CROP PROTECTION PROGRAMME

Promotion of IPM for smallholder cotton in Uganda
R8197 [ZA0516]

FINAL TECHNICAL REPORT

01 August 2002 - 31 March 2005

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Natural Resources Institute

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Contents

Project Summary

TITLE OF PROJECT:	Promotion of IPM for cotton in Uganda
R NUMBER:	R8197
PROJECT LEADERS:	Dr Rory Hillocks, Natural Resources Institute
RNRKS PROGRAMME:	Crop Protection Programme
PROGRAMME MANAGER:	Dr. F. Kimmins
SUB-CONTRACTORS:	Agricultural Production & Extension Project [APEP], Box 785, Kampala, Uganda NARO, Serere Agriculture & Animal Research Institute [SAARI] Soroti, Uganda
COMMODITY BASE:	Cotton
BENEFICIARIES:	Smallholder cotton farmers
TARGET INSTITUTIONS:	NARO [SAARI], APEP, Cotton Development Organisation, Uganda Cotton Ginners & Exporters Association [UCGEA].
GEOGRAPHIC FOCUS	Uganda, E. Africa
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Executive Summary

Following a visit to Uganda in 2001, CPP identified the IDEA [Investing in the Development of Export Agriculture] project as a potential partner for a Cotton IPM project. The IDEA project promoted improved agronomic practice through large numbers of demonstrations. The IDEA cotton demonstration programme began with a target of 300 demonstrations in Kasese and 300 in Pallisa.

Lessons learned from a successful CPP project in India that showed how IPM can be enthusiastically adopted by cotton smallholders to decrease their dependency on insecticides, were used to develop an IPM model for Africa. The main cotton insect pest in Africa is the same as in India, the bollworm *Helicoverpa armigera*. In Uganda in collaboration with NARO [Serere Agriculture and Animal Research Institute], NRI scientists developed an IPM model for use by cotton smallholders. At that time IDEA were using a calendar-based spray regime of 4 spray at 3–week intervals from first flower. Smallholders were getting enough insecticide for only two sprays with their seed in a 'starter pack' and often used their first spray before first flower to control aphids. An appropriate IPM system was designed and evaluated in Kasese. We were able to eliminate insecticide use against aphids, by using soapy water, and reduced the number of sprays from four to two or three, without loss of insect control. The system received approval from IDEA and from US AID who wanted pest control in the IDEA project to be based on IPM. In the following season in Pallisa [Teso] the IPM system was adopted on 300 OFTs and on a further 300 in Kasese in August 2003. When the cotton demonstration programme developed by IDEA was expanded under a new US AID project [APEP] in 2003, IPM adoption was scaled-up to reach 6000 OFTs by the end of 2005.

In order to achieve these levels of adoption of the IPM system, a large programme of training of trainers was initiated. The private sector ginning companies were enthusiastic and their participation increased from two companies in 2002 to all ginning companies in Uganda by 2004. The ginning companies provided the site supervisors for the OFTs and these were trained in IPM. This involved training workshops and the production of training guides and an IPM video. More than 600 site supervisors were required for the OFTs by the end of 2004. Each of these trained 10 demonstration farmers in IPM [ICM if the IDEA agronomic package is included]. Each of those farmers was expected to pass the knowledge on to at least 15 neighbours, friends and relatives. On this basis it was estimated that 180,000 cotton farmers would be exposed to the ICM technology by the time the target of 12,000 cotton OFTs was reached in 2005/6.

Together with the National cotton Programme at Serere Agriculture & Animal Research Institute [SAARI], we set-up 25 on-farm trials within the Teso area, to validate some of the ICM components that were being promoted in the APEP demonstrations. These trials showed that while overall, there was an economic benefit to fertiliser use, on an individual basis only three farmers obtained a yield increase that was statistically significant. Replacing one ploughing with reduced tillage based on herbicide use, was also found to be cost-effective. Intercropping with beans which is a common practice among cotton farmers was shown to be a risky strategy, decreasing cotton yields but giving poor or even zero bean yields on sandy soils.

Socio-economic studies showed that medium, rather than small, growers were the poorest cotton growers, as measured by ownership of physical assets. Poorer growers hired less labour for land preparation and weeding. This suggests that they lacked sufficient working capital for cotton cultivation. The frequency of cotton

spraying was determined by asset ownership and cash availability rather than knowledge of cotton cultivation. Among poorer medium growers, the route to higher productivity lies through planting less cotton but managing it better, particularly weeding and pest control. Yield increases might then compensate for the reduction in the area planted. However, since poorer growers plant more cotton than they can manage effectively because they lack alternative sources of cash income, improving productivity among this group might depend on opportunities for diversification into other cash crops or into off-farm employment. Spraying at least to some extent is almost universal, and all growers would benefit from IPM that reduced the number of sprays required. By reducing the cash needed for pest management, IPM would save poorer growers money and improve the timeliness of spraying.

The first part of this report summarises the main achievements under each output. More detailed results and discussion are to be found in the appendices.

Background

During the period between the end of the second world war and the early 1970s, Uganda became the leading producer of Upland cotton in SSA. Regional and internal conflict in Uganda in the 1970s and 80s saw cotton production decline by more than 90%. Rehabilitation of the cotton industry in the 1990s was supported by IFAD. High world cotton prices around the same time also encouraged private sector investment in the ginning sector. Although world prices subsequently declined to record levels, investment in the cotton industry has seen production levels recover to around one third of the 1970 levels. Further increases in production require more investment in extension and input support from the private sector to re-establish farmer achieve improvements in the poor standard of crop management. Pest control standards were particularly poor. The IDEA [later APEP] project funded by US AID began in 1998 to promote improved cotton agrononmic practice through a programme of on-farm demonstrations [OFTs]. With a target of 600 cotton OFTs IDEA was chosen as the main sub-contractor for this project with the objective of improving the efficiency and safety of pest control by the adoption of IPM. Later, US AID approved an expansion of the cotton OFT programme under the APEP project, with a target of 12,000 OFTs by 2007.

Falling world cotton prices in the latter half of the 1990s and continued problems with marketing, continue to discourage farmers from growing the crop where there are alternative sources of cash income. Nevertheless, in the drier areas of north-eastern Uganda there are few reliable alternative cash crops and at least 400,000 households depend on the crop for cash income. Furthermore, with the falling world price for coffee and the cotton price beginning to pick up, increased cotton production could play a greater role in the national economy and, in line with Uganda's 'Poverty Eradication Action Plan', contribute to improving rural livelihoods.

The Ugandan Government has adopted a 'Plan for the Modernisation of Agriculture' that creates the policy framework for the commercialisation of agriculture and encourages smallholders to produce farm surpluses for sale. However, there remain technical and socio-economic constraints that limit cotton yields and the attractiveness of the crop as a source of cash income. Average cotton yields are well below the yield potential of the present commercial varieties, due to a combination of poor crop management, failure to protect the crop from losses caused by insect pests and inadequate knowledge of the most appropriate use of available inputs. A further problem is the decline in the world market price during 2001, reflected in a fall in the farm gate price paid to Ugandan farmers. This has cut grower margins making efficient use of any inputs purchased off the farm essential.

The Investment in developing Export Agriculture [IDEA] Project was identified as the primary collaborating partner and sub-contractor. Collaboration with the IDEA project through their network of on-farm demonstrations, allowed the project immediate access to promotion sites and participating farmer groups. When the IDEA project was reviewed by the funding agency [US AID], the inclusion of an IPM component was crucial in gaining approval for further funding and expansion of the cotton demonstration programme under a new project, Agricultural Productivity and Extension Project [APEP]. The target for this project by end of 2004 was 6000 on-farm demonstrations [OFTs], with each farmer keeping the OFT for two seasons before moving to new sites, giving a total of 12,000 cotton OFTs by the end of the project in 2007.

The CPP project built upon the knowledge already gained from many years of cotton research in the region [National Cotton Programme at SAARI], combined with more recent knowledge from CPP-funded and other work on IPM, to develop a clear set of recommendations to provide farmers with the information to enable them to make the right crop management decisions. For example the CPP work in India from 1993 has provided a comprehensive understanding of the impact of insecticide resistance on pest control in cotton and of the effect of inappropriate use of toxic materials on the beneficial insect fauna and on the promotion of undesirable increases in secondary pest numbers. From this knowledge, appropriate and highly economically and environmentally successful pest control practices were developed and demonstrated. The general guild composition of insects on cotton in Uganda is sufficiently similar to the Asian situation for the IPM methods used to identify and address those problems in India to be useful in Uganda.

PROJECT COLLABORATIVE NETWORK

<u>NRI staff</u>

Integrated crop management cannot be developed and promoted without a strong multidisciplinary team. The NRI team for this project therefore consisted of:

Rory Hillocks: Cotton ICM and Plant Pathology [Team Leader]
Derek Russell: Cotton IPM specialist
Charlie Riches: cotton Agronomy and Weed Management
Alastair Orr: Agricultural Economist

<u>Main sub-contractor</u>

The main sub-contractor and collaborative partner at the beginning of the project in 2002 was the IDEA [Investing in the Development of Export Agriculture] project funded by US AID. Their remit is to deliver improved agronomic practice through large numbers of on-farm demonstrations [OFDs]. In 2003 the IDEA cotton demonstration programme was expanded under a new project SPEED which later became the Agricultural Productivity & Extension Project [APEP].

The IDEA cotton demonstration programme was originally to reach 600 OFDs but this was later expanded to 6000. As there were to be two cycles of demonstrations with each farmer retaining the demonstration for two years, the final target was 12,000 OFDs. This was attractive to the CPP who saw this as an opportunity for rapid dissemination and adoption of IPM technology.

Second sub-contractor
The National Cotton Programme is administered for the National Agricultural Research Organisation [NARO] from Serere Agricultural & Animal Research Institute [SAARI]. Collaboration with SAARI was sought in order to validate some of the ICM components in a series of on-farm trials. This also served as a further training and promotional exercise for IPM.

Collaborative linkages
The project has provided a mechanism to foster public/private partnership and collaboration between stakeholders in the cotton industry. Most of the main stakeholders have been involved in training of trainers in cotton IPM:

Private sector ginning companies – Ginning companies provided the extension staff to act as trainers of trainers in cotton IPM. In 2002 only two ginning companies were involved in the OFD programme: Nyakatonzi in Kasese and North Bukedi in Pallisa. By 2004 all private sector ginning companies were participating; CotCo, Dunavants, CN-ginning and Bon holdings.

Uganda Cotton Ginners and Exporters Association – this body represents the ginning secior in Uganda and provided financial support to help set-up the Busitema cotton Training Centre.

Cotton *Development Organisation* – This is the regulatory body for cotton in Uganda and also has responsibility for seed production. CDO has been kept informed of our activities and invited to attend project workshops.

Project Purpose

The purpose of the project was to contribute to improving the livelihoods of smallholder cotton farmers by developing and promoting appropriate IPM practices. The adoption of IPM allowed farmers to decrease the number of sprays used or to better target the use of insecticide to obtain greater cost benefit from input use. The project achieved this by collaborating with a US AID-funded project that promoted improved cotton agronomy through a massive programme of on-farm demonstrations [OFDs]. By the end of the CPP project the IPM system had been adopted on 6000 OFDs. The project successfully worked with the private sector which provided 600 cotton extensionists to be trained in IPM. The built capacity in IPM and the commitment of the private ginning companies to service delivery ensures that the project's contribution will be sustainable.

