank).*** This came out of the re-engineering of the mid-term review of World Bank support to NARP II; the Bank have expressed interest in supporting outreach activities. This initiative is concerned with technologies already developed by KARI but may become a more general dissemination pathway which CPP outputs could utilise. This is currently at very early stages and developments on this, and extension in general, are uncertain, and linked to Kenya's conformance to international donor demands.

The Critical Role of the Interaction of Gender and Opportunity Cost

29. Increasing participation of women in the formal work environment dramatically increases the valuation of the opportunity cost of their time leading to substantive increases in the demand for domestic labour saving devises. This has been the pattern in developed countries during the post second world war period and now in middle income countries. It is about the valuing of women's labour time and their empowerment (often though generation of, and control of their own income streams); this would appear to be at very early stages in the rural communities studied in this project. Women have limited access to household income flows whilst bearing most of the burden associated with weed control, with little consideration of the opportunity cost of their time by the individuals who have the decision-making power with regard to adoption of new technology/expenditure decisions. This is a major societal issue going well beyond the bounds of adoption of new agricultural technologies; however it has been shown to reduce agricultural productivity (partly though its depressing impact on women's education levels) and the sustainability of current farming systems. It should be a key issue for policy makers in Kenya and Uganda.

Credit and Enterprise Development

30. There is a critical need for institutional change to increase credit availability to smallholders, with current arrangements only providing credit to a minority of households. Closely related to this is enterprise development in terms of rural stockists (who could also be credit agents) and other service providers who could offer cost-effective break of bulk points and even herbicide spraying services (or sprayer maintenance, nozzle adjustment etc.). This is a critical link in the chain that is currently missing and will prevent the widespread adoption of herbicides by smallholder farmers in Kenya and Uganda.

[15] Full details of the Programme for Modernisation of Agriculture can be obtained from Government of Uganda (2000) which is the final draft of the strategy and operational framework.

Contribution of Outputs

31. DFID is of the view that poverty is driven by a lack of resources and economic opportunity and is promoting approaches which can deliver sustainable improvement (i.e. impact) in the livelihoods of poor people (purpose) in an efficient and effective manner. The overall goal is to reduce the overall proportion of people living in extreme poverty by 2015. Its research strategy for renewable natural resources must contribute to this by improving the productive opportunities and living conditions for the rural poor. To assist in this contribution the CPP is committed to the development and promotion of economic, social and environmentally sustainable technologies to reduce crop losses from pests in developing countries. In consequence the programme needs to better understand the processes that may constrain, and provide an opportunity for, the uptake of new technologies by farmers. Given the economic and social impact of weeds this must include their sustainable management and the potential benefits associated with herbicides.

32. The purpose of this study was to provide a critical assessment of the net benefits to rural communities associated with herbicides and to identify those factors constraining their adoption. Both of these goals have been achieved by this project indicating clearly that herbicides could be expected to produce positive benefits for communities. However their adoption is constrained by a combination of poverty, poor access to credit, limited knowledge, temporal cash flow issues and an undervaluing of the opportunity cost of female labour time. Many of these require policy interventions beyond the scope of both this project and the CPP. The key area in which CPP can impact is in addressing the knowledge issues by working with a broad range of institutional partners, and reaching an increasing number of farmers directly, under sister project R7405 (ZA0302) which is currently being implemented.

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Appendix 1 – Sampling Methods and Formal Survey Questionnaire

Methodology to be Used for Selection of Villages for PRA and Formal Survey Activities

The District in which survey activities will take place will be selected in a purposeful manner i.e. it must be an important maize growing area. From this point on it is essential that all village selection be random to avoid statistical bias and that which is often introduced by extension officers in the selection procedure. Accordingly 6 villages will be selected on a random basis in each District. Selection will be conducted in the following manner. For **each** village the following procedure must be followed:

1. The division will be selected at random
2. The location will then be selected at random from within the division
3. The sub-location will then be selected at random from within the location
4. The village will then be selected at random from within the sub-location

These selection procedures relate to the administrative structures/sampling frames in Kenya though a similar approach should be used in Uganda. Random sampling can either be conducted by using a random number generator (either on a calculator or computer) or by drawing pieces of paper (with the appropriate names on) from a 'hat'. There will be 30 farm households from each growing area (Masindi, Mbale, Iganga, Kiambu, Kitale, Kakamega, Embu, Coastal Zone (Kenya – probably Kalifi).

