A workshop on `The longitudinal impact of HIV/AIDS on agriculture and rural livelihoods in Uganda’

13\textsuperscript{th}/14\textsuperscript{th} April 2011, Mukono, Uganda

Proceedings
Acknowledgements
We are grateful to the FAO (Uganda) for supporting this workshop. We are particularly grateful to Ms Beatrice Okello of FAO (Uganda) for her advice, help and support.

We thank SIDA, through FAO, the Economic and Social Research Council (Res 189-25-0013) and the Medical Research Council (both of the UK Government) for funding our research.

We thank Diane Mugamba and Edward Ssennyongo for their help in arranging the workshop.

The photograph on the front cover is from the MRC/UVRI research site and was taken by Dermot Maher.
Introduction

The purpose of this workshop was to bring together researchers, policy makers and development implementers engaged in or interested in work on the longitudinal impact of HIV, and related areas, to share findings and discuss policy implications of recent research.

In these proceedings we provide a summary of the workshop presentations, which on the first day included introductions to the present status of the HIV epidemic in Uganda and agricultural systems in southern Uganda. The next session provided an overview of the research findings from a Food and Agriculture Organisation of the United Nations and Economic and Social Research Council/Medical Research Council (UK Government) supported study which looked at the impact of the HIV epidemic on agriculture in southern Uganda. The second day focused on food storage and emerging research on the impact of food storage on human health, looking specifically at the potential effects of mycotoxins on susceptibility to HIV infection and disease progression. The workshop concluded with working groups which in their feedback set out priorities for future research and policy. The workshop programme is given in annex 1, a list of participants in annex 2.
Wednesday 13th April 2011

Introductory sessions

Mr. Musa Bungudu, Country Coordinator, UNAIDS, Uganda

HIV has brought many changes in people’s lives and coping with the impact continued to be very difficult for many. In Uganda 1.2 million people out of a population of 32 million are infected with the virus. Despite the knowledge we have of how to prevent mother to child transmission 30,000 babies infected. We need to think about their future. We need to be morally responsible and take action on this.

Current information tells us that married people and those with multiple partners are at a high risk of acquiring the virus. In 2009, 123,000 new infections were recorded in Uganda. We need to use our knowledge effectively to address this epidemic and provide better services to people who are affected.

How do we get both the political leaders and health and other professionals to get involved in helping to address the pandemic? HIV incidence had been decreasing in the country, but now it seems to be rising. We have got money to address the epidemic but we are not using it convincingly, why? There are challenges in administration and support, we need to support the integration of health services as the community level so that people are given better access.

Preventive methods like male circumcision, Prevention of Mother to Child Transmission and the use of condoms need to be more actively promoted, being careful to ensure that people do not believe that circumcision or condoms provide a licence to have multiple partners! Nor should people see the existence of anti-retroviral therapy as a reason to stop worrying about HIV-infection. We need to take action now so as to stop the spread of HIV. If we don’t take action the trend in infections may continue to go up, and we will continue to face challenges in mitigating the impact of the epidemic.

In keeping with the theme of this workshop, it is important to consider the vital role that those working in agricultural extension, and other rural development services (like microfinance), can play in spreading prevention messages. We need to work with such workers to ensure they understand simple HIV prevention messages and share them with those they work with throughout Uganda.
Mr. Charles Owach, Deputy Country Representative, Food and Agriculture Organisation of the United Nations

There are very real concerns about the impact of HIV and AIDS on labour productivity in the country and subsequent reduction in agricultural output. The FAO pledges their continued commitment to efforts to mitigate the impact of the epidemic and inform policy in this area. The FAO in Uganda has five key areas of support (formulated with the participation of government, other UN agencies, civil society and development partners) which they plan to address in the next five years:

1. Policy and strategy support and implementation

2. Agricultural productivity and production enhancement

3. Improvements in market access and value addition

4. Provision of agricultural information, knowledge and education

5. Improvements in natural resource management

The FAO continues to support capacity development in the Districts and Sub County level planning, especially integration of food and nutrition and HIV/AIDS in district development plans of selected districts. There will be a continued exchange of ideas to develop more areas of support to deal with the harsh reality of the effects of the HIV epidemic. There is also a need for continued research in this important area to inform policy formulation and implementation.
The background to agriculture in southern Uganda

Piet van Asten (International Institute of Tropical Agriculture) -- Current and future drivers of agricultural systems in Uganda: scenarios for some major food and cash crops

... and why people choose to farm

People farm because they need food of sufficient quality and quantity for food security, but they also farm to get income: to buy food; basic daily goods; cover medical costs; buy somewhere to live, transport etc; buy land and water; send children to school; and cover the expenses of events like weddings and burials.

There are particular drivers of change in Uganda which are affecting farming.

Firstly, population growth is leading to a decrease in farm size and reduced time for fallowing land, which affects soil fertility. The population is expected to triple by 2050 and all those people will need to be fed.

The attraction of urban life draws migrants away from agricultural labour. Education also increases aspirations and may encourage people to look at other options rather than make a living from agriculture.

Infrastructure and policy also drive change. Better roads and markets increase opportunities for farming as do improved regulation and business support for farming, better schools and medical care can improve people's lives.

There are economic drivers that can have both positive and negative effects on agricultural growth. Rising commodity prices and fuel prices may make farming more expensive even though labour costs remain relatively cheap.
Meanwhile climate change is affecting temperature and making rainfall less reliable (even though the overall amount may be increasing).

There is a popular belief that Uganda is blessed with fertile soils that is, unfortunately, not so. The soils are Ferralsols and Acrisols which are poor and depend on organic matter for management. While the Rwenzoris and similar volcanic areas have young soils with bigger nutrient reserves this is not the case for the majority of the country with soil fertility declining as you move away from the Albertine rift.

Despite having these poor soils, Uganda ranks as one of the highest non fertilizer users in the world. There is virtually no fertilizer use (<5%), relatively little access to mulch or grazing land and land is not being fertilized by livestock because of increased zero-grazing, and ironically increased use of pit-latrines which means people do not defecate on their farm land.

Agricultural intensification is required to cope with increasing demands for food, but this means that something needs to be done to improve soil fertility. However, the price and availability of fertiliser as well as labour constraints make intensification difficult.

Increasing oil prices are playing their part. The price of oil is currently climbing back to the 2008 peak. This affects returns to fertiliser investment. Fertilizer use on bananas, for example, is very profitable near to the Kampala market, but not as you move further away.

![Chart showing agricultural yields and net benefits](chart.png)

The farm gate price for matooke drops by a third for every 100km you have to transport it.

There is some good news for farmers. Coffee prices are reaching record highs after a low in the late 1990s and early 2000s. However, can this last? Coffee is very sensitive to
temperature. Even a small rise in temperature can have an impact on crop physiology and pests and diseases.

Temperatures in this region are predicted to increase by 2-4 degrees in the coming decades while annual rainfall is expected to go up, but will have a less reliable distribution.

Banana pests and diseases are also temperature dependent.

![Graph showing relationship between weevil damage and altitude]

Major banana pests such as weevil and nematode (*R. Similis*) increase when grown at >1300m because of the higher temperature. As temperatures rise in Uganda because of climate change, areas affected by such pests will include some of the areas at high altitudes where banana production is currently doing very well.

What is the way forward?

**We need to consider some of the trends**

Smaller farm sizes require intensification if Uganda is to increase yields to feed its population – everyone, including the urban poor need cheap food. This will require the smart use of inputs and crop choice. People will may need to grow more for market to be able to afford inputs, unless they have alternative sources of finance. Will farmers’ cooperatives increase to help individuals get access credit and input/output markets?

Uganda probably needs to reshape it agricultural landscape with different food stuffs being grown closer to the market, to overcome the problem of high transport costs. There is a need to professionalize the agricultural product value chains – appropriate legislation will need to be put in place to support this. Perhaps people can adapt to climate change by increasing production of crops which like warmer temperatures and can cope with erratic rainfall. We are already seeing this with the increase in palm oil. This will affect access to food unless pest management and input use can improve so that people can continue to grow the staples.
Better use needs to be made of Uganda's comparative advantages, including the knowledge we have about how to improve yields.