Research Activities

The project began with an informal assessment of the pest control problems facing cotton smallholders in two main cotton growing areas, Kasese in the south West and Pallisa in the East. An IPM system was then designed to meet the pest control challenge using experience gained from CPP cotton projects in Asia and from a World Bank-funded IPM project at SAARI. The US-AID-funded IDEA project was set up to promote improved crop agronomy through on-farm demonstrations. Cotton was one of their component crops. Collaboration with IDEA provided them with an IPM component which they lacked and for the CPP project the OFDs offered the opportunity for large scale dissemination of the IPM technology. The IDEA project implemented their strategy through cooperation with private sector ginning companies. The IDEA project had initially 300 OFDs in Kasese and 300 in Pallisa with one collaborating ginnery at each location. Ginneries provided the cotton extension staff who were trained to act as ‘site co-ordinators’, each being responsible for training 10 demonstration farmers. The IPM system was first validated on 30 OFDs in Kasese comparing with 30 non-demo farms. Results showed that spray could be decreased by better targeting and 60 site co-ordinators were trained to deliver IPM to all 600 IDEA cotton demonstrations. When IDEA became APEP the cotton demonstration programme was expanded to 6000 and the IPM system was to be adopted on all of these. By this time all eight of the main ginning companies were participating.

Training literature was developed in support of the training of trainers programme. The site co-ordinators were trained in the principles of IPM, pest identification and recognition of beneficial insects. Implementation of the IPM system required that farmers carried out scouting and spraying was based on simple thresholds. This required the design and manufacture of 6000 wooden pegboards to record pest numbers and the action threshold was marked on the board.

The projects other main partner was the National cotton Research Programme based at the NARO institute at Serere [SAARI]. With SAARI 25 on-farm trials [OFTs] were set up to validate some of the integrated crop management [ICM] components that were being promoted by IDEA – mainly reduced tillage through the use of herbicide and the application of fertiliser. The OFTs were designed as factorial experiments with a single replicate at each site. Trials were planted and scored by the SAARI research team but otherwise managed by the farmer.

Trials were planted at 20 on-farm sites in early May 2003, but due to subsequent insecurity it was not possible to maintain regular visits to all sites. This and other problems with plot location or missing data reduced the number of sites for which adequate data sets were available for analysis to 14. Weed data was however collected at 20 sites early in the season, before the security situation deteriorated in Lira District.

Eight plots were established at each location as follows:

1. Minimum tillage/herbicide use, pure cotton, no fertiliser
2. Minimum tillage/herbicide use, pure cotton, fertiliser applied
3. Minimum tillage/herbicide use, cotton inter-crop with beans, no fertiliser
4. Minimum tillage/herbicide use, cotton inter-crop with beans, fertiliser applied
5. Conventional tillage, pure cotton, no fertiliser
6. Conventional tillage, pure cotton, fertiliser used
7. Conventional tillage, cotton inter-crop with beans, no fertiliser
8. Conventional tillage, cotton inter-crop with beans, fertiliser used

Minimum tillage plots were generally ploughed once 10 to 15 days prior to planting. Weed re-growth was then sprayed with the herbicide Touchdown (sulfusate), applied at rate of 180 mls per 15 l water, at planting. The effects of Touchdown are generally reported to be similar to those of Roundup (glyphosate). At two of the sites included in the subsequent analysis herbicide treated plots were no-till. Here, herbicide was applied twice with no land preparation. Examination of the yield data did not suggest this practice had a differential effect to the minimum tillage system so these sites were included with other farms in the analysis.

All fertiliser (NPK) was applied at planting at a dose of 200 kg ha^{-1}. Cotton (BPA 97) was planted at a spacing of 75 x 30 cm. Beans, on inter-crop plots, were sown in cotton inter-rows at 70 x 30cm. Both crops were thinned to two plants per planting station.

Numbers of major weed species were recorded from four random quadrats (0.5 x 0.5 m) in both minimum tillage and conventional tillage bocks prior to first (20-25 days after planting , DAP) and second (60 DAP) weeding. Pest control at all sites was by up to three applications of Contra-Z with first spraying delayed until after 70 DAP to allow build-up of natural enemies. Routine monitoring of pest populations at the trial sites was not undertaken due to insecurity in the region. Similarly no data on diseases or nematode attack is available for use in the analysis. Soil chemical and physical analysis was undertaken for all sites.

Socio-economic studies accompanied our work with the OFDs, using questionnaires and case studies to evaluate how farm size affected crop management practices and the contribution of cotton to livelihoods. An economic assessment of cotton input use was undertaken.

Outputs

OUTPUT 1. STRATEGIES FOR IPM AND ICPM IN SMALLHOLDER COTTON DEVELOPED AND TESTED IN UGANDA.

Activity 1.1 Identify appropriate technologies for cotton IPM

Achievements

An agronomic package based on minimal tillage and herbicide was developed for cotton in Uganda by the IDEA [Investment in Developing Export Agriculture] Project which was funded by US AID. The aim was to promote improved crop management technology through a large number of demonstrations. The IDEA demonstration had a high input plot that used minimal tillage with herbicide and fertiliser, while the low-input plot did not use fertiliser. US AID was concerned about the use of calendar sprays for pest control in these demonstrations. IDEA and its follow-on projects SPEED and APEP agreed that NRI should provide the IPM input to these demonstrations. This provided the CPP project with immediate access to hundreds of sites for the promotion of cotton IPM.

Based on another CPP project in India, information from the National Programme in Uganda [SAARI] and observations made in Uganda by this project, an IPM system was developed:

IPM system to overlay on the IDEA demonstrations

Principles

- Should delay the first broad-spectrum insecticides as long as possible and preferably up to 60 days from germination. First spray usually against aphids – this to be replaced by spraying with soapy water.
- Should be founded on need-based spraying. Scouting will be required. A wooden peg-board was designed and produced in large numbers as a scouting aid. This allowed easy recording of pest numbers and action thresholds were indicated on the board. [see Figs 1.1 and 1.2 below].
- Should comprise appropriate materials and rates.
- Should be applied only when threshold insect numbers or damage levels have been exceeded. These action threshold levels should balance the need to protect yield with the need to avoid destroying beneficial organisms and the risk of stepping on to the 'pesticide treadmill'. Action thresholds were based on information from the previous World-Bank-funded IPM project at SAARI.

Main insect pests	Main beneficial insects
Aphid [*Aphis gossypii*]	Ladybird [*Cheilomenes* sp.,*Scymnus* sp.]
Bollworm [*Helicoverpa armigera*]	Lacewings [*Chrysopa* spp.]
Lygus [*Lygus vosselerii*]	Anthocorid bugs [Orius spp.]
Stainers [*Dysdercus* spp.]	Hover-fly larvae [*Xanthogramma* and *Syrphus* sp.
	Earwigs [*Diaperasticus* sp.]

Fig. 1.1. Cotton farmer using the peg-board as a scouting aid for insect pest counts.

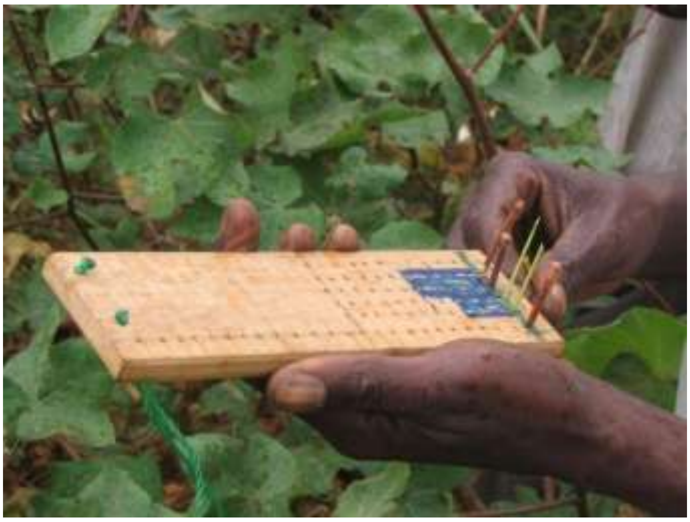


Fig. 1.2. Close-up of farmer using the peg-board as a scouting aid

Validation
The IPM system was validated on 30 farms and compared with the IDEA demonstrations where 4 calendar sprays were applied and with farmers own practice. Farmers were using too few sprays to be effective and they were applied only when substantial pest numbers were seen. By this time damage is likely already to have occurred. The IPM system was able to decrease by between one and two the number of sprays required for effective pest control compared to the IDEA plots [Fig.1.3.]

Pest levels were much higher in farmers fields than in the IDEA or IPM plots but they were lowest in the IMP plots [Fig.1.4.]. In the IPM system the first spray for aphid control, soapy water replaces insecticide.

Seed cotton yields were highest from the IPM plots but not significantly different from the IDEA plots. However all the demonstration plots significantly out-yielded the farmers' plots [Fig.1.5.]

Fig 1.3. Pesticide use in IPM plots compared to other IDEA plots and unsprayed farmers plots in Kasese season 2002/2003.

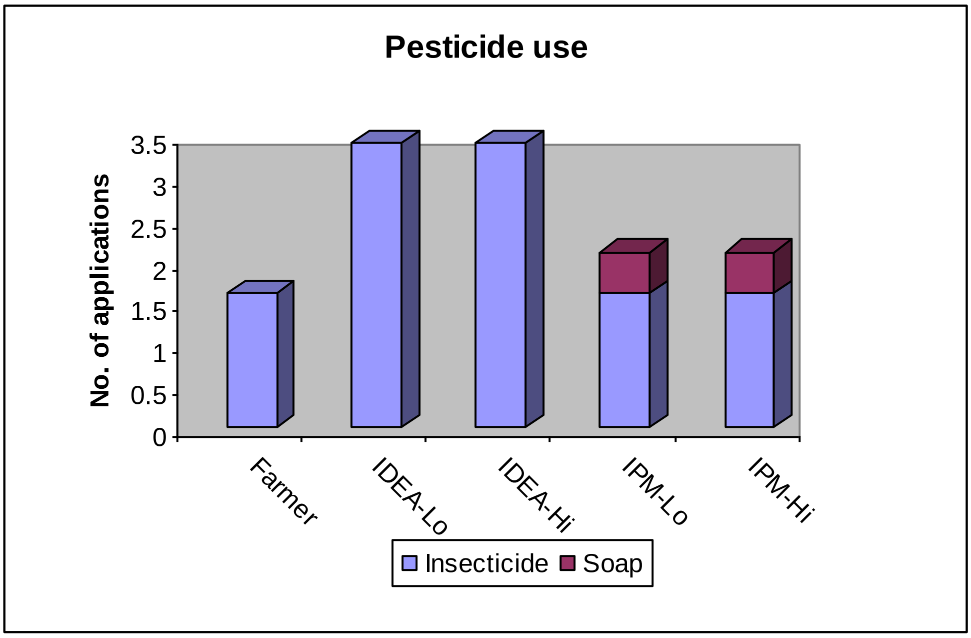


Fig.1.4. Pest incidence in IPM plots compared to other IDEA plots and farmers unsprayed plots in Kasese season 2002/2003.