Selection of Households for Formal Survey

Farmers should be selected at random from the villages in which the PRAs were conducted. As outlined before wealth ranking information should be collected prior to commencement of the formal survey and so that we can have a relatively uniform approach these findings must be communicated to me before any survey activity takes place. It would be best to develop a system of wealth criteria that can be used across all villages. Sampling should represent the different wealth criteria and the exact numbers in each wealth strata should be decided in conjunction with me. The information that is required (for each village) for deciding numbers in each strata are:

1. Total number of households in each village
2. List of wealth factors identified by participants
3. Number of households having each of these factors in the village (in a matrix table so that any correlations between factors can be identified)

The wealth ranking exercises should be conducted immediately on completion of the other PRA activities. In terms of overall numbers the formal surveys should have 30 farmers per growing area (5 areas/Provinces in Kenya, 3 areas/Districts in Uganda) which will amount to a total of 240 farmers which should give a high degree of statistical significance to the results. The wealth strata should then be constructed with the number of households selected from each (at random) being proportional to the importance of that strata (or proportion of total households in that strata).

Formal Questionnaire

All questions must be answered by each household. Questions must be answered by either (or both) senior members of the household (i.e. wife or husband) **only**

General Farming/Livelihood Structures

1. General Location Information

Reference Number (Sequential)	
Name of Household Head	
Indicate if Female Headed Household	
If female headed, why?	
Indicate who is being interviewed (husband, wife or both)	
Name of Village	
Name of Maize Growing Area	

2. Demographic Structure of Household (people living in village only)

Number of Male Adults (do not include non-productive older adults)	
Number of Female Adults (do not include non-productive older adults)	

Number of Children in Primary Education	
Number of Children in Secondary Education	
Number of Children in Other Education	
Other Children not in Education	
Total Number of Children	

Number of Children Outside Your Household Who You Pay Primary School Fees For	
Number of Children Outside Your Household Who You Pay Secondary School Fees For	
Number of Children Outside Your Household Who You Pay Other School Fees For	
Why are you paying these fees?	

Number of Non-Productive or Partially Productive Older Adults	

Number of Years of Formal Education of Husband	
Number of Years of Formal Education of Wife	

3. School Fee Payments

Type	Months Due	Amount Due
Primary Schooling		
Secondary Schooling		
Other Schooling		

4. Expenditure other than School Fees

Item	Months Spent	Approximate Amount

5. Sources of Income

Item	Who Receives	Months Received	Approximate Amount

6. Agricultural Advice and Information

List all sources of Agricultural Information and Advice	On what topics	Received on-farm or elsewhere (list if elsewhere)

7. Source of Agricultural Supplies

List Items that you buy/receive	Where do you get items you buy/receive	On which crops do you use these?

8. Sources of Credit

Do you have access to credit?	
From where is this obtained?	
Approximate annual interest rate	

9. General Land Issues

How many acres do you cultivate?	
Do you own the land you cultivate?	
If not, do you pay rent (how much)?	
If owned how did you gain access (if bought how much did they pay/acre)	
Did you inherit the land	
If inherited, was the land sub-divided	

10. Capital Items for Agricultural Production and Processing

Item	Owned, Shared, Borrowed or Hired	If hired, what is the hire charge?	If shared, between how many?
Hoe			
Sprayer			
Add in checklist in this cell and below			

11. General Labour Arrangements

What type of labour do you use? (Family, hired, casual etc.)	
Do you suffer from any labour shortage?	
If so, at what period is this?	
How do you deal with this?	
Or what activities get left undone?	

Labour Hired for:

Activity	Months	Payment (calculated on per acres basis if possible)	Is Labour Always Available?

Maize Production System

12. General production questions

Is maize grown for one or two seasons	
In the first (main) maize season is it mono-cropped, inter-cropped or a combination of the two?	
If mixed, which crops on same land?	
What is the length of this first season?	
In the second maize season is it mono-cropped, inter-cropped or a combination of the two?	
If mixed, which crops on the same land?	
What is length of second season?	

13. Production and Sales of Maize (estimates from the last 12 months)

Area Planted	**Total Production (Bags)**	**Total Sales (Bags)**	**Form of Sales (green or dry)**	**Place of Sale**	**Price Received (per bag)**
First Season					
Second Season					

Was the first season 'normal'?	
Was the second season 'normal'?	