![Figure 1: The total yield value of intercropped fields was much higher than monocropped coffee or banana in farmer control fields](image)

There are other issues which farmers will have to increasingly deal with:

The threat of mycotoxins which will affect internal and export markets, as will the increasing demand for certification of good practices (UTZ, 4C, etc.) in order to sell products on the international market. This could affect the sale of crops in the rest of East Africa, not just to Europe and Asia.

Some food crop scenarios for the future that might be considered:

BANANAS -- move to intensified production in peri-urban areas and accept the relative decline in importance in more remote areas. Pests and diseases need to be addressed.

CASSAVA -- becomes increasingly important in the rural areas as soil fertility declines and food security concerns increase.

MAIZE -- commercially oriented farmers will benefit from regional/global market demand for maize, but mycotoxins are challenge.

SWEET POTATO – will remain an important food security crop, but marketing and processing opportunities are limited because it is a bulky crop to transport.

SORGHUM and MILLET – are likely to become increasingly important in drought sensitive areas.

LEGUMES – will also become increasingly important throughout Uganda. They have an important role in nitrogen-fixing, so are good for the soil and people. Soybean in particular may have interesting prospects as a food crop.
COFFEE -- increasingly important export product but the threat of climate change is important. Need for improved certification to secure export markets.

OIL CROPS -- increasing demand – low transport costs. Sunflower can be grown by smallholders while large companies grow palm oil.

COTTON – viable in low population areas (Northern Uganda) where mechanisation is possible

SUGAR CANE -- remains important. Smallholders can participate where large-scale processing is available.

Overall, we may conclude that intensification of Uganda’s agricultural production will be required to feed the rapidly growing urban and rural population. Intensification opportunities vary across regions, with perishable and costly to transport products will need to be cultivated near the market, and high value, cheap to transport, and labour intensive crops (e.g. oil crops, coffee) will be important for the remote rural areas. The question will ultimately not be if intensification will take place, but where, how, and by whom. Disadvantaged families with low resource endowment will be the last to adopt intensification technologies and will continue to increasingly rely on production of food security crops (cassava, sweet potato) for their own use.

Discussion
Qn. While fertiliser may have benefits, what do we do about the excess use of fertilizers, pesticides and fungicides?

Ans. There is undoubtedly a great need for communication on correct usage. There is an urgent need, to sensitise people to the dangers of excess use and the other reasons why yields may be decreasing (climate change, for example). We have to go for small and targeted doses that are not only good for the (human) environment, but also for the economic efficiency.

Qn. What is the future for those areas with sandy soils, what guidance would be given to them? We rely on rain and little investment is made in irrigation.

Ans: Irrigation may only be economically viable for some limited regions and crops. Otherwise, people will have to think about their crop choice. For example, maize is very drought sensitive, but sorghum, millet or cassava can still produce reasonable yields when rains become less reliable.

Comment: There may be constraints but there are also emerging opportunities. COMESA is giving new market opportunities to our farmers. We need to work to attract investment in agriculture

Comments: we need to think carefully about population growth and the impact on our resources. How can we advise policy makers on this? How do we entice farmers to stay on the
land? It is a challenge to change people’s attitudes, when they see development as lying in the urban environments.
The longitudinal impact of HIV and AIDS on rural livelihoods in East Africa – study findings

Janet Seeley (MRC/UVRI) The longitudinal impact of HIV and AIDS on agriculture and rural livelihoods in Uganda: an introduction

The impact of HIV on agricultural production, a core part of rural livelihoods in much of Africa, has long been debated. De Waal and Whiteside (2003), for example, suggest that the epidemic has led to ‘new variant famine’ in southern Africa because the burden of mortality and morbidity has reduced the viability of farming households, threatening householders ability to manage food security stresses at times of drought. Barnett and Blaikie (1992) suggested that over a ten year period in the 1980s there had been a steady decline in the quantity and quality of agricultural production for affected households. Recent studies on the economic impact in Africa (Veenstra and Whiteside 2005, Dixon et al. 2002) provide commentary on the effects of the epidemic on economies at both national and local levels. There is evidence that HIV has slowed development and thrown some households into poverty southern Uganda and northwestern Tanzania (Seeley et al 2010a), a conclusion corroborated by the work of Bachmann and Booysen in South Africa (2003).

It is often assumed that there is a direct linear connection between AIDS-related illnesses and the loss of household labour, resulting in reduced area of land cropped which causes a fall in crop production giving rise to food insecurity. HIV is seen as the primary causal factor leading to this food insecurity.

The findings of our recent research question this linear connection.

The overall purpose of the FAO/ESRC/MRC-supported study was to analyse the trajectories of households and communities affected by HIV and AIDS and the impact of HIV and AIDS in Uganda on agriculture and rural livelihoods over the past 20 years, in order to understand the long-term impact of the epidemic and to contribute to the design of policies and programmes for impact mitigation.

In this introduction I will provide the background to the study, my colleagues Kenneth Ekoru, Dominic Bukenya, Tom Lutalo and Josephine Namatovu will then go on to present some of the results of our study.

The research was based in two study areas: the General Population Cohort (GPC) of the MRC/UVRI Uganda Research Unit on AIDS (in Masaka District) and the Rural Community Cohort Study (RCCS) of the Rakai Health Science Programme (in Rakai District). Our data are drawn from the two cohorts and a study conducted in 2009/2010 with a subset of the GPC/RCCS populations for a study of rural livelihoods.
conducted for the Food and Agriculture Organisation (hereafter referred to as `the FAO study').

**Background to the cohort and methods**

**General Population Cohort**

The GPC study was established in 1989 in 15 rural villages (expanded to 25 villages in 2000) in a sub-county in (then) Masaka district. This is an open cohort, allowing in-migrants and children born into the cohort to join. The total population covered, with no age limit, is about 20,000 people, because people leave the area as well as join. The main objectives of the study are to describe the dynamics of HIV infection within a rural population, to identify the major risk factors for contracting HIV, to quantify the impact of HIV infection on mortality and fertility and to study treatment seeking behaviour. Every year since its inception, the GPC team has conducted annual household censuses of the resident population that collect age, sex, education, and relationship to household head among other variables, and an adult medical sero-survey of all willing residents aged 13 and above including collection of blood specimens for HIV testing and a brief behavioural questionnaire. Every four years, starting at baseline, information is collected on socio-economic status using a list of household assets. The annual surveys are well accepted by the population, with coverage of 60 – 70% of the resident population in any given year. The cohort is currently funded by the Medical Research Council of the UK Government.

The Rakai Health Sciences Programme, initiated in 1987 in Rakai District south western Uganda, is a collaboration between the Ministry of Health through the Uganda Virus Research Institute and researchers at Makerere and the Johns Hopkins Universities. The core of the Rakai Programme has been the Rakai Community Cohort Study (RCCS). The current 50 village cohort was established in 1994/5 based on an earlier smaller cohort. All participants are followed annually in their respective homes, at which time they provide survey information (demographics, education, current and past sexual behaviours and STI history) and biological samples for detection of HIV, STDs and other infections. This is an open cohort of adults aged 15-49 years, which enrols new in-migrants and newly age-eligible residents at each annual survey visit. The open cohort structure maintains the number of participants under surveillance at between 12,000 and 16,000 annually. During each annual visit household information (for both new and old households) is collected. This consists of location of household, members within each household (includes movement if any or death of members), relationship to head of household, household characteristics and possessions, sources of water and animals being reared. Funding was received from National Institutes of Health (US Government) and currently from the Bill and Melinda Gates Foundation to continue with the cohort. To support the biomedical research efforts, the Programme established a full-time social science team which conducts qualitative research via focus groups and in depth
interviews, in order to facilitate the planning, conduct and interpretation of the Programme studies. Using these descriptive epidemiologic, behavioural and qualitative studies, the Rakai Programme documents the epidemic and elucidates risk factors and patterns of heterosexual transmission in this part of the country.

While the data collected by the two cohorts are similar, there are two important differences between the GPC and the RCCS. The GPC is concentrated in one sub-county of Masaka District, working in contiguous villages, while the RCCS study communities were selected to represent different parts of the District, so are scattered across the area. Secondly, the GPC includes all age groups, from infants to the very old. The RCCS focuses data collection on the age group 15-49 years.

**FAO study**

The overall purpose of the FAO study was to analyze the trajectories of households and communities affected by HIV and AIDS and the impact of HIV and AIDS in Uganda on agriculture and rural livelihoods for the past 20 years, in order to understand the long-term impact of the epidemic and to contribute to the design of policies and programmes for impact mitigation.