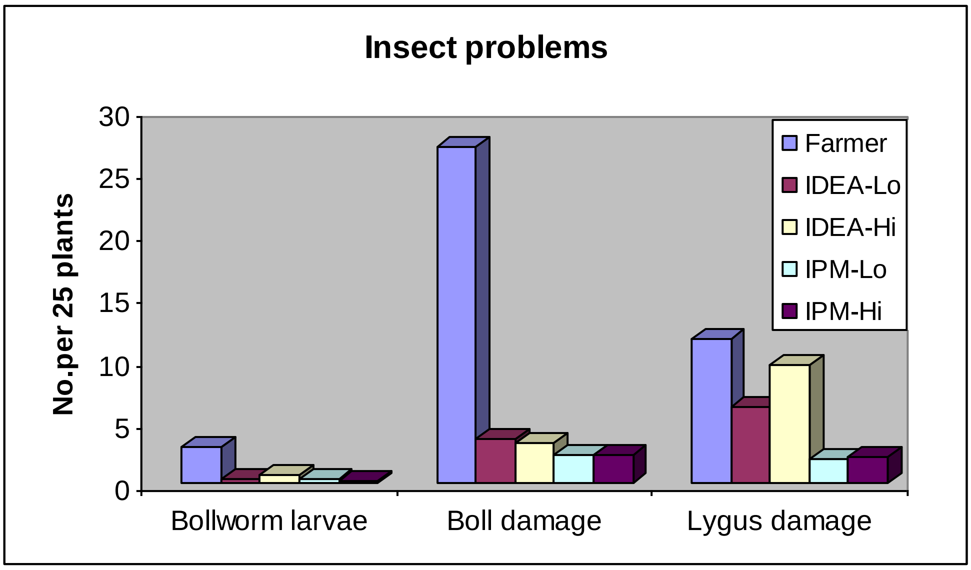
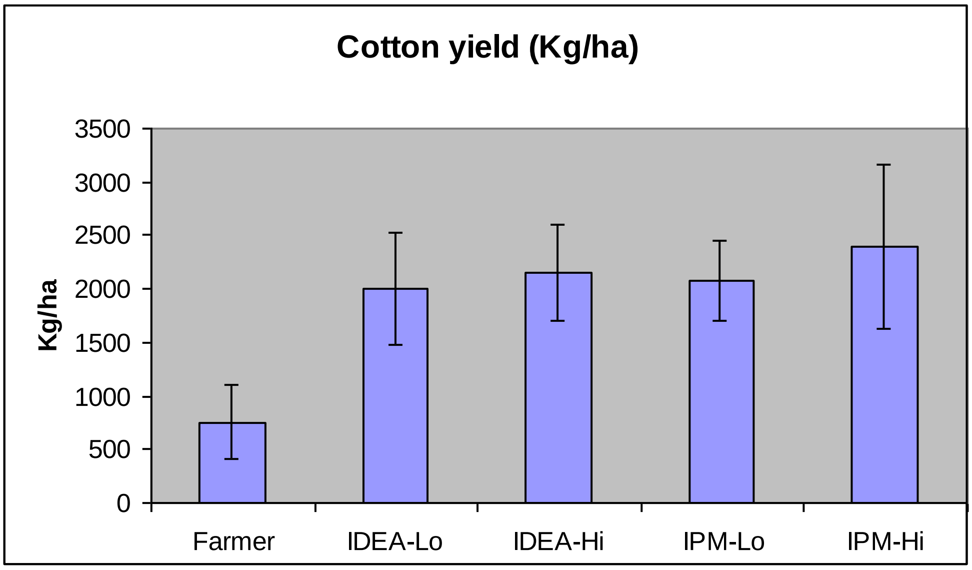


Fig. 1.5. Seed cotton yield from IPM plots compared with other IDEA plots and farmers unsprayed plots in Kasese season 2002/2003.



On-farm trials with SAARI

The APEP (previously IDEA and SPEED) project is running a programme of demonstrations of an improved, high input, approach to cotton production in major cotton growing areas of Uganda. The package is demonstrated as a whole and includes use of reduced tillage with application of the herbicide glyphosate (Roundup) prior to planting, in order to reduce labour and draught inputs for land preparation, and use of fertiliser. Serere Agricultural Research Institute in collaboration with NRI is undertaking a study of component cotton production practices in a series of on-farm trials in a number of districts of north-eastern Uganda. Farmers may well choose to adopt components of the production package that they believe are best suited to their resources. The aim of this study is therefore to understand the possible contribution of fertiliser use, cropping pattern and weed management options to cotton productivity. The IDEA technology is high-input, monocropping, so an additional component of intercropping with beans was added. The rationale for this was that it is common practice by cotton farmers in Uganda in less intensive systems and is also reputed to have IPM benefits.

[An overview of the 2003 trials, with site descriptions, detailed methods, raw data and a preliminary analysis has been reported by staff at Serere[1]. Further detailed statistical analysis (conducted by the project Biometrician) of the data is reported here].

Results

The results in Tables 1.1 – 1.3 are taken from the SAARI report based on the number of sites for which they had each data set. The analysis below was based on the 14 trial sites for which we had a complete data set.

Table 1.1. Effect of tillage system and fertiliser on bean yields [mean of 13 sites]

Fertilizer use	**Tillage System**		
	Sprayed with herbicide	**Conventional tillage.**	**Mean**
No fertilizer	283	189	**236**
NPK (200 kg/ha)	311	296	**304**
Mean	**297**	**243**	**270**

Table 1.2. Effect of tillage system, intercropping and fertiliser on seed cotton yield [mean of 17 sites]

Tillage System	**Sprayed with Herbicide**		**Conventional tillage.**		
Cropping System	**Pure cotton**	**Inter-cropped**	**Pure cotton**	**Inter-cropped**	**Mean**
Fertilser Use					
No Fertilizer	1036	820	980	816	**913**
NPK (200 kg/ha)	1181	951	1150	966	**1062**
Mean	1009	886	1065	891	
Mean	**997**		**978**		**988**

[1] P. Elobu, T.J. Takon and O. Solomon (2003) Annual report for IPM smallholder cotton project at Serere Research Institute for 2003. Soroti, Uganda: SARI.

Table 1.3. Effect of Cropping system and intercropping with beans on cotton yields, with and without fertiliser [means of 17 sites]

Cropping System	**Pure cotton stand**		**Cotton intercropped with beans**		
Fertilizer Use	**No Fertilizer**	**200 kg/ha of NPK**	**No Fertilizer**	**200 kg/ha of NPK**	**Mean**
Tillage System					
Sprayed with Herbicide	1036	1181	820	951	**997**
Conventional tillage	980	1150	816	966	**978**
Mean	1008	1166	818	958	
Mean	**1087**		**888**		**988**

For the analysis below, each site was assumed to comprise a complete block of the 8 treatment combinations. Within each site, the 8 plots were split into two ‘main’ plots on which two crop systems were compared (pure cotton, cotton/bean inter-crop) and, within these ‘main’ plots, fertiliser use (-/+ fertiliser) * tillage system (herbicide, conventional) were compared on the four ‘sub’-plots. For some of the measured variables data were missing from complete sites so these sites have been excluded from the analysis. As all main effects and interactions for the 2^3 treatment structure have a single degree of freedom in the Analysis of Variance (ANOVA), no further t-tests were required as they are exactly equivalent to the variance ratio F test. Data were examined for compliance with assumptions of the ANOVA procedure and necessary transformations were undertaken where necessary and indicated below.

<u>Crop responses</u>

Cotton yield: Data were available from 14 sites. No data transformation was required. Only the main effects for crop system (p=0.006) and for fertiliser use (p<0.001) being significant. Yields harvested from sole crop cotton were 25% greater than from the inter-crop, fertiliser increased yield by 18% on average:

Crop system	**Pure cotton**	**Cotton/bean inter-crop**	
Mean	**1089**	**870**	**SED(13df) = 67.5**

Fertiliser use	**None**	**+Fert**	
Mean	**899**	**1059**	**SED(78df) = 40.1**

Bean yield: Data on bean yield were available for 13 sites. Yields were generally low, ranging from 80 to 570 kg ha^{-1}, with mean yield depressed by crop failure at two sites due to wilt disease early in the season. To improve the variance homogeneity a log transformation was required; an increment of 20 was added to each yield before taking logs in order to include the zero yields in the analysis. Only the plots in the intercrop system had beans planted, thus the analysis is based on 52 plots in total (one of which was a true missing value). The overall fertiliser effect was significant (p=0.007) with 16% higher bean yields harvested from fertilised plots:

Fertiliser use	None	+Fert	
Mean [$\log_e$(yield+20)]	**4.874**	**5.006**	**SED(35df) = 0.0671**
Back-transf. Mean kg ha^{-1}	**110.8**	**129.3**	

Income: The productivity of sole or inter-cropping can be compared by reference to the monetary value of the harvest. This was assessed by assuming a cotton farm gate price of UG Sh. 500 Kg^{-1} and two prices for beans, either Sh. 300 or Sh. 500 kg^{-1} reflecting different values for the commodity at different times of the year.

At a bean selling price of Sh. 300/kg, only the main effect of fertiliser use is significant ($p<0.001$) such that there was a higher overall income where fertiliser was applied. The effect of crop system had a probability level just below 0.1 ($p=0.096$):

Fertiliser use	None	+Fert	
Mean	**482374**	**561161**	**SED(71df) = 21695**
Crop system	**Pure cotton**	**Cotton/bean inter-crop**	
Mean	**551123**	**492411**	**SED(12df) = 32540**

The relative performance of the systems remained the same when the bean price was increased to Sh. 500/kg with fertiliser use significantly ($p<0.001$) increasing income by 16%.

Fertiliser use	None	+Fert	
Mean	**500620**	**582726**	**SED(71df) = 22292**

Regression analyses using soil data: Soil data were available for 13 sites; these comprised a site reading for each of pH, % organic matter, %N, phosphorous, potash, calcium and % sand. Cotton yields were extracted for the two plots growing no cotton with no added fertiliser. An initial ANOVA of these 26 cotton yield values gave no indication of any effects due to the differing tillage regimes on the two plots within sites. Overall there was evidence of site to site variability ($p=0.005$). An initial regression analysis ignored the structure of plots within sites and treated units as 26 separate units. Individually the only soil record giving a significant linear regression for cotton yield was phosphorous ($p=0.003$, a positive coefficient indicating increasing yield with increasing levels of phosphorous). A multiple regression was then carried out and both methods (forward selection and backward elimination) selected the same 3 soil explanatory variables; these were phosphorous, % sand and calcium. Terms were allowed to enter or stay in the model is they reduced the RMS, not just if they showed a statistically significant reduction.

However, when the structure of the units was taken into account (i.e. 2 yield values for each site and therefore its single measurements for the soil variables), the residual MS on 22 degrees of freedom could be partitioned into lack-of-fit (on 9 df) and within site residual (on 13 df). The lack-of-fit was significant ($F=2.979$ on 9 & 13 df, $p=0.036$) and testing the overall regression against lack-of-fit was then not quite significant ($F=3.215$ on 3 & 9 df, $p=0.083$). Thus this regression appears to be of only borderline significance. In the table below the parameter estimates are given along with the two estimates of standard error (from lack-of-fit on 9 df and from combined residual on 22 df) and their corresponding individual significance.

From Table 1.5, it can be seen that, even ignoring structure, only Phosphorous and % sand were significant at around $p=0.05$ (Phosphorous rather more so, % sand very borderline). The data suggest that yields are higher from soils with greater phosphorus content and there is a slight indication that they are lower on free-draining soils with a high sand content.

Table 1.5 Regression anlaysis of yield against some soil fertility factors

Parameter	Estimate	SE	t-prob (on 9 df)	SE	t-prob (on 22 df)
Constant	1766	468	0.001 ***	808	0.057 (*)
Phosphorous	13.28	4.16	0.004 **	7.18	0.097 (*)
% sand	–9.60	4.70	0.054 (*)	8.11	0.267
Calcium	–4.28	3.35	0.214	5.78	0.478

Treatment effects on weeds: In all cases the distribution of weed counts showed strongly increasing variance with increasing mean. The use of a log transformation [$\log_e$(count+1)] was reasonably successful throughout in giving a more uniform spread of residuals. In addition to examining treatment effects on total weed number three important species, the rhizomatous grass *Imperata cylindrica*, perennial *Cyperous* spp. and *Commelina benghalensis* were considered separately. These are difficult to control by mechanical means and observations after spraying suggested that *Commelina* was poorly controlled by the herbicidde. However, for none of the analyses undertaken was there any evidence of any significant effects of tillage on counts. Also, the ordering of the two means differed for different counts, with some showing conventional having more weeds and some showing the reverse (although none of these differences was statistically significant). Table 1.6 shows the means for each count (on the log scale and back transformed scale) for the two different forms of tillage.