14. Exact Labour Arrangement for Maize Production (from land prep to selling)

Activity	Male, Female Adults or Both	Children Involved	Any Hired Labour or other Arrangements (in kind with neighbours/community etc.)

15. Decision making in maize

List all Decisions Made	Who makes this?

16. Problems in Maize Production

List Problems	What are done about them (if anything)

Weed Management in Maize

17. How do they control their weed problems in maize?

18. Do they know of any other control methods?

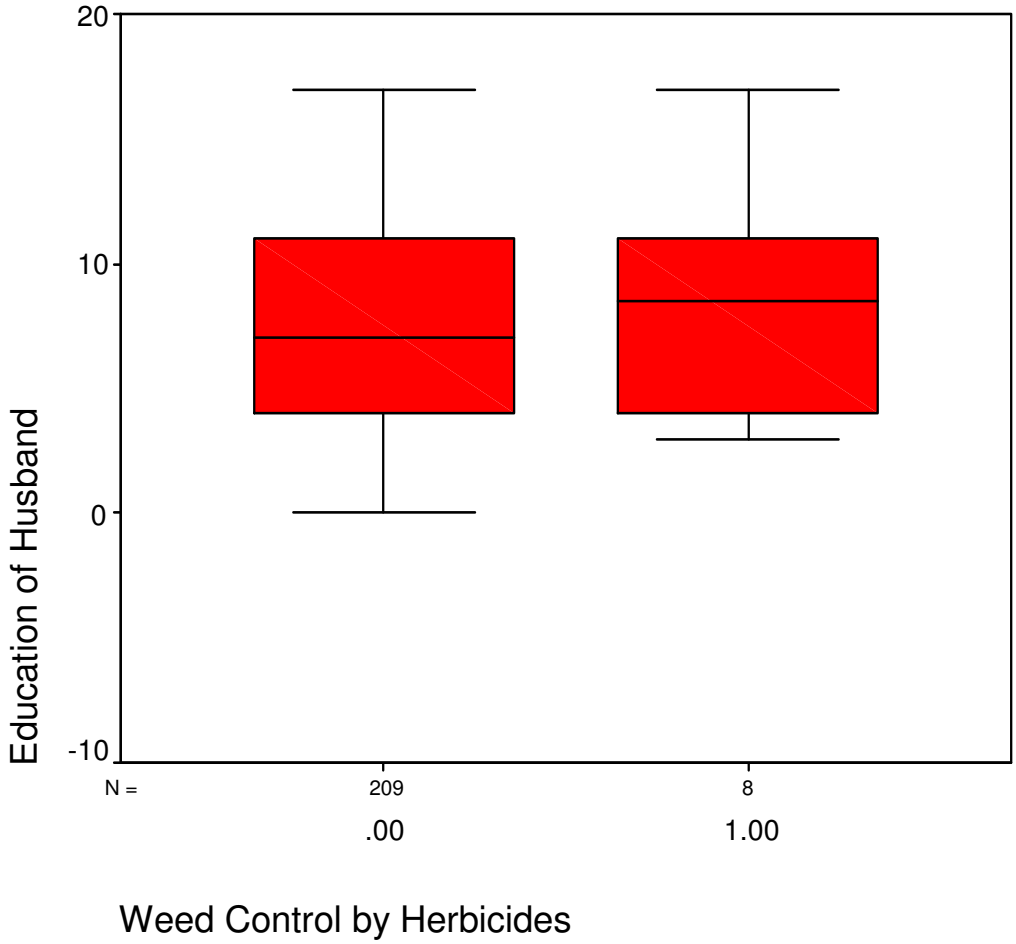
19. If they know of other control methods, why do they not use them?