A stratified random sample of 300 households was selected from the GPC and RCCS (200 from the GPC and 100 from the RCCS). The sample was stratified by HIV-infection. An ‘HIV-affected household’ was defined as where at least one previously HIV-positive adult had died. This definition was used because people living with HIV can be healthy for some considerable amount of time. An asymptomatic HIV-infected person who was not suffering from AIDS-related illness would be expected to carry on with his or her livelihood activities, and we would not expect to see any direct effect of HIV-infection on their household. The GPC households were chosen from villages close to main trading centres and more remote locations, those in the RCCS from two different areas in the District (so called ‘super clusters’, in the RCCS, which consist of clusters of study villages).

A sub-sample of 10 percent of the GPC households was selected for in-depth qualitative data collection. These households were purposively sampled to represent HIV-affected households and those that have not had anyone living with HIV in the household over the 20 year period. The households were chosen from villages close to main trading centres and more remote locations. In the RCCS in-depth interviews were undertaken with members of 15 households purposively selected from the sample of 100 to represent different types of household. Two to three visits were carried out with these households over the course of one month to build up a picture of their livelihood activities.

In the quantitative part of the study, with the 300 households, study information was collected at the individual and household level. Informed consent for data collection
was sought after detailed information about the study has been shared with potential and willing participants. Semi-structured interviews using a brief questionnaire and a household calendar to collect retrospective data on agricultural livelihoods was used with the household members. Information was collected on both individual/household level changes (through the tool) and community-wide issues (through brief discussion with informants) that may have affected livelihoods. Detailed information on cropping patterns and food security in households over the last 5 years (2003-2008/9) was collected. Then, in order to collect more general retrospective information (recognizing the limitations of recall for collecting data on events more than a few years ago) a household event calendar was used to collect information from as far back as household members could remember or have records for what may be the baseline year (1989/1990 or when the household joined the cohort) for major events (such as significant crop losses or the introduction of new varieties). Information was also collected on household membership changes and illness events in order to triangulate these data with the GPC information.

One ‘problem’ with our study and our analysis is the focus on the household as the unit of analysis: most households had links to family and neighbours who provided support. HIV affected and non-affected households may not be so different in terms of their agriculture-based livelihoods.

**Background to rural livelihoods in the study areas**

The people living in the study areas have been mainly subsistence farmers. The land is largely fertile. Agriculture is primarily rain fed and therefore agricultural production is subject to the effects of periods of dry weather, which is a major constraint to agriculture in the area (particularly for banana and maize production). The majority of the population is ethnically Baganda, but there is a large representation of immigrants from Rwanda. There are also some in-migrants from Tanzania and other parts of Uganda. The main local language is Luganda which is spoken and understood by all the tribes.

The area experienced a considerable amount of unrest in the years prior to 1986, when President Museveni took power. Masaka town, which is 20 km from the study area, was largely destroyed in the Uganda-Tanzania war in 1979 and again in 1981. Civil conflict during the 1970s and 1980s undoubtedly affected people’s lives, and many people in the study areas tell stories of taking refuge in more remote villages away from troop movement and fighting. Given the role of rainfed agriculture in the District, prolonged dry spells as well as pests and diseases have also been an important influence on people’s farming. In 1992 a particularly dry year caused severe food shortages, a pattern that was repeated again in 2009, when the rainfall was again sparse.

This area of Uganda has a rich cropping system with seven core crops, perennial, semi-perennial and annual, that are cultivated over two cropping seasons that run into each
other. This is inherently a relatively secure cropping system in an area of relatively reliable rainfall given the buffering effects of this diversity against specific crop failure and the fact that longer term food crops (such as banana and cassava) provide against shorter term crop failure of maize or beans, for example. It is significant that this is not a farming system where crop storage has been traditionally practiced.

As outlined in Piet Van Asten’s presentation, a number of different factors have affected agricultural systems in the area, summarised in the tabled below (page 18).

You can see that coffee, reportedly the least labour demanding of crops has over the last two decades or more experienced a significant rise and fall in production, a rise driven upwards by price increases and downwards by price decreases and the effects of disease. More recent price rises have not apparently offset the effects of coffee wilt. In contrast cassava has steadily increased in area although yields may be falling due to disease effects.

Another crop that has seen a long term rise in area and production is maize which with a relatively short growing season fits well into both cropping seasons, potentially increasing calories output per unit area over banana, has a good market and is also said to be less labour intensive than banana. The other major food crop of the system, banana, although remaining culturally significant and still an important food source over the last two decades has been in decline both in area and yield. Whether this is because expanding maize production is pushing it out or because of disease, is unclear but banana is seen to be a more labour demanding crop than maize, not least for its pest management in recent years.
Table 1: Long Term trends in crop area and production and potential drivers of these

<table>
<thead>
<tr>
<th>Crop ranked by increasing labour needs (less to more)</th>
<th>Prices</th>
<th>Pests</th>
<th>Changes in area/production</th>
<th>Drivers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1995-2001 ↓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2002-2010 ↑</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2005-2008 ↑</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2009 ↑ ↑ (because of food shortages)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2000-2010 ↑</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Key: ↑ = increase; ↑↑ significant increase; ↓ = decline; → = no major change
In summary the major crops of the study areas cropping system have been undergoing long term changes in terms of their contribution (in area, production and function) to the cropping system, as we have described elsewhere (Taylor et al. 2010).

**What have been the lasting effects of HIV?**

The 1918 influenza epidemic, like HIV, primarily affected young adults aged 15-44 years old. Discussion on the economic impact of that epidemic generally concludes that while the death toll exacted was one of the highest ever recorded during a health crisis in world history, there was little long-term impact on growth and, indeed, in some places growth accelerated in the immediate aftermath (Brainerd and Siegler 2003). James and Sargent (2006) offer an explanation for the lack of economic impact of the 1918 influenza pandemic, arguing that such an epidemic rather than stopping people from going about their daily work people `engage in strategies that effectively manage fear and avoid becoming paralysed by it’ (p. 61).

We looked at the data from the FAO study for the 100 HIV-affected households in the GPC sample, and found the same trend. Not only did cultivation begin to pick up ten years after the death but it continued to increase beyond the area cultivated prior to the decline due to sickness.

**Average land cultivated before and after an HIV-related death**
There could be many explanations for this. One of the most likely could be that relatives have taken over the land after the death and begun to cultivate it once more; a similar pattern might be likely were one to plot the impact of the death of a person over 70 years old on land for which they were the main farmer. Or, perhaps, the resident household members may have simply got older and become able to tend the land, or able to afford labourers to do so, thereby increasing their cultivated area.

**Conclusion**

We do not wish to suggest that HIV at the individual household and family level has not had a serious effect. Indeed HIV has undoubtedly had a devastating impact on many households and families and one should not belittle the losses that have occurred. But the effects of scale that have been predicted for HIV on household structures and agricultural livelihoods are not supported by the data from this particular context, as the presentations which follow will show.
Kenneth Ekoru (MRC/UVRI) -- What has been the impact of HIV and AIDS on agricultural labour availability?

Introduction

This presentation consists of two parts. In the first part as background we present the conceptual framework of how HIV/AIDS was expected to impact on society, and the predictions and projections of labour force changes which were made in the early years of the epidemic and the assumptions upon which these projections were based.

The second part provides an overview of the trends of HIV prevalence and incidence in the GPC research area in Masaka. Results from analysis of our data from are then presented to see if the assumptions and predictions made about the impact of HIV/AIDS on labour availability have been correct for this population. Possible explanations of the observations are then suggested.

Background

Figure 1: Structural channels of HIV/AIDS impact

This figure provides a conceptual framework of the main structural channels that the impact of HIV/AIDS was thought to follow affecting all levels of society. It shows how the twin intermediate impacts of HIV infections - AIDS morbidity and mortality feed through at a micro-level (firm, household, sector and labour) to the macro-level.