Table 1.6. Weed populations prior to first weeding (No. m^{-2} from back transformed data)

	Conventional tillage		Minimum tillage		
Weed	Log	No. m^{-2}	Log	No. m^{-2}	**SED(19df)**
Imperata	0.82	1.27	0.78	1.19	0.170
Cyperus	1.60	3.95	1.52	3.57	0.263
Commelina	1.92	5.82	2.04	6.69	0.220
Total Perennials	2.76	14.8	2.62	12.7	0.221
Total annuals	4.17	63.5	4.27	70.5	0.195
Total weeds	4.45	84.4	4.55	93.5	0.168

Table 1.7. Weed populations prior to second weeding (No. m^{-2} from back transformed data)

	Conventional tillage		Minimum tillage		
Weed	Log	No. m^{-2}	Log	No. m^{-2}	**SED(19df)**
Cyperus	1.5	3.48	2.04	6.69	0400
Commelina	1.75	4.75	1.45	3.26	0.322
Total Perennials	2.61	12.6	2.59	12.2	0.383
Total annuals	3.66	37.9	4.03	55.3	0.294
Total weeds	4.04	55.8	4.37	78.0	0.232

Discussion

Yields of fertilised cotton ranged from 733 to 2200 kg ha^{-1} with seven sites producing 1000 kg ha^{-1} or less. These yields were somewhat less than those achieved by farmers participating in IDEA/SPEED cotton production demonstrations in Palisa during the previous season. An average 2288 kg ha^{-1} seed cotton was harvested from areas managed according to the high input package in the demonstrations including pre-plant application of herbicide and use of fertiliser. In 2003 at a cotton farm gate price of UG. Sh. 500/kg, an additional 280 kg ha^{-1} seed cotton would have been needed to cover the cost of the fertiliser. While fertiliser significantly boosted cotton yields in the current trials the additional harvest only covered the cost of the fertiliser or led to a profit at three of the 14 sites for which full data sets are available.

There was no evidence in the trials for any effect on yield of the change from the conventional practice of ploughing twice to a reduced tillage system incorporating the use of a herbicide. The major advantage for the farmer is that saving in and labour, draught at land preparation. For those who need to hire a draught team there is an added advantage of being able to plant when weather conditions are optimum as there is no need to wait for draught to become available to undertake a second plough pass. Farmers participating in the demonstration programme have reported that subsequent weeding is easier after using herbicide and that less labour is needed compared to weeding following conventional tillage. Weed data collected from the trials did not provide any evidence to show that in-crop weed populations were lower after herbicide application. This aspect needs more detailed investigation in 2004. A detailed economic analysis of costs and benefits of herbicide application is also needed. However, in 2003 no data was collected on labour use for weeding.

Bean inter-crops were clearly detrimental to cotton growth in the trials and up to a selling price of Sh. 500/kg, the additional bean harvest did not offset the reduction in seed cotton yield. Beans also proved to be a risky crop with generally low yields and crop failure due to disease at some sites. However, this is a system favoured by some farmers and has the advantage of producing a food crop in addition to cotton. In the second season we may get some insect data to allow us to assess the impact of the bean intercrop on cotton pests.

Fertiliser significantly increased seed cotton yield. Across all districts the mean yield of fertilised cotton was 1368 kg ha^{-1} ($\pm$ 46) compared to 939 ha^{-1} ($\pm$ 38) when unfertilised, an increase of 428 kg ha^{-1}. With reduced tillage and herbicide use there appears to be no difference between cropping systems, but for conventional tillage the inter-crop has a significantly lower yield than cotton alone. For cotton alone conventional tillage gave a significant increase in yield compared to reduced tillage.

Results [Season 2 - 2004]

Results from the second season confirmed the impact of fertiliser use. Fertiliser significantly increased seed cotton yield ($p<0.001$) (Table 1.8). Across all districts the mean yield of fertilised cotton was 1368 kg ha^{-1} ($\pm$ 46) compared to 939 ha^{-1} ($\pm$ 38) when unfertilised, an increase of 428 kg ha^{-1}. A district by fertiliser interaction ($p=0.004$) was evident. Yield also varied with crop system and tillage ($p=0.023$) (Table 1.9). With reduced tillage and herbicide use there appears to be no difference between cropping systems, but for conventional tillage the inter-crop has a significantly lower yield than cotton alone. For cotton alone conventional tillage gave a significant increase in yield compared to reduced tillage.

Table 1.8. Seed cotton yields kg ha^{-1} in sole cotton and cotton/bean inter-crops as affected by fertiliser in Pallisa, Kumi and Soroti districts.

	Pallisa		Kumi		Soroti	
	Fertiliser					
Crop	**-**	**+**	**-**	**+**	**-**	**+**
Cotton	940	1141	1133	1347	945	1612
Coton/beans	793	1110	884	1470	845	1337

Table 1.9. Effect of land preparation and crop system on mean seed cotton yield kg ha^{-1}

	Tillage	
Crop system	**Reduced**	**Conventional**
Cotton	1119	1276
Cotton/beans	1125	1093
SED between crop sys. (32 df)	81.5	
SED till within crop sys (108 df)	57.9	

Soil and nutrients: As the soil characteristics are the same for all 8 plots within a farm, regressions were fitted for each treatment to explore the influence of various soil characteristics on seed cotton yield. When each soil variable was fitted separately, only organic matter content (OM) and potassium level (K) had any effect of significance (see below). These were subsequently incorporated into a multiple regression. For neither explanatory variable (OM, K) was there any indication of an interaction with treatment, implying that the regression coefficient ('slope') could be deemed the same for each treatment ('parallel lines'). The difference between treatments was adequately accounted for by different intercepts. The results were similar both for unfertilised plots and for all plots, so these are presented below with the standard errors and F-probabilities relevant for all data.

Explanatory variable	F-prob (adjusted for the other expl. variable)	Coefficient (se)
OM	0.004 **	-174.1 (59.7)
K	<0.001 ***	-1.147 (0.322)

Seed cotton yield appears to be negatively correlated [see above] with both organic matter and potassium content of soil with this relationship accounting for 34.6% of the total variation. This suggests that work with fertilizer formulations containing higher potassium content may be worthwhile.

Economic implications: Beans proved unreliable, failing to produce a harvestable yield at more than 50% of trial sites. Further more data has been presented indicating that bean inter-crops reduced cotton growth and yield. In on-farm trials conducted during 2003 beans were also found to be a risky crop, failing at 2 of 14 sites and producing a mean yield of 120 kg ha^{-1} (Riches, 2004). Competition was also significant with cotton. Indeed sole crop cotton produced 25% higher yield than the inter-crop with beans. Based on the evidence of these two seasons, beans are not a good option for inter-cropping in cotton in Teso.

Table 1.10. Costs and returns from use of tillage and cotton nutrient management options (ha^{-1}).

Treatment	Reduced till/herbicide		Conventional tillage	
	No fertiliser	Fertiliser	No fertiliser	Fertiliser
Costs that vary:				
Ploughing[1]	74,130	74,130	148,260	148,260
Herbicide[2]	65,940	65,940	-	-
Fetiliser[3]	-	112,500	-	112,500
Total costs that vary	140,070	252,570	148,260	260,760
Yield (kg)	917	1327	959	1408
Gross returns Sh.[4]	320,950	464,450	335,650	492,800
Net Returns	180,880	211,880	187,390	232,040

[1] Sh. 74,130 per ha per plough pass;
[2] Mean dose of Touchdown used in trials 4.7 L ha^{-1} costing Sh. 14,000 per L;
[3] *Basal DAP 125 kg ha^{-1} with top dressing of 125 kg ha^{-1} urea*
[4] Cotton price in 2004 buying season Sh. 350 per kg;

[1] Cotton price in 2004 buying season Sh. 350 per kg;
[2] Sh. 74,130 per ha per plough pass;
[3] Mean dose of Touchdown used in trials 4.7 L ha^{-1} costing Sh. 14,000 per L;
[4] *Basal DAP 125 kg ha^{-1} with top dressing of 125 kg ha^{-1} urea*
;

The combination of production practices that are therefore of interest from an economic point of view are those involving reduced land preparation with herbicide applied before planting and use of fertiliser. Partial budgets covering the variable costs of land preparation and fertiliser use options, computed from yields obtained from sole crop cotton, are shown in Table 1.10. At the relatively low cotton price (Sh. 350 kg ha^{-1}) for grade b cotton in 2004 buying season the most profitable option was to use conventional tillage and fertiliser. A number of caveats need to be added. Firstly, due to perennial weed infestations at a number of sites, the mean dose of herbicide used in the trials was high. Based on experience gained in 2003 higher doses wee used at sites with dense infestations of *C. rotundus, C. dactylon, D. abyssinica* or *I. cylindrica.* At sites with less sever infestations a lower dose could be used so reducing herbicide costs. Further more perennial weed infestations often have a “patch distribution” so that it will not be necessary to spray the entire field with a high dose. Glyphosate is also likely to reduce regrowth of the problem species leading over time to a reduction in infestation. However, a long-term study would be needed to confirm that herbicide use and hence tillage costs can be reduced in subsequent seasons. Secondly, the budget shown assumes that farmers use the same amount of labour for in-crop weed control following both reduced and conventional tillage. Farmer observations from APEP demonstrations sites suggest that weeding times are reduced on land to which herbicide has been applied before planting. The weed cover scores reported here suggest that this is likely to be the case so increasing the profit from use of reduced tillage and reducing profit from cotton on areas that are ploughed twice due to greater expenditure on labour for weeding. Another advantage of using reduced tillage is that farmers who do not own draught power do not need to hire a team for a second ploughing. Competition for hire of draught could lead to later planting and this, depending on rainfall, may in turn result in lower yields.

Activity 1.3 Validate appropriateness of IPM strategies for different farmer client groups

Achievements

Using baseline survey data, cluster analysis was used to classify cotton growers in Pallisa and Kasese Districts into distinct groups. Classification was based on a range of socio-economic and production variables, selected to capture key aspects of the Teso and montane farming systems. Full details may be found in project Working Paper A1060/2. Here we illustrate how the classification was used to explore constraints on adoption of new technology and the potential impact of IPM.

Table 1.11. Production and income data for different categories of cotton growers

Cluster	Small grower	Medium grower, low productivity	Medium grower, higher productivity	Large grower
Acres [a]	1.8	2.4	1.9	3.5
Yield [a]	254	126	172	282
Output [a]	449	303	333	988
Income [a]	67,000	89,000	103,000	326,000
Share of area planted to cotton (%)	17	17	28	49
Tillage	Oxen	Hoe	Oxen	Oxen
Weeding (x)	3.3	3.1	3.5	3.6
1st spray (WAP)	3.8	5.7	4.4	3.5
2nd spray (WAP)	5.7	8.5	5.9	6.4
Asset score	3.3	2.5	3.0	5.6
Off-farm income (%)	30	15	45	50

A = 2001 season. All other variables are 2002 season.

Table 1.11 presents results for Pallisa district. Growers could be classified into four groups. These corresponded to small growers, large growers, and two groups of medium growers, one with lower and one with higher productivity. Comparing variables across the four cluster groups we find that:

- Smaller growers are not necessarily the poorest growers. The poorest households (measured by asset scores) were medium growers with low yields (126 kg/acre in 2001B).

- Low yields among this low-productivity group were caused by poor crop management (use of hoe for land preparation, later first weeding, later first and second spraying).

- Poor crop management reflected lack of access to cash income. The medium-grower, low-productivity group had only 15 % of household income from off-farm sources. Low cash income was reflected in a lowest asset score (2.5) among the four groups.

Among this cluster group, the route to higher productivity lies through planting less cotton but managing it better, particularly weeding and pest control. Yield increases might then compensate for the reduction in the area planted. However, since poorer growers plant more cotton than they can manage effectively because they lack alternative sources of cash income, improving productivity among this group might depend on opportunities for diversification into other cash crops or into off-farm employment.