20. List any weeds that occur on maize that have other purposes (grazing, medicinal etc.)

Name of Weed	Purpose

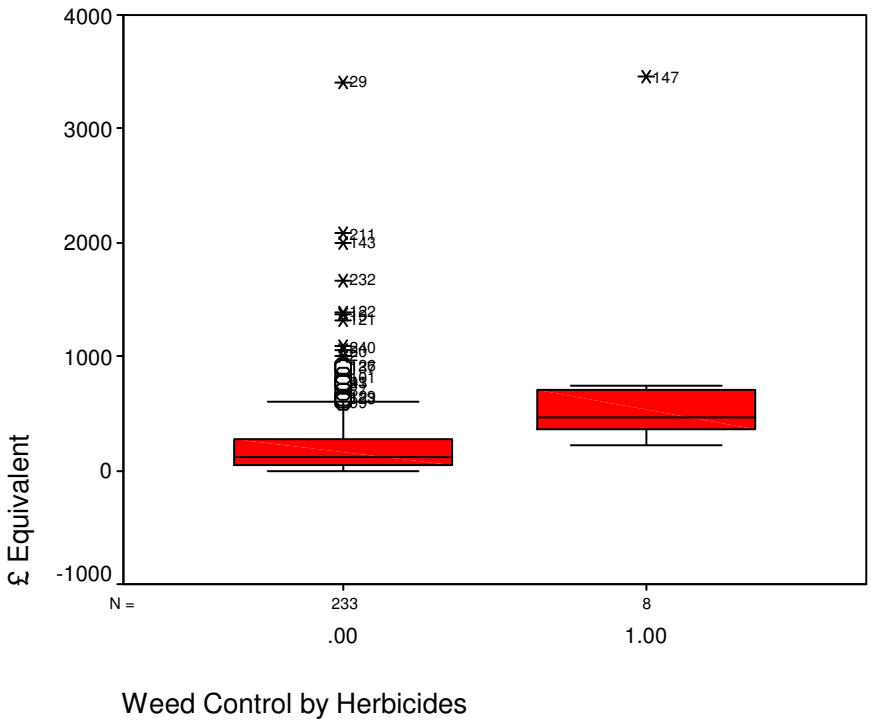
Appendix 2 – Differences between Herbicide and Non-Herbicide Users

Due to the small number of households using herbicides (8 out of 240) it was not possible to establish statistically the determinants of usage (using an appropriate logistic model). Hence all information is this appendix is presented in box-plot form to give some idea of differences in averages and variability. It is important to note that these differences are not statistically significant. In all cases on the X axis, 0=non-user, 1=user.

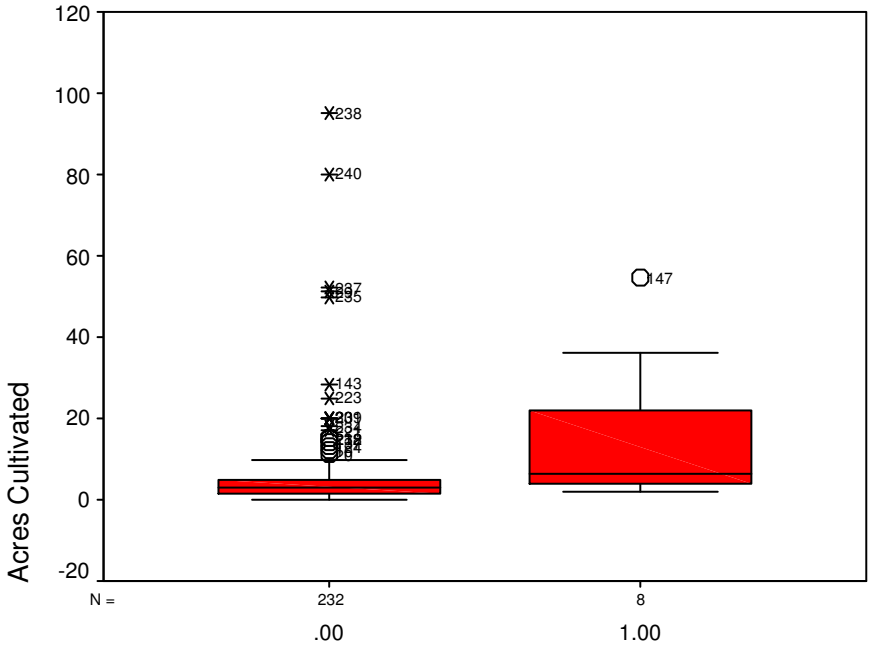


Education relates to number of years in formal education of household head (not necessarily husband).