Impact on labour supply

Early studies painted a gloomy picture for labour availability. For example Gillespie in 1989 cautioned that AIDS would significantly reduce the availability of labour because of high morbidity and mortality, not only among adults but also among children. A study by the Uganda Ministry of Agriculture, Animal Industry and Fisheries in 2002 concluded that agriculture was threatened by changes in family structure resulting from increased death of able bodied people due to AIDS.
Barnett and Blaikie (1992) described this impact on family structure and labour availability for agriculture, based on their observations in Rakai District. They described the impact of HIV on a couple and their five children as gradually over a period of ten years they went from being a prosperous farming household to poverty, as the adults die and the children left alone struggle to cultivate the land.

When we look elsewhere in Africa we find that for South Africa as study in 2001 predicted that the size of the labour force would be 20% less than it would otherwise be without AIDS in 2015. In fact the size of the labour force in 2015 would be less than what it was in 2000. This is shown in Table 1.

Table 1: Projected changes in the size of the labour force (millions), 2000-2015 (South Africa)

<table>
<thead>
<tr>
<th>Year</th>
<th>No AIDS scenario</th>
<th>AIDS scenario</th>
<th>Difference (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>14.5</td>
<td>14.4</td>
<td>-0.7</td>
</tr>
<tr>
<td>2005</td>
<td>15.8</td>
<td>15.1</td>
<td>-4</td>
</tr>
<tr>
<td>2010</td>
<td>17.2</td>
<td>15.1</td>
<td>-12</td>
</tr>
<tr>
<td>2015</td>
<td>18.7</td>
<td>14.1</td>
<td>-21</td>
</tr>
</tbody>
</table>


Assumptions and mechanisms through which HIV affects labour supply

It is well established that in the absence of HIV in developing countries, mortality is concentrated among the very young and very old while HIV-related deaths are primarily among adults aged 15-50 years old.

1. Thus it was assumed that by shifting the usual pattern of deaths HIV would distort and alter the population age structure.
2. Secondly it would reduce the life expectancy as more people die younger.
3. As more people in the working age group die, the already high dependency ratio would rise further.
4. More women would have to take over headship of households as more male household heads die.
5. As more children are orphaned the incidence of fostering would rise increasing the burden of child care on labour force.

It is these assumptions that we test using our empirical data from southern Uganda

The setting

These findings are taken from the General Population Cohort study (GPC), described above in the previous presentation. The cohort was set up in 1989 covering 15 villages
of a sub county in Masaka District. The main objective was to describe the epidemiology and dynamics of the HIV epidemic in rural Uganda. The initial population was about 10,000 people but it was expanded in 2000 to cover 25 villages, raising the population to about 20,000 people.

Every year since its inception, a household census and a medical survey of all willing residents aged 13 and above have been conducted which include collection of blood specimens for HIV testing and a brief behavioural questionnaire.

**Figure 4: HIV prevalence in the GPC cohort**

This graph shows the trend in HIV prevalence in the GPC study over a 20 year period. HIV prevalence steadily dropped from over 8% in 1990 to below 6% around 2004 (about the time ART was introduced). From then on there was a rise and in 2010 HIV prevalence in the study area was about 7% which is similar to the current national prevalence. The drop in the prevalence between 1990 and 2004 is attributed to the national response by the Uganda government and other partners mainly through Information, Education and Communication (IEC). The rise from 2004 onwards is attributed to the introduction of Antiretroviral Therapy (ART) which allows HIV-infected people live longer.

HIV incidence rate has on the other hand shown a less clear pattern (not presented here) – it has taken a wavy path, rising and falling sometimes sharply from year to year. Between 1990 and 2010 it has ranged from 0.2 to 0.9 per 100 person years. In 2008 the incidence rate in this population was 0.7 per 100 person years which is also similar to the national incidence rate for that year.
Evidence from the General Population Cohort

This starts the presentation of the results of the analysis of GPC data to see if the assumptions made about the impact of HIV/AIDS on labour availability have held true in this population.

Table 2: GPC Population distribution by age and sex

<table>
<thead>
<tr>
<th>Year</th>
<th>Age (Years)</th>
<th>Males</th>
<th>Females</th>
<th>Total (Column %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>0-5</td>
<td>1262</td>
<td>1232</td>
<td>2494(24)</td>
</tr>
<tr>
<td></td>
<td>6-14</td>
<td>1467</td>
<td>1510</td>
<td>2977(29)</td>
</tr>
<tr>
<td></td>
<td>15-64</td>
<td>2137</td>
<td>2272</td>
<td>4409(43)</td>
</tr>
<tr>
<td></td>
<td>65+</td>
<td>216</td>
<td>199</td>
<td>415(4)</td>
</tr>
<tr>
<td>1997</td>
<td>0-5</td>
<td>1134</td>
<td>1160</td>
<td>2294(22)</td>
</tr>
<tr>
<td></td>
<td>6-14</td>
<td>1716</td>
<td>1590</td>
<td>3306(31)</td>
</tr>
<tr>
<td></td>
<td>15-64</td>
<td>2196</td>
<td>2396</td>
<td>4592(43)</td>
</tr>
<tr>
<td></td>
<td>65+</td>
<td>234</td>
<td>217</td>
<td>451(4)</td>
</tr>
<tr>
<td>2008</td>
<td>0-5</td>
<td>1940</td>
<td>1953</td>
<td>3893(21)</td>
</tr>
<tr>
<td></td>
<td>6-14</td>
<td>2901</td>
<td>2818</td>
<td>5719(31)</td>
</tr>
<tr>
<td></td>
<td>15-64</td>
<td>3830</td>
<td>4380</td>
<td>8210(44)</td>
</tr>
<tr>
<td></td>
<td>65+</td>
<td>406</td>
<td>455</td>
<td>861(4)</td>
</tr>
</tbody>
</table>

Table 2 shows the population distribution of the GPC by sex and age. It shows that more than 50% of the population is under 15 years at all the time points. Secondly there is little difference in distribution by sex in the different age groups in all periods except among the 15-64 year age group in 2008 when there were more females. In addition, across time the proportion of each age group has remained more or less the same.

In particular there is no evidence to suggest the size of the labour force has reduced over 20 years of the HIV epidemic.

The age pyramids below show the same data for two time periods, 1990 and 2008.
In addition to what was shown in the Table 2, we can see missing members of the population among those aged 20-24. This could be due to labour migration and AIDS related deaths. In 2008, a sizable portion of the age group 20-24 is missing. However, the population age structure in the two time periods 1990 and 2008 is similar showing no evidence of increased impact of HIV/AIDS across time.

We now look at the dependency ratio. The dependency ratio is defined as the ratio of the total young people aged less than 15 years and those aged 65 and older, to those in the age group 15-64 years. This statistic indicates the relative importance of those in the “dependent” ages to those in the so-called “productive” ages.
Figure 7 traces the dependency ratio yearly from 1991 to 2008. It shows that dependency ratio reduced from 133 in 1991 to 128 in 2008. This is contrary to the assumption that HIV/AIDS would raise the dependency ratio.

**Figure 8: Proportion of female headed households**

![Graph showing trends in proportion of female headed households](image)

Figure 8 shows the trends in the proportion of female headed households over a period of 17 years (1992-2008).

It shows that the proportion of female headed households had increased in both HIV-affected (where an HIV death occurred) and HIV-unaffected households from about 26 percent in both the 133 HIV-affected and 1,692 HIV-unaffected households in 1992 to 42 percent in HIV-affected households and 32 percent in HIV unaffected households in 2008. There were 372 HIV-affected and 3,205 HIV-unaffected households in 2008.

This difference in the proportion of female headed households between HIV-affected and HIV-unaffected households in 2008 was statistically significant. Overall the proportion of households headed by women rose to 33 percent of all households in 2008.
Figure 9 shows the average number of children fostered per household. In HIV-affected households the average number of children fostered-in has been fairly stable over time at about 2.4 children per household although it is beginning to show a decline. For HIV-unaffected households the average number of children fostered-in fell from 3.4 in 1991-1995 to 2.3 in 2001, and has since 2002 stabilized at about 2.4 children per household. The overall trend of the average number of children fostered-in is not very clear but it is certainly not rising. In fact from 2006 onwards it has tended to decline.