Large growers have the highest productivity of all four groups. They would benefit financially from herbicides, which would cut their cash expenditure on hired labour for weeding and are most likely to drive adoption of this technology. The benefits from increased cotton production would be partly offset by the social costs of the loss of employment in weeding, and any damage to the environment from inappropriate use of herbicides. The benefits to large growers from zero-tillage are harder to predict, since they do not seem to face a draught-power constraint on planting. Adoption of new cotton technology by this group would have the biggest impact on aggregate cotton production.

Small growers evidently use cotton to supplement cash income from other sources. They are not the poorest households. They rent land, hire oxen for ploughing and hire labour for weeding. Thirty percent of their income is earned off-farm. This group would adopt new technology that increased their profits from cotton. But they are small players and adoption would not have much impact on aggregate cotton production.

Since all four groups use chemical sprays for cotton, all would benefit from IPM interventions to reduce their frequency. Large growers would save the most cash in absolute terms. The poorest growers would also benefit, however. “Lower productivity” medium growers would benefit not only from spraying less often, but because they might then be able to afford to spray at the appropriate time. The poorest producers sprayed as frequently as other groups, but later. Evidence suggests they sprayed late because they lacked cash to acquire insecticides on time. Thus, IPM would save poor cotton growers money they can ill afford, and also help improve the timeliness of spraying, boosting yields and their income from cotton.

Activity 1.4 Conduct economic cost-benefit analysis of best-bet IPM strategies

Achievements

Table 1.12. Costs and returns for IPM and non-IPM cotton pest control, Kasese district, 2003B season

Costs that vary	Units	Calendar spraying	High input plots		Low input plots	
			IPM [a]	Non-IPM	IPM [a]	Non-IPM
Labour for spraying						
Quantity	Days/acre	4	3.3	3.4	2.5	3.4
Costs [b]	UGS/acre	4000	3300	3400	2500	3400
Labour for scouting						
Quantity [c]	Hours/acre	-	8	-	8	-
Costs	UGS/acre	-	1200	-	1200	-
Materials						
Insecticide [d]	UGS/acre	8000	6600	6800	5000	6800
Hire of pump [e]	UGS/acre	2000	1650	1700	1250	1700
Sprays	No.	4	3.3	3.4	2.5	3.4
Total costs that vary						
Cash costs	UGS/acre	10000	8250	8500	8750	8500
Full costs	UGS/acre	14000	12750	11900	9950	11900
Benefits						
Yield	Kg/acre	Na.	1163	882	718	816
Price	UGS/kg		600	600	600	600
Gross returns	UGS/acre		697800	529200	430800	489600
Net returns	UGS/acre	Na.				
Cash-cost basis	UGS/acre		689550	520708	422050	481100
Full-cost basis	UGS/acre		685050	517300	420850	477770

[a] Technician's plots
[b] wage rate of 1000 UGS/day
[c] 1 hour to scout 50 plants/acre, weekly for 8 weeks
[d] UGS 2000/acre (commercial price)
[e] 500 UGS/spray (baseline survey)

Net returns from IPM for new cotton technology were estimated by comparing yields and frequency of spraying on plots monitored by IPM technicians (IPM-plots) and demonstration plots without IPM. On non-IPM plots, farmers did not always follow the recommended calendar-based spraying regime. For comparative purposes, the cost of the recommended calendar based regime has been included.

Results from Kasese [Table 1.12] district (2003B season) show that:

- Net benefits were higher on IPM plots for both high-input and low-input cotton technology.

- Benefits from IPM were greater on high-input technology plots. On a cash-cost basis (excluding labour costs), IPM gave an additional 168842 UGS/acre with high-input technology and an additional 59050 UGS/acre with low-input technology.

- On both a cash-cost and full-cost basis, costs on IPM plots were lower than costs of the calendar-spray regime.

Table 1.13. Costs and returns for cotton in Pallisa and Kasese districts, Uganda, 2002.

Description		District	
Costs	Units	Pallisa (n=31)	Kasese (n=48)
Family labour [a]	Days/acre	41	39
- costs [b]	Uganda shillings	41,000	39,000
Of which:			
Weeding labour	Days/acre	24	14
Costs	Uganda shillings	24000	14000
Spraying labour	Days/acre	1	2
Costs	Uganda shillings	1000	2000
Hired labour	Uganda shillings	29,076	28,976
Of which:			
Weeding	Uganda shillings	7754	6566
Spraying	Uganda shillings	1865	2940
Pest control			
- insecticide	Uganda shillings	2977	5271
- hire of pump	Uganda shillings	1655	1911
Total – full cost basis [c]	Uganda shillings	74708	75158
Total – cash cost basis [d]	Uganda shillings	33708	36158
Benefits			
Yield (seed cotton) [e]	Kg/acre	200	700
Price [f]	shillings/kg	350	350
Gross revenues	Uganda shillings	70000	245000
Net returns			
- Full cost basis [c]	Uganda shillings	-4708	169842
- Cash cost basis [d]	Uganda shillings	36292	208842
Cost-benefit ratio			
- Full cost basis [c]		0.94	3.26
- Cash cost basis [d]		2.01	6.78

Source: Grower Survey, NRI/IDEA 2002.
Notes:

[a] Standardised to 6 hours/day using weights of 1.0 for adults and 0.5 for children (aged <=15).
[b] using market wage rate of 1,000 shillings/day
[c] including cost of family labour

[d] excluding cost of family labour
[e] median, based on farmers' estimate of expected yield
[f] official producer price at start of the buying season (November, 2002).

1 US $ = 1875 Uganda shillings (November, 2002).

Table 1.14. Cotton pest management variables Pallisa and Kasese districts, 2002 season.

Variable	District		Significance-level (P)*
	Pallisa (n=60)	Kasese (n=60)	
Area cultivated (acres)	12.73	5.17	0.008
Area planted to cotton (acres)	3.01	2.57	0.264
Household owns sprayer pump?			
- Yes	15	13	0665
- No	45	47	
Total expenditure on sprays	5921	14227	0.001
Total expenditure on pump hire	4529	6000	0.273
Average number sprays/field			
Mean	2.83	2.87	0.759
Median	3.00	3.00	
Mode	3.00	4.00	
Frequency of sprays/field	(n=110)	(n=95)	
0	1	0	0.061
1	11	12	
2	29	28	
3	37	16	
4	29	38	
5	3	1	
Sources of information on cotton	(n=60)	(n=59)	
Extension worker	39	51	0.005
Radio	34	16	0.001
Friends/neighbours	21	14	0.177
Written material	6	3	0.311
Own knowledge	35	1	0.001
Looking at other fields	18	10	0.093
Parents/family	34	9	0.001
Other	6	6	0.976
For non-demo farmers:	(n=29)	(n=27)	
- Heard about demo plot	28	25	0.511
- Visited demo plot	20	24	0.069
- Attended field day at demo plot	15	18	0.256
- Know farmer with demo plot	26	25	0.700

* By one-way ANOVA or Chi-square

Cotton production variables were similar in the two areas [Table 1.14] and most farmers were aware of the cotton demonstration programme, and 25% had visited one. Advice from extension seems to be more easily obtained in Kasese than in Pallisa.

Table 1.15. Farmers views on factors limiting cotton production

Variable	District		Significance-level (P <)*
	Pallisa	Kasese	
Most important causes limiting cotton yields on your fields (no. of farmers reporting):	(n=60)	(n=59)	
Weeds	50	41	.0751
Diseases	9	3	.0725
Pests	40	49	.0395
Soil fertility	19	10	.0615
Weather	42	35	.2229
Lack of knowledge	2	9	.0247
Lack of inputs	11	24	.0074
Trained in safe handling of pesticides			
- Yes	47	33	.0139
- No	11	22	

* By one-way ANOVA or Chi-square

Farmers' perceptions of their constratnts was similar in the two areas surveyed with weed control coming out top. Lack of inputs was more important in Kasese than in Pallisa [Table 1.15].

Activity 1.5 Advise and support IDEA on monitoring and evaluation for cotton demonstration programme

<u>Achievements</u>

IDEA employs an M & E specialist whose responsibilities cover not only cotton but other cash crops like beans and maize, lower value crops, and horticulture. Because of this workload the M & E specialist is primarily concerned with monitoring, and evaluation is largely contracted to external consultants. Thus, collaboration with NRI has allowed the M & E specialist to obtain information about cotton growers that would otherwise have been unavailable.

Cooperation with the M & E specialist has involved collaboration in the design and administration of the baseline survey (2002B season) and an adoption-process study (2003B season). The M & E specialist also participated in training enumerators for the baseline survey.

NRI has had relatively little involvement with IDEA's monitoring of new cotton technology. IDEA collects input-output data from its cotton demonstration plots. This data has been used to provide an assessment of the 2001 Cotton Demonstration Program (Mwesigwa, 2002). From 2003B season, monitoring has been systematised. A monitoring book is kept for each demonstration plot operated by a lead farmer. This records the names and gender of collaborating farmers; the quantity and costs of different inputs; harvest data; information on scouting; and cost of production data. This will provide valuable information on farmers' use of IPM and the costs and benefits of new cotton technology.

For example:

- Data from high-input and low-input plots will show the difference in yields between plots with fertiliser and herbicides and those without.

- Data from high-input plots will show variation in yields with fertiliser application, and allow estimation of the risk of fertiliser use. For example, what share of fertilised plots had negative returns, what share broke even, and what share had positive economic returns?

IDEA's current monitoring system requires strengthening in at least two areas. First, the volume of information being collected will prove very difficult to analyse efficiently. This season (2004) the industry had organised 6,000 demos with 15 contact farmers per demo. The target was 12,000 demos and 180,000 farmers. This would include the majority of cotton growers in Uganda. According to Ben Sekamatte, the total number of demos actually in place this season was 6,400 funded by APEP and 700 funded by ginneries. Some ginneries have 30 contact farmers/demo rather than the suggested 15. Rather than collect information from this huge number of plots, it would be more appropriate to select a sample.

Second, there is an apparent lack of reliable figures on cotton yield with and without new technology. Yield information is given in the form of means (Mwesigwa, 2002). The raw data for these trial plots was obtained to estimate dispersion around the mean. Efforts by NRI to locate the data from 2002 demonstration plots, which was collected by SPEED, were unsuccessful, since the person responsible has now left the organisation. Future evaluations of IDEA demonstration plots need to pay more attention to the question of comparative yields. If this cannot be obtained accurately through the existing monitoring system, a sampling approach should be used to provide accurate data. To design an appropriate sampling frame, it is recommended that IDEA employ the services of a professional statistician.

Both these points were made at the recent Workshop where the IDEA (now APEP) management and the M & E specialist were present. However, IDEA/APEP remains committed to a complete coverage (census) approach for the 2004B season.

OUTPUT 2. STRATEGIES FOR IPM AND ICPM IN SMALLHOLDER COTTON TO REDUCE IMPACT OF PESTS AND IMPROVE ECONOMIC RETURNS PROMOTED.

Activity 2.1 Assessment of training needs for cotton IPM trainers and farmers

Achievements

The main partner with NRI in this project was the' IDEA' project[later became' SPEED' then' APEP']. These projects promote improved cotton agronomy through close collaboration with the private sector ginning companies. District extension officers have been involved but every 10 of the cotton demonstrations has a site co-ordinator provided by the corresponding ginnery. Site co-ordinators were trained by IDEA and they in turn train the demonstration farmers. Each farmer is then expected to train at least 15 - 20 of his neighbours. The CPP project has added the IPM component to this system and undertaken a training of trainers exercise to train all the site co-ordinators in the principles of IPM, identification of pests and beneficial insects and scouting using a peg board to record insect numbers. As the demonstration programme expanded to over 600, more than 60 site co-ordinators were trained in IPM and large numbers of peg-boards were required to supply all the demonstration farmers and then at least their 15 trainees.

Activity 2.2 Develop training courses for IPM trainers

Achievements

Based on the preliminary training in Kasese and experience in India and Africa, Derek Russell and Ben Sekamatte developed training material for the March 2003 training of IPM facilitators in Pallisa and provided templates to IDEA for printing and distribution as required.