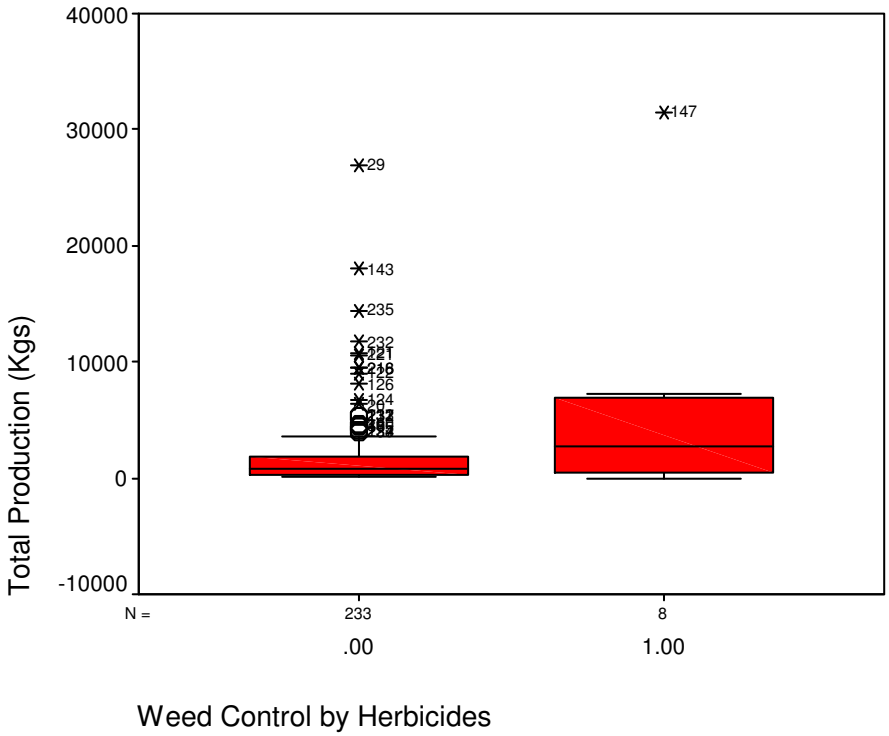
Differences in Farm Incomes



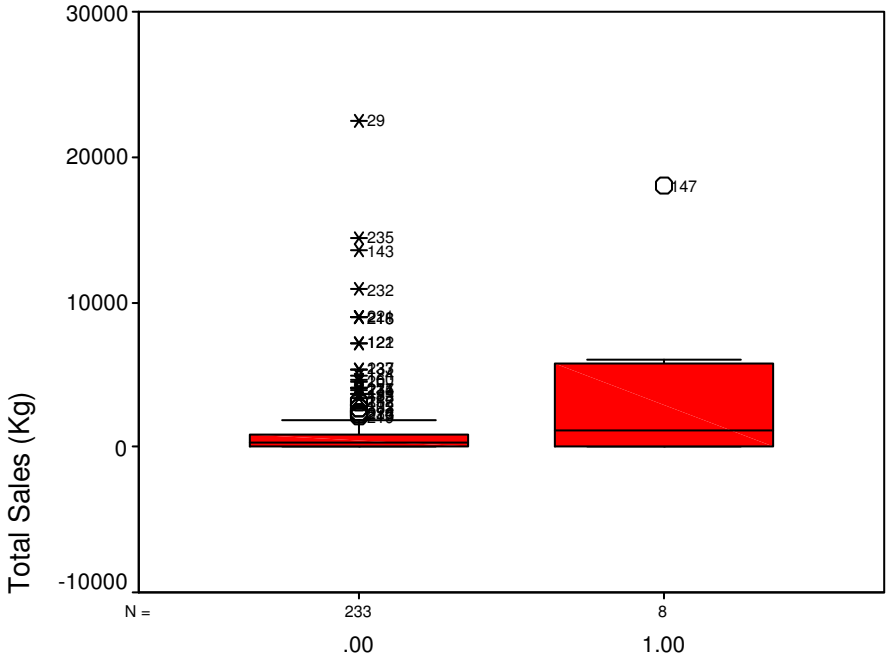
Total Acres Cultivates by Households



Household Production of Maize

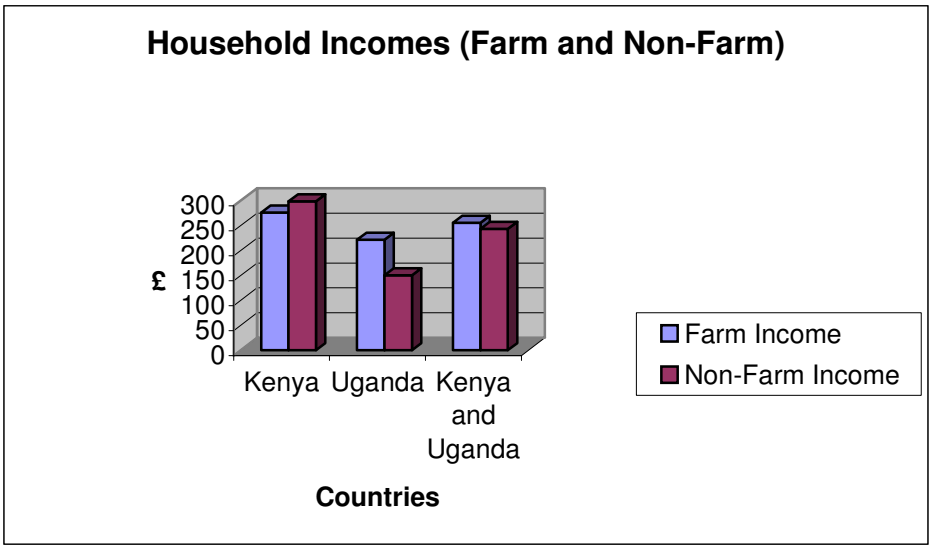


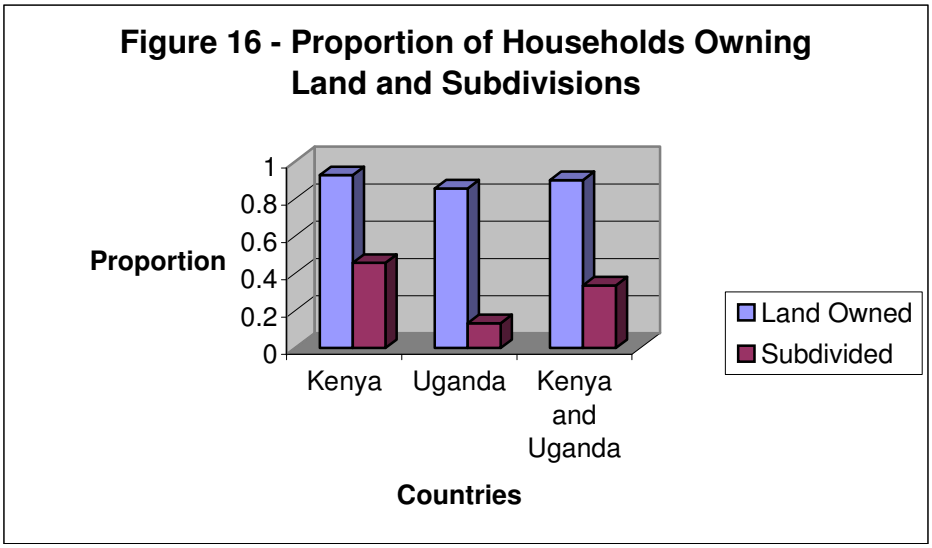
Household Sales of Maize



Appendix 3 – Indicators of Household Vulnerability

This appendix provides information on household vulnerability relating to household incomes relating to incomes, land issues and dependency ratios. Most is presented in the form of bar charts; the appendix concludes with some of the regression analyses – which are initial indications and are the subject of further work.