**Discussion**

In the last two figures an attempt was made to categorize households into HIV-affected (where an HIV death occurred) and HIV-unaffected (where no HIV death occurred). This attempt to categorize households in this way proved problematic, because each household was not an isolated unit. A household which did not appear to experience an AIDS-related death, for example may have been profoundly influenced by the death of a relative in another household if that person had been providing support. People may have moved into an 'unaffected' households from an HIV-affected household. One could argue that such a household was –even if indirectly – bearing the impacts of HIV/AIDS. It should be pointed out this phenomenon could serve to make worse the welfare of the household members or improve it depending on whether those moving in from the affected household added or drained the pool of resources. This problem of definition may have distorted the impact of HIV on households and blurred the comparisons we sought to make.

Secondly, the movement of an already HIV-affected household into the study area was also a challenge. Such a household would be considered HIV-unaffected because the HIV-death or indeed any death occurring before joining the study area would not have been recorded in the GPC study. This could potentially distort and blur the comparisons between affected and unaffected households.

Bearing those challenges in mind, our results show no evidence of the impact of HIV/AIDS with regard to the assumptions that HIV/AIDS would distort the population structure and raise the dependency ratio.
The unchanged population structure especially the static size of the 15-64 year old age group might be explained by population momentum, whereby the additional mortality due to AIDS among adults is not noticeable because the loss is compensated for by people in younger age groups, of which there were many, graduating and becoming adults.

On the other hand the reducing dependency ratio observed in the GPC might be explained by reduction fertility (although this does not appear to have been very great), so that the additional loss of people in the working age group due to AIDS is more than compensated by the reduction in the population of dependants brought about by reduction in the fertility rate.

Our results also show evidence of an increasing proportion of female headed households. This may be explained in part by early deaths of male household heads. However, we know that HIV is not alone in causing a reduction in male household heads, given women are infected too. This trend is affected by other factors such as labour migration and unstable relationships.

Our results also found no evidence to support the assumption that HIV/AIDS would escalate the problem of fostering in this population. The explanation may be that orphaned children are taken care of in their own households or that HIV affected households receive help from various sources which has meant that they are able to look after orphaned children.

**To summarise:**

There is no evidence of the impact of HIV on labour availability of the scale that had been predicted at onset of the epidemic.

Development policy premised on the presumed impact of HIV on demographic structures needs to be reconsidered.

HIV epidemic is one among many other factors, including labour migration, that are affecting population structures in rural Uganda.
Southwestern Uganda and the adjacent areas were commonly referred to as the epicentre of the African HIV/AIDS epidemic. During the mid 1980s and early 1990s, HIV/AIDS related illness, death and cost of care provision were predicted to eventually cause household food insecurity. Food insecurity was predicted to occur through labour losses and the cost of health care provision that would reduce the household capacity to hire labour. In order to cope with food insecurity, households were expected to alter their cropping and livestock rearing patterns. A shift to less labour intensive crops/livestock was too predicted to occur.

We explored these predicted effects through our longitudinal study of cropping and livestock rearing patterns in this part of Uganda. This presentation focuses on the data from the General Population Cohort of the MRC/UVRI Uganda Research Unit on AIDS.

You will recall that our sample was made up of 200 households. However, initially a random sample of 400 households was selected. This sample was equally distributed into HIV affected and non affected households. The extra 200 households provided us with households to replace dissolved, out migrated, refusals and those too sick to participate. When replacements were made, like was replaced by like: HIV affected households replaced HIV affected households and non-affected with other non-affected households.¹

We had to replace 116 households. We had expected most of the replacements to be in HIV-affected households and had been concerned that this would bias our sample, but as the table below shows this was not the case with almost equal numbers of replacements being made in affected and unaffected households.

¹ HIV affected households were defined as those where an HIV-infected person had died while HIV non-affected households were where no one was known to have died of HIV.
Reasons for household replacement

<table>
<thead>
<tr>
<th>Reason</th>
<th>Number (HIV affected)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left the study area</td>
<td>29 (17)</td>
</tr>
<tr>
<td>Dissolved</td>
<td>22 (12)</td>
</tr>
<tr>
<td>Refused</td>
<td>18 (7)</td>
</tr>
<tr>
<td>Could not be traced</td>
<td>16 (10)</td>
</tr>
<tr>
<td>Recently settled/recruited in GPC</td>
<td>15 (4)</td>
</tr>
<tr>
<td>Never participated in General Population Cohort</td>
<td>1 (1)</td>
</tr>
<tr>
<td>Vacant land plot/empty house</td>
<td>6 (4)</td>
</tr>
<tr>
<td>Owned no land</td>
<td>4 (0)</td>
</tr>
<tr>
<td>Too sick</td>
<td>4 (1)</td>
</tr>
<tr>
<td>Deaf</td>
<td>1 (1)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>116 (57)</strong></td>
</tr>
</tbody>
</table>

We looked at the households’ socio economic status (based on an index developed in the context of other research from the GPC data) because we thought that a difference in socio economic status could have influenced the growing/rearing/not growing/rearing a particular crop/rearing animal. We found no association between household HIV status and SES.

We explored how much land was under use for the last 20 years before exploring what the land was actually used for. See the figure below. In 1991-2001 HIV-affected households had slightly more land under use compared to HIV non affected ones. There was evidence that over time HIV-affected households were associated with a higher acreage of land under use (t-test p=0.029) although this was not statically significant.
Average land under cultivation by household HIV status from 1991-2009

We then went on to look at the different major crops cultivated: bananas, maize, beans, cassava, sweet potato and coffee and changes in cultivation for HIV-affected and non-affected households across time. We asked about crops – the definition of ‘major’ was left up to each household but usually it meant the crop that contributed most to household livelihood security.

**Major crops 1990-2009**

Beans were consistently reported as being the major household crop grown over time while bananas emerged in the second position as the households’ major crop. Coffee and maize exhibited declining and increasing trends respectively.

We went on to ask about second and third major crop.
Second major crop from 1990-2009

Third major crop from 1990-2009

When it came to third major household crop other crops were mentioned in addition to bananas, maize, beans and coffee: sweet potatoes, cassava and groundnuts.

We then looked at crops grown by the HIV-status of the household.

Coffee growing by HIV status from 1991-2009

Coffee as a major household crop exhibited a general decline over time. The proportion of HIV unaffected households reporting coffee as a major household crop over time was
on average higher than HIV affected. However, this variation was not statistically significant (P=0.38).

**Beans growing by HIV status from 1991-2009**

The proportion of households reporting beans as a major household crop was consistently high over time. A higher proportion of HIV un-affected households consistently reported beans as a major household crop compared to those that were HIV affected but this showed no trend over time.

**Maize growing by HIV status from 1999-2009**

Proportions of households reporting maize as major household crop was similar between HIV affected and none affected households till 2003. However after 2003, a higher proportion of HIV affected households reported maize as a major household crop than HIV non affected ones and over time, this variation was statistically significant.

Livestock rearing was another land use activity. Animals reared included cattle, goats and pigs. These were reared for both subsistence and sale of products. In addition some households had other sources of income like bee keeping, bark cloth and basket/mat
making as well as fishing in swamps. Some of the more traditional livelihoods have been dying out over time as older people with the skills have died.

**Major livestock from 1990-2009**

Pigs were the major livestock kept across time.

**Second major livestock from 1990-2009**

We then looked at livestock rearing by HIV-status.

**Cattle rearing by HIV status from 1991-2009**
A statistically significant proportion of HIV unaffected households reported cattle as the major household livestock over time.

**Pig rearing by HIV status from 1991-2009**

A statistically significant proportion of HIV affected households reported pigs as the major livestock, however this decreased over time while it increased for HIV unaffected ones. There is need to treat this with caution because the numbers included in this analysis were small (44 HIV-affected households). The overall numbers keeping goats were even smaller (27 households) so we do not show the break down by HIV status for those households.

**Major poultry from 1990-2009**

Almost every household reared chickens at one point in time although this declined slightly over time. Was this decline in reporting poultry rearing associated with household HIV status? To find out this, we controlled for household HIV status against reporting chicken as the major household poultry.
A higher proportion of HIV affected households reported chicken rearing compared to HIV un-affected ones. However, this was not statistically significant over time.