The intention was to put IPM issues in a global and local context for the demonstration co-ordinators, review the success of the previous season and undertake theoretical and practical training in the necessary IPM skills. These included:

- Understanding the role of various pests, beneficials, weeds and diseases in the cotton system and of the limitations these roles place on the tolls available for management.
- Understanding the nature of the plant protection chemicals, their advantages and limitations.
- Understanding the need for pest scouting and being clear on how to undertake it, including the values and use of the project 'pegboard' system.
- How to efficiently apply pest management chemicals.
- How to facilitate farmers to take up these skills and practices.
- How the progress reporting system will operate in 2003.

Activity 2.3 Deliver training of trainers in cotton IPM

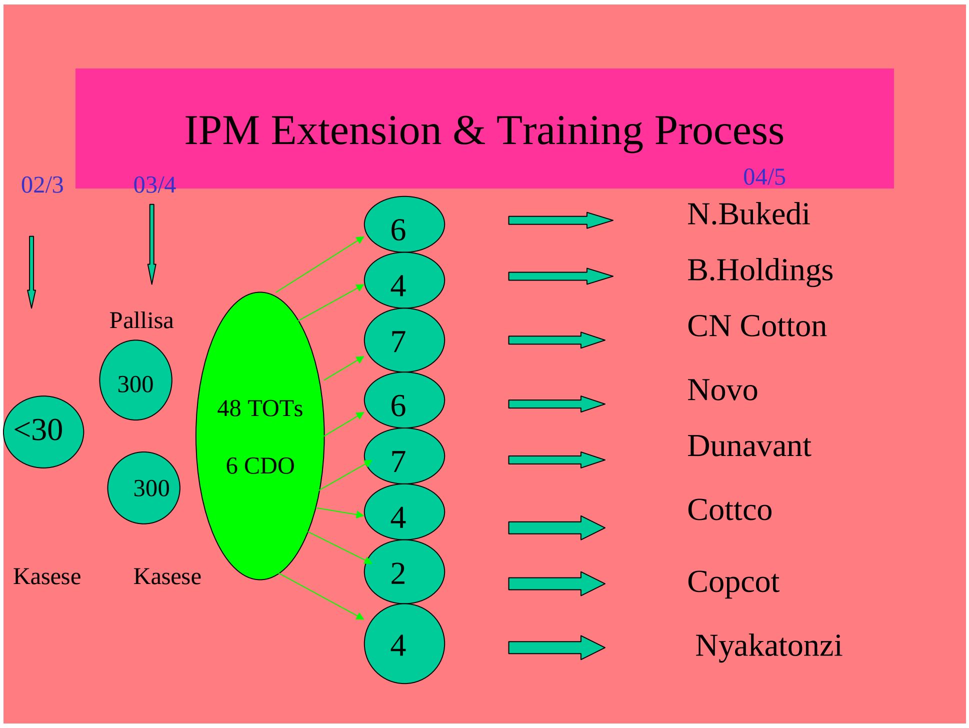
Achievements

A general IPM theory training and an introduction to the biology of the main cotton pests and the theory of their control was given in the field to the 30 IPM scouts in

Kasese in September 2002, with such limited visual material as could be organised at short notice. The IPM scouts then delivered training to the 300 participating farmers.

For the 03/04 season the training was repeated in Kasese with the completed manuals and expanded to include a further 300 scouts in Pallisa [see Fig 2.1]. During 2004 training was conducted at the Busitema Cotton Training Centre of 48 site co-ordinators provided by the participating ginneries and a further 6 provided by CDO. By now almost all of the private sector ginning companies were participating in the APEP.

Fig 2.1. Progress in training of trainers



TOT = Training of trainers from ginneries. Column on the right indicates the ginning companies that provided the personnel to be trained.

Busitema Cotton Training School

CDO are interested to expand cotton training activities at the Busitema National College of Agricultural Mechanisation on the Tororo-Mbale road. This small college has had a ginning training programme for some years. According to ICAC, this is the only ginning school in Africa and one of only four in the world. It operates under the Technical and Vocational Programme of the Ministry of Education and Sports offering various certificates and diplomas. The school trains 10-20 ‘engineers’ in cotton ginnery skills each year (two levels – certificate and diploma). Graduates seem to find work readily within the region.

CDO orchestrated additional financial support from the ginners – Uganda Cotton Ginners & Exporters Association [UCGEA] to enable larger, short-term courses in IPM and other things to be run. Residential facilities and water supplies have been upgraded and the first extension IPM course was run there in September with 26 trainees; most ginneries sending 1-2 staff for training. David, Mark and Martin were the IDEA trainers and Ben and Lastus provided DFID/NARO inputs. Two further courses will be run in Nov and January.

The International Cotton Advisory Council [ICAC] would like to see this built upon as an E.African regional facility (my discussions with Rafiq Chaudry who has visited the centre). This would fit well with APEP (and the DFID project) needs and it has been suggested to APEP that this might be an area that DANIDA or DFID could support. 20 acres of cotton have been planted for IPM trails and experiments for 2004. APEP put in an irrigation capacity to enable training to occur year round.

CDO and UCGEA have put considerable resources into building up Busitema College as a national, and possibly regional, cotton production training centre, including the planting of early cotton for IPM training. The Kadoma training centre provided a tremendous resource for Zimbabwe cotton; the intention is for Busitema to take that role in Uganda. DANIDA seems likely (i.e. has agreed in principle but not yet signed up) to support this centre shortly. A full-time trainer and cotton manager to run the Busitema training was appointed and the CPP project supported this national capacity building from 1 June 04 to end Feb 05.

Student 'Intern' Scheme

APEP is using BSc students in their final year (when they undertake a field programme) as 'interns' to support the implementation of the demos and collection of data in the cotton zones. The CPP project supported one intern in each zone for three months (June to Sept) specifically to collect and analyse the data necessary to validate the benefits (and problems) of the IPM system. This was necessary as there will be no non-IPM demos to produce data for comparative purposes.

Activity 2.4 Field demonstration of the IPM and ICPM systems.

<u>Achievements</u>

IPM demonstration results in Kasese and Pallisa in 2003

In 2002, testing of the IPM system was carried out with a small number of growers in Kasese only, with non-IPM demo plots and farmer practice plots as controls. This validation exercise was expanded in 2003 in both Kasese and Pallisa [Tables 2.1-2.5].

Table 2.1. Yield and number of sprays in Pallisa 2003

	DEMO FARMERS		
	Data from Site Co-ordinators ex lead farmers N=313		**Data from Technician scouting N=14**
	High Input	**Low Input**	**Low Input only**
Mean Yield Kg/ha	**1745.4** ±588.3	**954.7** ± 371.3	**933.6** ± 265.6
Mean Yield Kg/acre (± s.d.)	**733.1** ±247.1	**400.1** ± 156.1	**392.3** ± 111.6

Mean No. of sprays	**2.8** +1.1	**2.3** +1.0	**2.6** + 0.9
Range	1-5	1-5	2-4
Sprays required ex technical scouting every 14 days*	7	4	

*If the required sprays had been made, the need for later applications should have been reduced.

Table 2.2. Pest damage in Pallisa 2003

SUMMARISED TWO WEEKLY INSECT DATA COLLECTION FROM 10 DEMO PLOTS									
	HIGH INPUT					**LOW INPUT**			
DATE	**Average damaged plants (50 plants/plot)**					**Average damaged plants (50 plants/plot)**			
	Aphid	**Lygus**	**BWs**	**Stainer**		**Aphid**	**Lygus**	**BWs**	**Stainer**
Ist week Aug	9	8	2	0		7	5	2	0
3rd week Aug	15	5	2	0		6	17	2	0
Ist week Sept	4	21	3	2		5	5	3	2
3rd week Sept	4	16	9	1		5	9	5	1
2nd week Oct	3	38	9	0		7	27	9	0
4th week Oct	1	9	3	0		1	9	3	0
2nd week Nov	2	7	17	2		3	7	17	2
Mean/plant	0.11	0.3	0.13	0.01		0.1	0.23	0.12	0.01
No. recommended sprays*	1	3	3	0		0	2	2	0

* Required according to the scouting by the technicians at 14 day intervals but not made – farmers were undertaking their own scouting and spraying (over the low and high input plots as one unit) and actually sprayed an average of 2.6 + 0.93 times.

Table 2.3. Yield and number of sprays in Kasese 2003

	DEMO FARMERS			
	Data from Site Co-ordinators ex lead farmers N=258		**Data from Technician scouting N=10**	
	High Input	**Low Input**	**High Input**	**Low Input**
Mean Yield Kg/ha	**2,277.2** + 1,017.4	**1,330.9** + 598.6	2,770 + 631.8	**1710.0** + 413.9
Mean Yield Kg/acre (+ s.d.)	**956.6** + 427.4	**599.0** + 151.4	1,163 + 256.4	**718.0** + 173.8
Mean No. of sprays	**2.7** + 1.1	**2.3** + 1.0	3.3 + 0.67	**2.5** +1.0
Range	1-5	1-4	2-4	1-4

Sprays required ex technical scouting every 14 days*			4	3

*If the required sprays had been made, the need for later applications should have been reduced.

Table 2.4. Pest damage in Kasese 2003

SUMMARISED TWO WEEKLY INSECT DATA COLLECTION FROM 10 DEMO PLOTS									
	HIGH INPUT					**LOW INPUT**			
DATE	**Average damaged plants (50 plants/plot)**					**Average damaged plants (50 plants/plot)**			
	Aphid	**Lygus**	**BWs**	**Stainer**		**Aphid**	**Lygus**	**BWs**	**Stainer**
2nd week Oct	2	3	0	0		23	0	0	0
4th week Oct	15	7	0	0		6	2	0	0
2nd week Nov	4	19	1	0		5	5	0	0
4th week Nov	4	9	4	1		5	5	2	1
2nd week Dec	3	22	11	0		7	16	7	0
4th week Dec	1	4	4	0		1	3	13	0
3rd week Jan	2	4	7	3		3	2	3	1
1st week Feb	7	2	5	2		2	5	5	3
Mean/plant	1.0	0.18	0.08	0.02		0.13	0.10	0.08	0.01
No. recommended sprays*	1	2	1	0		1	1	1	0

* Required according to the scouting by the technicians at 14 day intervals but not made – farmers were undertaking their own scouting and spraying (over the low and high input plots as one unit) and actually sprayed an average of 3.3 ± 0.67 times in the high input plots and 2.5 ± 1.0 times in the low input plots.

Table 2.5. Yields from high and low input plots, with and without IPM in Kasese.

	High Input				**Low Input**			
	Yield Kg/acre	**± s.d.**	**No of sprays**	**± s.d.**	**Yield Kg/acre**	**± s.d.**	**No of sprays**	**± s.d.**
2003								
IPM-demos n=259	**956.6**	427.4	2.7	0.97	**559.0**	151.4	2.3	1.05
2002								
IPM demos *n=10	**976.5**	168.9	1.6 + 1 soap		**847.5**	81.1	1.6 + 1soap	
Non-IPM demos * n=10	**881.9**	93.6	3.4	0.52	**816.0**	112.6	3.4	0.52
Farmer					**307.0**	72.0	1.6	0.7

Practice n=10								
2001								
Non-IPM demos n = 10	**904**				**626**			
Farmer practice n = 10					**350**			

* 2002 yields in IPM and non-IPM plots not significantly different

Conclusions [Tables 2.1 – 2.5]

Yields:

- Low input plots in Pallisa in 2003 yielded 2.0 times non-demo farmer yields from 2001. High input plots yielded 3.7 times as much.
- Low input plots in Kasese in 2003 yielded 1.6 times non-demo farmer yields from 2001. High input plots yielded 2.7 times as much.
- High input plots yielded 80% more than low input plots in Pallisa and 71% more in Kasese
- All farmers produced more yield on their high input plots than on their low input plots.
- Yield is very variable. Some farmers produced less on their high input plots than others did on their low input plots.