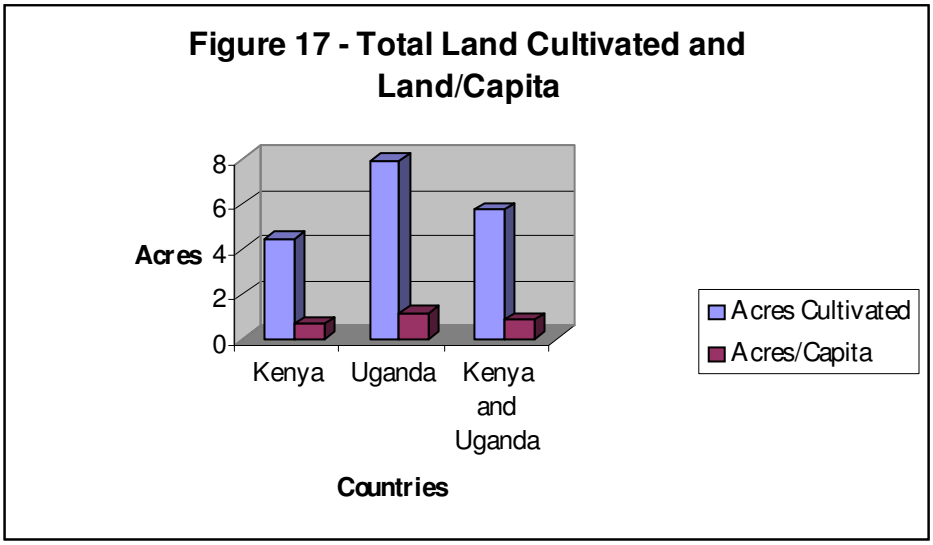
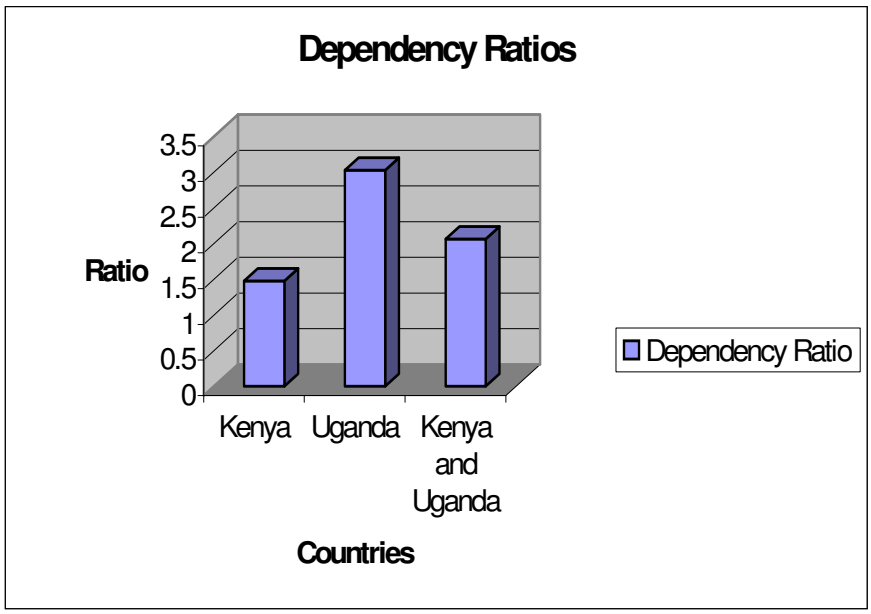


Figure 17 - Total Land Cultivated and Land/Capita
Acres
8
6
4
2
0
Kenya
Uganda
Kenya and Uganda
Countries
Acres Cultivated
Acres/Capita


Dependency Ratios
Ratio
3.5
3
2.5
2
1.5
1
0.5
0
Kenya
Uganda
Kenya and Uganda
Countries
Dependency Ratio

Regression Equations Determinants of Income

1: Importance of Different Income Streams

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	1.794	1.279		1.402	.162	-.727	4.314
	MaleFY£Equ	1.000	.003	.479	351.709	.000	.994	1.006
	FemaleFY£Equi	1.000	.008	.183	130.900	.000	.985	1.015
	Joint FY£EQU	.997	.008	.158	121.886	.000	.981	1.013
	MaleNFRE£EQ	.999	.002	.604	444.756	.000	.995	1.004
	FEMALE NFRE£	.999	.005	.285	204.658	.000	.989	1.008
	JOINTNFRE£EQ	.999	.008	.168	130.052	.000	.984	1.014

a. Dependent Variable: £ Equivalent

R2= 1, n=240
Dependent Variable = Total Household Income (£)
'Independent Variables':
MaleFY£Equ = male derived farm income (£)
FemaleFY£Equi = female derived farm income (£)
JointFY£EQU= jointly derived farm income (£)
MaleNFRE£EQ = male derived non-farm income (£)
FemaleNFRE£ = female derived non-farm income (£)
JointNFREREQ = jointly derived non-farm income (£)

The regression equation presented above represents a tautology and cannot therefore be interpreted as a normal OLS curve. It is presented entirely to give an indication of the relative importance of different income streams in the household. It indicates the dominance of male income streams (both farm and non-farm sources) and the effective separation of income streams by gender – with much smaller female derived flows.