**Discussion**

It seems likely that the falling and rising trends of coffee and maize growing were due to factors like crop prices, pests and diseases drought and crop preferences, although HIV/AIDS could have played a part in the changes (Hunter et al. 1993, Barnett et al. 1989, Seeley et al. 2010a, 2010b and 2008). HIV/AIDS impact has not occurred in isolation. Other factors like seasonality, crop prices, drought, population growth, rural-urban migration, pests and diseases, death from other causes, probably worked together with HIV/AIDS to cause the above changes. HIV-affected households could have recovered from the severe impact of HIV/AIDS over time. Alternatively, they may have got external help through former household members’ remittances and relatives/friends.
In this presentation we cover a summary of the findings from the ‘FAO study’ covering: reported land ownership and utilization, study population structure and reported occupation changes. We conclude with some observations from the survey teams.

As has already been mentioned the Rakai Community Cohort Study is in Rakai (and now neighbouring districts, because of a subdivision of the Rakai District since 1994). The District has a population of ~500,000. The cohort follows 12,000-16,000 people annually with an HIV prevalence of ~13.7% which is quite high compared to national prevalence which is estimated to be six percent.

The FAO activities were conducted in two Rakai Cohort ‘super clusters’ of Kabira and Kalisizo. These clusters were purposively selected for ease of reach and following history of interview compliance.

We used existing RCCS data to identify households with adult surviving members we have been with since 1994-95. Household heads or their designees were identified and used as entry points to these households. After informed consent each of the 104 households was visited at least two-three times with a minimum of 2-3 days between visits. We used the data collection tools and methods already described in previous presentations.

**Results**

The graph below shows land ownership by household HIV status at four time intervals. We observed that those households affected by HIV steadily had less land in acres that they owned compared to the households un affected by HIV. There was a sharp drop in land ownership in the period before antiretroviral therapy was introduced and also during the very last period covered after the introduction of ART in Rakai.

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2 Note, we aimed to recruit 100 households and had allowed for refusals/absent households in our sampling. We had over-estimated the number that might not take part and therefore had four ‘extra’. 
Land ownership by HIV status

For land under cultivation we observed that those households affected by HIV reported that they were cultivating more land than those households not affected by HIV. However this has dropped significantly during the recent study period.

Average land under cultivation by household HIV status

We wanted to explore population structure as a possible reason behind these changes. We found that there were sharp drops in population between those aged 15-19 to those aged 20-24 among men whereas for women a drop was observed between ages 10-14 and 15-19 during the last study period. However these age groups were not associated with land ownership. These changes may have affected land utilization.
With occupation we found that agriculture for home use and for selling had dropped sharply especially during the recent periods. We however noticed a sharp rise for those reported to be at school. This may affect land utilization. We found that many were reporting resorting to other occupations like tailoring and handcrafts., perhaps encouraged by the many non-governmental organizations in Rakai working with people affected by HIV.

**Reported occupation by household**

![Graph showing occupation by household (1994-2008)](image)

**Study team impressions**

While our findings on crop utilization were no different from the Masaka GPC findings, the interviewers had the impression that labour movement and occupation shifting may have affected land utilization in Rakai. Most households grew similar crops but over time have been shifting to high yielding and pest and weather resistant varieties. Thus there was an observed shift from traditional cash crops to food crops for subsistence and for selling. Many households also reported rearing animals on a small scale.
Discussion

Qn. If more females are dying, why is it that the number of females heading households is still going up?

Ans. The increase in female headed households was due to death of male, migration of a male partner and also failed relationships. Men usually remarry when they separate from a partner whereas women may not, or be slower to establish a relationship with a new partner. We cannot attribute this solely or mainly to HIV, because you are right – many women have also died.

Qn. What was the cause of the reduction in adoption rates, due to child death or reduction in child birth?

Ans. Perhaps some family planning and confidence that children will survive so that the fertility rate is beginning to go down.

Qn. Did you look at the impact of ART in relation to labour? Or did you look at the issue of why beans are the major crop grown?

Ans. We were not able to distinguish an impact of ART during our present analysis, but we hope to look at this in more detail shortly. We know from our qualitative data that ART has certainly had an impact on labour, with people who had fallen very sick being able to work again.

Qn. Was there any influence of changing prices on what to grow or not to grow?
Ans. Yes, among other factors.

Qn. Did you ask about the effects to the investments made by the yields? Did you manage to capture some of it?

Ans. We collected some information on this, but we also observed that this is quite complicated as many people have been diversifying their livelihoods and engaging in activities other than agriculture. In Rakai, for example, a number of organizations have come in to support small enterprises which has given people alternative ways of earning their living. So, investment may not have gone back in to farming and a reduction in cultivation may be because of other livelihood opportunities not necessarily because of sickness and death.
Thursday 14th April 2011

Background to the session on food storage, mycotoxin exposure and HIV

In 1988 Hendrickse and Maxwell suggested that the interaction between HIV infection and aflatoxin exposure demanded urgent attention, based on their research with intravenous heroin users in Britain who were injecting with drugs contaminated with aflatoxin B. They did not follow-up on their research suggestion and it was not until over a decade later that Tim Williams and colleagues (2005) suggested that aflatoxin could promote HIV transmission and progression because of the effects of aflatoxin on immunity and nutrition. Other research on aflatoxin and human health provides a background for this work: the work of Chris Wild, Andy Hall and colleagues on the impact of aflatoxin on child health and development in West Africa in the 1980s and 1990s, being one example. In 2008 Williams and colleagues found that high aflatoxin ‘appeared to accentuate some HIV associated changes in T-cell phenotypes and in B-cells in HIV-positive participants’ (Yi et al. 2008: 1).

In Uganda, Archileo Kaaya has developed a body of work on aflatoxin in different crops (maize, ground nuts and cassava) and the impact on human health, building on research undertaken in the 1960s and 1970s which showed a link between liver cancer and aflatoxin (Kaaya and Harris 2003, Kaaya and Warren 2005). While much research has been undertaken on the `malnutrition-infection complex' (Chevalier et al. 1996, Scrimshaw and San Giovanni 1997 among many others) and there is an increasing body of work on HIV and nutrition (Drain et al. 2007, Pribram 2011, for example) there have been fewer studies of the adverse effects of toxins in food stuffs and HIV susceptibility and progression. Detailed work on the potential links between HIV progression and aflatoxin has not been undertaken in Uganda (or East Africa) nor has any research been done on the possible impact of aflatoxin on the health of people living with HIV and taking anti-retroviral therapy (ART). This area appears to be of particular importance as the numbers of people infected with HIV in Africa continues to grow while increasing numbers of people need access to ART to sustain their lives, lives that may be affected by comorbidities related to their HIV infection and ART (see Palella et al. 2006 and Lewden et al. 2004, for example). We know little about the role food quality may play in co-morbidity and disease progression.

The two presentations on this topic, by Archileo Kaaya and Tim William provide an overview of this topic and set the stage for future research in this area.
Uganda’s temperatures of 15 – 30°C and rainfall of 750 – 2200 mm per annum provide conditions which are favourable for mould growth on crops both pre and postharvest. A major problem with moulds is the production of mycotoxins.

Dangerous mycotoxins include:

- Aflatoxins (AF, the commonest and most lethal)
- Fumonisins
- Ochratoxins (found in coffee, cocoa)
- Zearalenones
- Deoxynivalenol (DON)
- Ergot alkaloids

Some are produced before harvest (AF, DON) and some post- harvest (AF, fumonisins, ochratoxin).

**What are Aflatoxins?**

They are secondary fungal metabolites of *Aspergillus flavus/A.parasiticus*. Mainly found in: grains, groundnuts, cassava, soy, cotton, spices, tree-nuts; many dried foods including fruits and fish; milk, both human and animal; eggs and meat and animal feeds. The effects are both of health and economic concern. Health effects are for both humans and all domestic animals. These toxins can cause acute and chronic toxicity.

Acute toxicity (quick death): due to high doses (>200 ppb). Individuals die immediately of: high fever, stomach pain, vomiting, edema of the limbs, rapid progressive jaundice (main symptom) and a swollen liver.

Chronic toxicity: individuals die slowly (this is what we see in Uganda) from liver cancer, suppression of Immune system thus enhanced HIV, binding of important nutrients in the body, kwashiorkor and stunting in children and susceptibility to malaria.
FAO estimates that each year, Africa loses 760 million dollars due to aflatoxins. There are costs associated with impounding affected food stuffs, disposing of contaminated grain/food plus regulatory and inspection costs. It is estimated that aflatoxins cause 40% of the daily disease burden in Africa, with increased susceptibility to a range of diseases and conditions.