Pest numbers:

- The general pattern of pest attack was as expected, with aphids early, lygus later, bollworms later still and a few stainers at the end of the season.
- As realised by the farmers, pest numbers were generally higher in the high input plots (they were not asked to scout the two plots separately).

Spraying:

- $US 30/acre. In the IPM demos the cost of producing a Kg of cotton was around 320/- In the demonstrations farmers scouted the low and high input plots together and they should have been sprayed together when required. In fact high input plots were sprayed more often (2.8 v 2.3 in Pallisa and 2.7 v 2.3 in Kasese).
- Technical scouting (50 plants every two weeks, versus 25 plants/week for the farmers) suggests that Kasese farmers were spraying only slight less than perhaps they should have been (about 0.5 sprays) but the Pallisa farmers should have been spraying considerably more frequently. It may be that if the technicians recommendations for spraying had been followed in the early season (and farmers were not asked to do this), there would have been less need for later sprays. However, it is clear that farmer spraying was not doing an adequate job.
- Technical scouting suggests that the high input plots should be sprayed more frequently than the low input plots (4 versus 3 times in Kasese and 7 versus 4 times in Pallisa).

- In practice, chemicals were available in a reasonably timely manner in Kasese (where the ginnery had a good stock of quality chemicals). In Pallisa, the chemicals were late and of poor quality (much of the stock was returned for replacement), resulting in many delays. This made timely applications very difficult, perhaps to the point where many farmers were not able to spray in a more timely fashion than their non-IPM counterparts.
- Spraying was light in this season (perhaps too light). Is this due to lack of access to material or lack of willingness to pay for materials once the IDEA/SPEED provided product was used up? In Pallisa it is clear that the supply chain did not function adequately, removing most of the benefit from the scouting.
- All 6,000 demo plots will be IPM plots. Therefore the 2003 data is only chance to quantify IPM impacts on yield and cost unless we set up specific trails to do so. We therefore need the non IPM demo data ex SPEED.
- Much of the spraying was not done at the proper time because of the non-availability of the proper (or any) insecticide. This makes nonsense of the scouting! The single more important thing that APEP could do in 2004 is to try to make the spray materials available on time.
- All ginneries should have sufficient single organophosphates (preferably systemically active ones like dimethoate) available for two applications and sufficient pyrethroid for a further two applications. On the basis of experience to date, IPM farmers will expect to spray on average 3-4 times with a range of 1-5. One or more of these applications is likely to be soapy water for aphids.
- The Micron Ulva+ sprayers being distributed may not be suitable for aphid control with soapy water (where spraying upwards at a high volume is required), nor for herbicides where higher application volumes are required (despite the company advice). This should be carefully tested this season, as farmers would otherwise require to have access to both the knapsack and Micron Ulva+ sprayers.
- Profitability: The increase in farm gate minimum prices from 255 Shs/Kg in 2001 to 350 Shs/Kg in 2002 and 600Shs/Kg in 2003 has changed the economics of the demonstrations dramatically. In 2001 neither farmers practice nor the low or high input demos broke even. Whether the farmers made a significant profit in 2003 depends on which production costs are used in the calculations. In Kasese at least, even the conventional practice farmer would have made a small profit of around for the low input plots and 255/- for the high input plots. Net profit in the low input plots would thus have been around 156,500/-/acre (c.$US84) and in the high input plots 327,900/-/acre ($US177) even with labour cost included.

Activity 2.5 Production and dissemination of extension literature.

Achievements

A set of training visuals was produced in S. Africa and Kampala. These were used in the initial training. The draft co-ordinator manual (22 A4 pages) was revised in Kampala and trialled in the training. It was then revised, and the illustrations added. For the participating farmers, a short guide to the IPM scouting and pest management procedures was finalised, as has a guide to weed control, including the use of minimum tillage.

With funding from the CPP project and the US Aid projects two booklets were printed in sufficient numbers for all the site co-ordinators [600] to have ‘Integrated control of pests, weeds and diseases in Ugandan cotton, and for many of the demonstration farmers [1000] to have a copy of ‘How to control insect pests of cotton. Both booklets contained colour illustrations of the pests and beneficial insects. In addition The agrochemicals company Balton Ltd used the colour photos of insect pests and beneficials to produce a laminated identification chart which is intended to be carried by all demonstration farmers during scouting.

OUTPUT 3. UNDERSTANDING ABOUT MARKET-ORIENTED TECHNOLOGY AND KNOWLEDGE PROMOTION PROCESSES TO REDUCE RURAL POVERTY IMPROVED.

Activity 3.1/3.2 Survey of access to cotton production technology and assess socio-economic constraints to adoption of ICPM technology.

Achievements

The original focus on IPM was broadened to include the new cotton technology package developed and demonstrated by IDEA.

Potential constraints on adoption of new cotton were identified by the baseline survey conducted in 2002B for 120 cotton growers in Pallisa and Kasese districts. Full results can be found in project Working Paper A1060/1.

The survey revealed that IDEA Demonstration Farmers (DFs) were significantly better off then other growers and that adoption of new cotton technology among this group could not be extrapolated to other growers. DFs in Pallisa had larger areas under cultivation, planted to cotton, and under fallow. They were also more likely to own a bicycle, an ox-plough, a farm store, a tin-roof house, a radio-cassette, a TV and a telephone. They owned significantly more livestock (oxen, cows) and chickens. However, they had the same level of food security as non-DFs, buying their staple food for 2-3 months each year. DFs in Kasese had the same area under cultivation, planted to cotton, and under fallow as non-demo farmers. They were more likely than non-demo farmers to own a bicycle, have a farm store, or a radio-cassette. They owned more oxen, goats, pigs, and chickens. But they had the same level of food security as non-DFs.
The survey also showed the levels of cotton yield required to make cotton remunerative to farmers under existing technology.

- On a cash-cost basis (excluding the cost of family labour), CBRs of 2.0 were obtained with yields of roughly 200 kg/acre in each district (193 kg/acre in Pallisa, 207 kg/acre in Kasese). CBRs of 3.0 would require yields of roughly 300 kg/acre, while CBRs of 4.0 would require yields of approximately 400 kg/acre.

- On a full-cost basis (including the cost of family labour), CBRs of 2.0 would require yields of approximately 425 kg/acre (425 kg/acre in Pallisa, 4229 kg/acre in Kasese. CBRs of 3.0 would require yields of roughly 650 kg/acre while CBRs of 4.0 would require yields of 850 kg/acre and above.

These yield levels were achieved in Kasese district, but not in Pallisa where medium-sized growers averaged yields of 126-172 kg/acre (see cluster analysis results presented under Activity 1.3). This was because medium growers had insufficient cash resources for efficient crop management. This suggests that these growers will be unlikely to adopt the high-input cotton technology promoted by IDEA. However, these growers accounted for only 34 % of the area planted into cotton in Pallisa.

IPM, by contrast, will benefit all growers because the technology is not land-augmenting but cost-reducing. The baseline survey showed that cost of chemical pest control (equipment and sprays) averaged 4632 shillings/acre in Pallisa and 7182 shillings/acre in Kasese. Including the cost of hired labour, and valuing family labour for spraying at market rates, the total cost of chemical pest control averaged 7497 shillings/acre in Pallisa and 12122 shillings/acre in Kasese. Expenditure on pest control (hired labour, equipment, and sprays) accounted for 19 % of cash costs in Pallisa and 28 % in Kasese. This represented 10 % of total costs in Pallisa and 16 % of total costs in Kasese.

Further information on potential adoption constraints was provided by a small study of 31 Demonstration Farmers (DFs) in Kasese district in the 2004B season. Full details are available in project Working Paper 1060/3

Results showed that of the 11 "components" in the cotton technology package:

- Six components (early planting, planting in pure stand, spacing, scouting, removing stalks, and thinning/gap filling) had been almost universally adopted and these components had been quickly extended to all the fields that DFs planted to cotton;

- Components that involved cash costs (herbicide, planting with fertiliser, topdressing fertiliser) had been adopted by only one-third of growers, and growers were much less likely to extend use of these components to all the fields they planted to cotton.

This suggests that DFs were challenged by the cost of some components of the new cotton technology, despite the fact that they were on average better off than non-DFs,

An additional constraint to uptake of new cotton technology was the poorly developed market supply chain. This was illustrated by the experience of DFs in Kasese. The only private fertiliser supplier in Kasese was the Farm Inputs Care Centre (FICA), which operated through a network of stockists at various trading centres. Stockists get fertiliser on credit at reduced prices to allow them a trading margin. Many of the DFs that we interviewed buy inputs from Mbwera Mponda trading centre, which did not have a stockist in 2003. This left cotton growers wishing to buy fertiliser with a 60 km trek into Kasese, adding significantly to overall costs.

Activity 3.3 Assess institutional constraints to increased cotton production.

This activity was made redundant by recent research on cotton market systems. This included the Research Project on "Competition and Coordination in Cotton Market Systems in Southern and Eastern Africa" conducted by Imperial College (http://www.wye.icac.uk/AgEcon/ADU/research/projects/cottonE/)
This research covered Mozambique, Tanzania, Zambia, and Zimbabwe. For Uganda, institutional issues for the cotton sector were recently analysed by:

NRI/KIT (2002). *Transaction Cost Analysis, Final Report. Prepared for the Modernisation of Agriculture*. NRI Report No. 2708. Project Code C1521. Mimeo, 194 pp. final consultancy report can be read on NRI's project database.

Cotton production at current national average yields and farm gate prices is unprofitable for farmers in many parts of the country and future profitability will be dependent on improved efficiencies in production, marketing and processing, enabling economically viable farm gate prices to be paid. The profitability of the cotton enterprise to farmers is essential for the long term sustainability and expansion and we consider that his is the key issue facing the sector. Farm gate prices are not transparent and the indicative price advised by the CDO remains in force for a whole season despite fluctuations in global levels.

Substantial national ginnery over-capacity exists and factory units tend to be old with, in many cases, outdated technology and a national strategy for the rationalisation of the size and location of ginneries is essential to achieve sustainability and growth of the sector. The value-added sector is very small, under financed and unable to take advantage of the opportunities presenting themselves in the textile sector and oil-milling sector.

J. Lundbaek (2002). *Privatisation of the Cotton Sector in Uganda: Market Failure and Institutional Mechanisms to Overcome It*. Dept. of Economics, Copenhagen, Royal Danish Agricultural University. Abstract can be read at http://www.netard.dk/viewAbstract.php?Id=17

For policy purposes the report says, agricultural policy and research need to [i] focus more on the costs and benefits of the use of important inputs [i.e. pesticides and fertilisers] in cotton production, thus identifying optimal on-farm needs for increasing productivity; [ii] focus more on smallholder credit constraints preventing smallholders from obtaining inputs when they need them; [iii] focus more on the potential role of government in providing these services, where the private sector fails to do so.

Publications

As a promotional project, the work done did not produce data suitable for publication in Peer-reviewed journals. The dissemination outputs consist therefore of conference presentations, internal reports and extension manuals.

Conference presentations

LUSEESA, D., SEKAMATTE, B and RUSSELL, D. (2003) Advances in the extension of Ugandan cotton management. [Scientific Poster] World Cotton Research Conference [3], Cape Town, South Africa, 9 - 13 March 2003.

SEKAMATTE, B., RUSSELL, D. A., HILLOCKS, R. J., ORR, A. and RICHES, C. (2003) Extending IPM practices into Ugandan cotton pest management. Paper presented at the African Crop Science Congress, Nairobi, Kenya. 12 – 17 October 2003.

Working papers

ORR, A., WATHUN, P. and Kayobyo, G. (2003) Cotton Grower Survey, Pallisa and Kasese Districts, Uganda. DFID Renewable Natural Resources Research Strategy Crop Protection Programme. Working Paper A1060/1, Natural Resources Institute, Chatham, Kent, 19 pp.