**Control of aflatoxins**

Once in produce aflatoxins are hard to eliminate. Cooking and roasting at normal temperatures has no affect. Control methods used in developed countries include: developing resistant varieties, biological control at field level, proper farming /harvesting /drying/storage practices, sorting of harvested produc. Appropriate secondary processing technologies include dehulling of maize, application of ammonia and ozone. Testing currently on-going in U.S. adding Bentonite clay to food (1%) – already applied to commercial animal feeds, this has the effect of binding the toxin.

**Aflatoxin Research in Uganda**

Research began in the 1960s looking at acute toxicity from cassava. In 1969: Hepatoma was related to AF contamination but there were no AF research results reported between 1970 – 1990. In the 1990s research restarted and the major emphasis has been on maize and groundnuts; with some few studies on dried cassava and sweet potato chips; other oil seeds and legumes and animal feeds.

**Aflatoxin contamination of foods in Uganda**

<table>
<thead>
<tr>
<th>Food</th>
<th>Max. Levels (ppb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize</td>
<td>700</td>
</tr>
<tr>
<td>Groundnuts</td>
<td>2000</td>
</tr>
<tr>
<td>Cassava chips</td>
<td>30</td>
</tr>
<tr>
<td>Soybean</td>
<td>40</td>
</tr>
<tr>
<td>Sunflower seeds</td>
<td>25</td>
</tr>
<tr>
<td>Dried fish (Mukene)</td>
<td>32</td>
</tr>
</tbody>
</table>
Aflatoxin levels in infant foods in Uganda

<table>
<thead>
<tr>
<th>Infant food</th>
<th>Aflatoxin (ppb)</th>
<th>Year analysed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize/Soya/Fish</td>
<td>20 - 50</td>
<td>2002 - 2004</td>
</tr>
<tr>
<td>Whole millet</td>
<td>10 - 20</td>
<td>2002 - 2003</td>
</tr>
<tr>
<td>Conflakes (Imported)</td>
<td>10 - 20</td>
<td>2002</td>
</tr>
<tr>
<td>Cerelac (Imported)</td>
<td>0</td>
<td>2002</td>
</tr>
<tr>
<td>Gnut pastes</td>
<td>0 - 65</td>
<td>2003 - 2005</td>
</tr>
<tr>
<td>Soya/millet</td>
<td>0 - 35</td>
<td>2005 - 2006</td>
</tr>
<tr>
<td>Gnuts/Simsim</td>
<td>0 - 48</td>
<td>2006</td>
</tr>
<tr>
<td>Instant Maize flour</td>
<td>0 - 18</td>
<td>2006</td>
</tr>
<tr>
<td>Bagiya</td>
<td>0 - 34</td>
<td>2006</td>
</tr>
<tr>
<td>Rice porridge</td>
<td>0 - 5</td>
<td>2006</td>
</tr>
<tr>
<td>Nkejje flour</td>
<td>10 - 16</td>
<td>2006</td>
</tr>
</tbody>
</table>

Aflatoxin content in animal feeds

<table>
<thead>
<tr>
<th>Feed</th>
<th>Aflatoxin levels (ppb)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Range</td>
</tr>
<tr>
<td>Broiler Starter</td>
<td>0 - 60</td>
</tr>
<tr>
<td>Broiler Finisher</td>
<td>0 - 75</td>
</tr>
<tr>
<td>Layers Mash</td>
<td>15 - 85</td>
</tr>
<tr>
<td>Chick Mash</td>
<td>0 - 45</td>
</tr>
<tr>
<td>Growers’ Mash</td>
<td>10 - 70</td>
</tr>
<tr>
<td>Dairy Meal</td>
<td>5 - 150</td>
</tr>
<tr>
<td>Sow and Weaner Meal</td>
<td>10 - 50</td>
</tr>
</tbody>
</table>
### Mould species observed in foods and feed ingredients

<table>
<thead>
<tr>
<th>Food/ingredient</th>
<th>Mould species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize grain</td>
<td><em>Aspergillus niger</em>, <em>A. flavus</em>, <em>A. ochracious</em>, <em>Fusarium verticillioides</em>, <em>F. graminearum</em>, <em>Penicillium</em></td>
</tr>
<tr>
<td>Soy bean</td>
<td><em>A. niger</em>, <em>A. flavus</em>, <em>A. fumigatus</em>, <em>Penicillium spp</em></td>
</tr>
<tr>
<td>Fish (dry, Mukene)</td>
<td><em>A. flavus</em>, <em>Rhizopus stolonifer</em>, <em>Mucor spp</em></td>
</tr>
<tr>
<td>Cotton seed cake</td>
<td><em>A. niger</em>, <em>A. flavus</em>, <em>Fusarium graminearum</em></td>
</tr>
<tr>
<td>Bran</td>
<td><em>A. flavus</em>, <em>Rhizopus spp</em>, yeasts</td>
</tr>
<tr>
<td>Germ</td>
<td><em>A. niger</em>, <em>A. flavus</em>, <em>A. penicilliodes</em>, <em>A. wentii</em>, <em>Fusarium verticillioides</em>, <em>F. graminearum</em>, <em>Rhizopus spp</em>, yeasts</td>
</tr>
<tr>
<td>Sunflower</td>
<td><em>A. flavus</em>, <em>Fusarium spp</em>, <em>Rhizopus stolonifer</em></td>
</tr>
</tbody>
</table>

### Factors contributing to Aflatoxin contamination of foods in Uganda

<table>
<thead>
<tr>
<th>Image</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Drying produce on bare ground" /></td>
<td>Drying produce on bare ground</td>
</tr>
<tr>
<td><img src="image2" alt="Inadequate drying techniques" /></td>
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<tr>
<td><img src="image3" alt="Inadequate shelling methods" /></td>
<td>Inadequate shelling methods</td>
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There are problems with sorting contaminated from uncontaminated produce, processing, poor handling and transporting of produce and poor storage (both at home and at the market)
Conclusion

We need to sensitize key stakeholders about the aflatoxin problem. Management will involve all those who participate in the crop chain (farmers, traders & consumers). Uganda National Bureau of Standards needs to enforce standards and regulations.
Jonathan H Williams and Pauline Jolly (University of Georgia and University of Alabama) -- Food toxins important for HIV and AIDS

Food quality in terms of beneficial foods (protein, fats, calories, fibre and essential micro-nutrients) are well understood in the context of HIV. The harmful side of food quality is less studied: the role of mycotoxins, bacteria and other contaminants – like pesticides.

Toxicities of aflatoxin: a function of dose and dose duration resulting in three sets of consequence/symptoms.

Acute – cytotoxic from high levels of ingestion -- clear symptoms – usually >30% mortality;

Chronic -- no diagnostic symptoms – failure to thrive – weakened immune system and lowered nutritional status; increased infectious diseases

Cumulative -- all exposure increases risk of hepato-carcenoma in a cumulative dose dependent manner.

Synergistic with HBV

**Exposure to mycotoxins in Africa:**

**AFLATOXIN**

- >95% of people have biomarkers for chronic exposure
- 30-40% of breast-milk samples have short term biomarkers

**FUMONISIN**

- Limited biomarker data but in Tanzania, South Africa and Ghana exposure frequencies are high (>90%)
- Almost all maize is contaminated

Aflatoxin influences immunity by affecting T Cells, B Cells, NK Cells, Macrophages, Cytokines and IGA, IL etc

Babies can be exposed to aflatoxins while still in the womb, and can ingest through breast milk.

Animals models have shown a link between aflatoxin and viral diseases in livestock and bacterial diseases in livestock

Human studies have shown a link with susceptibility to malaria and aflatoxin.
Fumonisin is less researched but links have been found between this toxin and oesophageal cancer (South Africa); neural tube defects (Latin America) and nutritional interference (Tanzania). Tanzanian work shows that the growth of children was impaired by fumonisin.

**Mycotoxins and HIV**

Our research implicated two mycotoxins in the HIV epidemic. Aflatoxin is likely promoting the progression of HIV to AIDS, and the incidence of opportunistic infections during that phase of the disease. Fumonisin in contrast seems to be involved in making people more prone to infection.

Research in Ghana has found that HI-infected people have more AF exposure biomarkers and HIV and AF exposure interact at the level of immunity. In Ghana where we are doing a AF/HIV longitudinal study we see the risk of active TB approximately 2x for high AF.

**HIV related to maize consumption**

Using the nations of Africa as analysis units maize consumption is very strongly associated with two diseases: oesophageal cancers and HIV (see figure below). The cancer correlation is a good indicator of fumonisin exposure and maize samples from across Africa confirm this contaminant is prevalent in maize. This new discovery is made plausible because fumonisin increases membrane porosity, thereby allowing easier passage of the virus into the blood system.

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4 see [http://www.ajcn.org/content/early/2010/05/19/ajcn.2009.28761.abstract](http://www.ajcn.org/content/early/2010/05/19/ajcn.2009.28761.abstract)
Model A: All countries  \( Y = 5.26 \times X + 63.0 \) (n = 36 : \( R^2 = 0.47 \))
Model B: Excluding outliers \( Y = 4.98 \times X + 42.4 \) (n = 33 : \( R^2 = 0.67 \))
Model C: S African outliers  \( Y = 7.47 \times X + 550.5 \) (n = 3 : \( R^2 = 0.94 \))

We need to:
- Eliminate or decrease exposure by
  - Reducing contamination of staple foods
  - Diversify diet
  - Block uptake (application of specific clays or similar)
  - Prevent activation in the body

We need to study further this relationship within countries.
**Discussion**

Qn. There are different levels of PPB, FDA, 2PPB and level set for veterinary level exports, why don’t we have a uniform standard?

Ans. There is a world standard but countries insist on setting their own standard. Because by having a higher standard they would reduce on people with cancer per year. Aflatoxin became a trade barrier because the countries want to protect their people.

Qn. Are there new technologies to test for Aflatoxin in food stuffs?

Ans. Test kits are available for field testing however they are expensive. UV light can be used to test the cereals.

Qn. In event of people who have been exposed, are there measures to manage exposure?

- Stop exposure
- Add Bentonite to food

Qn. You mentioned the effects on immunity, did they put into consideration the body response to mycotoxins?

Ans. The response is quick from ingestion to absorption and then damage to the liver.
Discussion groups – summary of main points

On the afternoon of 14th April, the participants broke into discussion groups to draw up a list of priorities for both policy and for future research.

Research areas

1. What makes agricultural communities resilient to HIV?
   - Foster relationship or collaborative research linking climate change researchers and ‘food and infectious diseases’ researchers
   - Further research required on affected/unaffected definitions. How can we understand the links between households better for research on impact? Qualitative research best for this.
   - Greater attention to the non-farm livelihood contributions to farming households. How does livelihood diversification contribute to resilience?

2. The impact of food on infectious diseases – investigate the hypothesis that there is a casual effect between mycotoxin and HIV
   - Survey to establish the exposure to mycotoxins
     - Prevalence
   - KAP on exposure to mycotoxins
   - Exploratory research to establish mycotoxin levels in community
   - Determine prevalence of mycotoxicity (can we look at the costs of the burden of mycotoxicity on communities – health economics?)
   - Further inquiry into how mycotoxins increase susceptibility of infection with HIV
     - Use available opportunities with MRC/Rakai cohorts (well characterised cohorts where fast and slow progressors are followed) to compare aflatoxin/fumonisins levels in stored sera to assess the correlation between exposure and immunity
     - Do mycotoxins affect efficacy of anti-retroviral therapy?
     - Might mycotoxins affect the efficacy of HIV vaccines under trial?
– Explore modes to improve food processing and storage – less costly, less labor intensive techniques for farmers

– Develop rapid tests for mycotoxins – ‘field friendly’

– Exploratory research on bentonite (a clay that can be used to treat contaminated food) and its binding properties
  
  • Quality of bentonite
  • Binding capacity
  • Sources – import, mining in Uganda
  • How is it delivered – applicator modes – salt? Other foods e.g. flour products – fortified in maize
  • Randomized trial of bentonite clay
    
    • Does it effectively reduce aflatoxin and fumonisin in humans?

Policy makers

• Programmes to mitigate HIV should take a holistic approach (not just focus on health, or agriculture – need a broader view)

• Promote food security as being about quality as well as quantity

• Promote IEC materials especially for rural populations - awareness campaigns for mycotoxicity

• Develop and implement a certification process, including enforcing regulatory standards in place/new ones – UNBS

• Actively promote a research agenda on mycotoxicity

Communicating the messages

One to one meetings with policy makers (including politicians)

Briefing papers

Radio programmes (including slots on talk shows) for information on mycotoxicity
There was general agreement that we need to build more evidence particularly on the relationship between mycotoxins and HIV.

**Conclusion**

The workshop participants suggested, in the concluding session, that the focus on the impact of HIV on agriculture may be the wrong way round. Given link between mycotoxins and human health, we need in the future to direct our attention to the impact of agriculture on HIV. It could be the case that poor harvesting and storage practices are contributing to people’s susceptibility to HIV in Africa.

This suggests that there is an urgent need to talk to research funders and policy makers so that this link can be investigated as a matter of priority.

There is also a need to spread information to policy makers and programme implementers from the recently completed research by MRC/UVRI and RHSP that HIV-focused policy interventions in agriculture may not be appropriate. The HIV-epidemic has not happened in isolation; other factors such as climate, pests and diseases, growing land pressures, broader changes in the economy and increasing availability of public goods, notably education, have and continue to have an impact on and drive change in rural livelihoods and need to be seen as part of the broader approach to mitigating the impact of HIV.
### Annex 1

### Workshop Programme

**13th April**

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Presenters</th>
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<tbody>
<tr>
<td>9.00-10.00</td>
<td>Registration</td>
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<tr>
<td>10.00</td>
<td>Welcome and introduction</td>
<td>Ms Beatrice Okello and Prof Janet Seeley</td>
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<tr>
<td>10.30</td>
<td>Opening Statements</td>
<td>Mr Charles Owach, Deputy FAO Country Representative</td>
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<td>Mr. Musa Bungudu UNAIDS Country Coordinator, Uganda</td>
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<tr>
<td>11.00-11.30</td>
<td>Tea</td>
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<tr>
<td>11.30-13.30</td>
<td>The background to agriculture in Southern Uganda</td>
<td>Dr Piet van Asten, IITA</td>
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<td>Current and future drivers of agricultural systems in Uganda – scenarios for some major food and cash crops.</td>
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<td></td>
<td>Discussion</td>
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<tr>
<td>13.30-14.30</td>
<td>Lunch</td>
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<tr>
<td>14.30-17.30 (with a tea break)</td>
<td>The longitudinal impact of HIV and AIDS on rural livelihoods in East Africa – study findings</td>
<td>Prof Janet Seeley</td>
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<tr>
<td></td>
<td>Overview of the study</td>
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<td></td>
<td>The impact of HIV agricultural livelihoods – the big picture</td>
<td>Kenneth Ekoru</td>
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<td>The impact of HIV on household food security (Masaka)</td>
<td>Dominic Bukenya</td>
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<td></td>
<td>The impact of HIV on household food security (Rakai)</td>
<td>Tom Lutalo</td>
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<td>Discussion</td>
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**14th April**

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<tr>
<td>Time</td>
<td>Session Description</td>
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<tr>
<td>9.00-9.30</td>
<td>Overview of the previous day</td>
<td>Prof Janet Seeley</td>
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<tr>
<td>9.30-12.30</td>
<td><strong>Food storage and human health.</strong></td>
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<td>Overview on aflatoxin and human health in Uganda</td>
<td>Dr Archileo N Kaaya</td>
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<td></td>
<td>Aflatoxin and HIV – what’s the association and what are the risks?</td>
<td>Dr Jonathan H Williams</td>
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<td></td>
<td>Discussion</td>
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<tr>
<td>12.30-13.30</td>
<td>Lunch</td>
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<tr>
<td>13.30-15.00</td>
<td><strong>Policy and Research – what should be on the agenda?</strong></td>
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<td></td>
<td>Groups to discuss: policy issues and future research priorities</td>
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<tr>
<td>15.00-16.00</td>
<td>Group presentations</td>
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<tr>
<td>16.00-17.00</td>
<td>Summing up and next steps</td>
<td>Prof Janet Seeley</td>
</tr>
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## Annex 2

### Participants

<table>
<thead>
<tr>
<th>Name</th>
<th>Organisation</th>
<th>Contact telephone</th>
<th>Contact email</th>
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References