ORR, A. (2003) Classification of Cotton Growers in Pallisa and Kasese Districts of Uganda. DFID Renewable Natural Resources Research Strategy Crop Protection

Programme. Working Paper A1060/2, Natural Resources Institute, Chatham, Kent, 27 pp.

ORR, A., WATHUM, P. AND KAYOBYO, G. (2004) Adoption of new cotton technology in Kasese District, Uganda. DFID Renewable Natural Resources Research Strategy Crop Protection Programme. Working Paper A1060/3, Natural Resources Institute, Chatham, Kent, 28 pp.

Visit Reports

HILLOCKS, R. J. [2002]Report of a visit to Uganda to initiate a project on cotton IPM, 23 September - 4 October 2002. Report A1060[1]. Natural Resources Institute, Chatham, Kent, 34 pp.

ORR, A. (2002) Report of a visit to Uganda to design and initiate a socio-economic survey of cotton growers, 16 - 28 November 2002. Report A1060[2]. Natural Resources Institute, Chatham, Kent, 7 pp.

RUSSELL, D. (2003) Report on a visit to S. Africa and Uganda to present the results of the CPP cotton IPM project and to organise for the 2003-4 cotton season, March 6- 31 2003 Project R8197, Natural Resources Institute, Chatham, Kent, 8 pp.

RICHES, C. R. (2003) Report on a visit to Serere, Uganda for the CPP cotton IPM project, May 15 – 21st 2003. Project R8197, Natural Resources Institute, Chatham, Kent, 10 pp.

HILLOCKS, R. J. (2003) Report of a visit to Uganda to review cotton ICM trials, 24 - 31 August 2003**.** Project R8197, Natural Resources Institute, Chatham, Kent, 4 pp.

ORR, A. (2003)Report of a visit by the Agricultural Economist to the Cotton IPM Project in Uganda, 22 Sept- 4 Oct 2000. Project R8197, Natural Resources Institute, Chatham, Kent, 8 pp.

RUSSELL, D.R. (2003) Report of a visit by the Entomologist to the Cotton IPM Project in Uganda, 18 Oct – 02 Nov 2003. Project R8197, Natural Resources Institute, Chatham, Kent, 8 pp.

RUSSELL, D. R (2004) Report of a visit to Uganda to support the CPP cotton OPM project R8197, 10-25 April 2004, Natural Resources Institute, Chatham, UK, 7pp.

RICHES, C. R. (2004) Report of a visit to Uganda to support the CPP cotton IPM project R8197, 30th May to 6th June 2004, Natural Resources Institute, Chatham, UK 9 pp.

HILLOCKS, R. J. (2004) Report of a visit to Uganda to review cotton ICM trials, 24 - 31 August 2003, Natural Resources Institute, Chatham, UK, 4 pp.

ORR, A. (2004) Report of a visit to Uganda to conduct an impact survey among cotton farmers and attend project workshop, 23 September – 01 October 2004. Project R8197 Natural Resources Institute, Chatham, UK 11 pp.

HILLOCKS, R. J. (2004) Report of a visit to Uganda to attend cotton IPM project workshop, 20/30 September 2004. Project R8197, Natural Resources Institute, Chatham, Kent, 2 pp.

Other dissemination, training etc.

RUSSELL, D. A. (2003) Integrated Control of Pests, Weeds and Diseases in Ugandan Cotton. A guide for use with the SPPED.IDEA cotton demonstrations. SPEED Project, Kampala, Uganda, 32 pp.

RUSSELL, D. R. (2003) How to Control Insect Pests of Cotton. A guide for use in cotton field demonstrations. SPEED project, Kampala, Uganda, 11 pp.

APEP[Uganda](2004) *Cotton IPM*. 20 min. 20 copies. [Video] [Extension & Farmers Groups].

Contribution of outputs to developmental impact

Project Goal: Strategies developed and promoted to reduce the impact of pests and stabilise yields in smallholder cotton in Uganda.

The project has made an impact on development by developing and promoting improved cotton crop and pest management strategies. The project has also worked successfully with the private sector to deliver extension services to smallholders, training over 600 trainers in IPM.

From 2004 on wards the US AID funded programme of on-farm demonstrations [OFDs] (which included the IPM system developed by the project) was expanded to reach around 6000 by the end of 2004 and by May/June 2005 when the crop is planted in Pallisa, the IPM system will have been adopted on all 6000 OFDs.

Such a massive programme of OFDs means that initial adoption of IPM will extend to at least 12,000 demonstration farmers by the end of the programme in 2007. With each demonstration farmer responsible for training 15 of his neighbours, this means that 180,000 cotton farmers [more than half the national total] will have been reached by the technology by 2007.

The IPM system in combination with the IDEA agronomy system constitutes a fully integrated crop and pests management [ICPM] system for cotton. However, it is clear from our M & E activities that few farmers are willing yet to adopt the full package, but are taking individual components. Many farmers are reluctant to spend money on herbicide although the use of reduced tillage was shown to save on both labour and cut the cost of hiring oxen.

Although the project has the advantage of access to 6000 demonstrations and IPM was adopted at those sites, problems remain with delivering knowledge-intensive technologies to large numbers of scattered smallholders. Other studies have highlighted problems in the cotton sector with lack of confidence in the farm gate price and poor access to affordable credit for input purchase. Through this project some progress has however been made in developing a model for private sector engagement in agricultural service delivery.

In implementing the IPM system the project has helped to build the capacity of CDO and the ginning companies in IPM. Over 60 individuals have been trained as IPM

trainers and practitioners. Most of these are funded by the ginning companies, expanding the involvement of the private sector in agricultural service delivery.
The project has also helped in capacity building with the expansion of cotton training activities at the Busitema College.

Main conclusions:

IPM adoption on smallholder cotton can reduce the number of sprays and/or make spraying more efficient.

Widespread adoption requires large-scale training of trainers to deliver the technology to farmers. It is knowledge intensive and few of the contact farmers at the outset, were aware of natural enemies, often targeting their sprays at beneficial insects such as ladybird larvae and lacewings.

Crop management levels are often poor and IPM needs to be implemented within an ICM framework.

IPM needs to be adopted as a national policy to which all stakeholders should subscribe. A good example of the failure to achieve this was that the insecticides recommended by CDO were not IPM-compatible. That they should be those most compatible with IPM is fundamental to successful implementation of IPM.

Making time or finding the labour to weed at the right time remains one of the major constraints to increased cotton yields. Reduced tillage with herbicide offers one option, while greater use of animal draught for inter-row cultivation may be another option.

The private sector [ginning companies] is willing to invest in crop development. In this case there is strong incentive because demand for seed cotton exceeds supply.

Adoption of all components of the ICM system [combining APEP agronomy with NRI IPM] was rare outside of the OFTs. Farmers picked some of the technologies –often those that were cost-neutral.

The education of farmers in best practice for crop management and crop protection is a continuous process. For cash crops this needs to be supported by the private sector, backed by the appropriate authority, in the case of cotton this should be a partnership between the CDO and the UCGEA.

ADOPTION & EXIT STRATEGY

The project has seen a commitment by the private sector to take on agricultural service provision. Ginning companies have provided extension staff that are now trained in cotton IPM. Some ginning companies have planted cotton demonstrations additional to those in the APEP programme. This is a long-term commitment to crop development in Uganda and a model that can be followed elsewhere in the region.

CDO has also bee involved in the development and expansion of the cotton IPM system which also contributes to the sustainability of the system.

Through the combined efforts of CDO, UCGEA and DFUID through the CPP project, Busitema College has been developed into a Cotton Training Centre that may eventually serve the entire region.

There are permanent interests and institutions that will remain committed to increasing cotton yields and output in the smallholder sector, long after the APEP and CPP project end. The main promotional pathway for the projects IPM system will be the private sector ginning g companies and the network of IPM trainers.

Attach final version of logframe: *(include any revisions such as additional outputs and activities from 'add-on' funding/project extensions).*

Project LogFrame:
All sections to be completed. Please contact the Programme Manager for further guidance if necessary. Successful applicants should note that they will be given the opportunity to revise the LogFrame during the project.

Narrative Summary	**Indicators of Achievement**	**Means of Verification**	**Risks and Assumptions**
Goal			
The goal is given by DFID: **Livelihoods of poor people improved through sustainably enhanced production and productivity of cotton production systems..**	*These are under discussion with DFID. Leave blank.*	*These are under discussion with DFID. Leave blank.*	
Purpose			
Strategies developed and promoted to reduce the impact of pests and stabilise yields in smallholder cotton in Uganda.	By 2005, adoption of IPM practices by cotton farmers giving 20% yield increases.	Monitoring against baseline data. Reports of target organisations.	Economic conditions continue to favour cotton production.
Outputs			
1. Strategies for IPM and ICPM in smallholder cotton developed and tested. 2. Strategies for IPM and ICPM in smallholder cotton to reduce impact of pests and improve economic returns promoted. 3. Understanding	1. ICPM system validated in at least one demonstration site in each of 15 Districts by end 2004. 2. ICPM system widely promoted through field schools, extension and the IDEA network by end of project. 3. Poverty Monitoring and Analysis Unit	1/2. Research reports and reports of target organisations. Socio-economic reports and extension literature. 3. Socio-economic report	Weather conditions favour cotton production. There are no unexpected pest or disease epidemics. World cotton price does not fall substantially during the project cycle. The IDEA project continues to be

about market-oriented technology and knowledge-promotion processes to reduce rural poverty improved	supplied with lessons/recommendations from cotton IPM project		supported by US AID.
Activities			

1.1 Identify appropriate techniques for cotton IPM based on experience in India and Zimbabwe 1.2 Test identified IPM techniques for pest control with minimal use of pesticides under farmers' field conditions 1.3 Validate appropriateness of IPM strategies for different farmer client groups 1.4 Conduct economic cost-benefit analysis of best-bet IPM strategies 1.5 Advise and support IDEA on monitoring and evaluation for cotton demonstration programme 2.1 Assessment of training needs for cotton IPM trainers and farmers 2.2 Develop training literature for cotton IPM trainers 2.3 Deliver training of trainers (TOT) in cotton IPM based on literature and farmer feedback from OFTs 2.4 Field demonstrations/trials on integration of IPM and minimum tillage [ICPM]. 2.5. Production and dissemination of extension literature. 3.1 Survey to determine	1.1/1.2 Field demonstrations set up for 2003 cotton growing season [i.e. by April 2003]. 1.3 Stratification of client groups completed by March 2003 1.4 Cost benefit completed by March 2004. 1.5 M&E system in place by March 2004 2.1 Training literature produced 2.2 Create links for removal of constraints to adoption of ICPM during the 2003 season. 2.3 15 cotton IPM trainers (1 per district) trained by 2004 2.5. Extension literature produced and disseminated to 15 districts by end 2004. 3. Socio-economic reports	1.1/1.2 Quarterly and annual project reports. 1.3 Socio-economic report 1.1 Socio-economic report 1.2 IDEA reports Results of M&E will appear in FTR. 2.1/2.2 Training reports 2.3 Training course report 2.4 Project reports 2.5. Printed extension document.	District officers appointed by the IDEA project are available for training. The IDEA project meets its targets for on farm demonstrations. Transport is available through the IDEA project and/or Cotton Ginners Association. SAARI has access to reliable transport to visit demonstrations on a regular basis.

Biometricians Signature

The projects named biometrician must sign off the Final Technical Report before it is submitted to CPP. This can either be done by the projects named biometrician signing in the space provided below, or by a letter or email from the named biometrician accompanying the Final Technical Report submitted to CPP. (Please note that NR International reserves the right to retain the final quarter's payment pending NR International's receipt and approval of the Final Technical Report, duly signed by the project's biometrician)

I confirm that the biometric issues have been adequately addressed in the Final Technical Report:

Signature:
Name (typed):
Position:
Date: