PROJECT R8197 [FTR Part 5]
APPENDIX 4. Socio-economic Working Paper 2
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Classification of Cotton Growers, Pallisa and Kasese districts, Uganda.

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SUMMARY

Cotton growers in Pallisa and Kasese districts were classified into groups using cluster analysis. The data came from a random sample of 120 growers in Pallisa and Kasese districts conducted in 2003. The sample was stratified to include equal numbers of farmers with IDEA demonstration plots and those without. Cluster variables were selected to capture key aspects of the Teso and montane farming systems.

Cluster groups differed in area planted to cotton, methods used for land preparation, cotton's share in land cultivated, and the availability of family labour for weeding. In Pallisa, medium growers were subdivided into two subgroups, with one relying on hoe cultivation. In both districts, medium and large growers accounted for 90 % of the area planted to cotton.

Cotton management practices showed no consistent pattern between small, medium, and large growers. Medium growers weeded less frequently and gave fewer insecticide sprays (Kasese) or sprayed later (Pallisa). Time of planting did not differ noticeably between groups.

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 large growers, the route to higher productivity lies through more intensive use of inputs on the area planted to cotton. They have sufficient cash resources to buy fertiliser and herbicides. Since they did not plant cotton later than small and medium growers, the incentive for adoption of zero-tillage would be to reduce the cost of land preparation, provided this did not reduce yields from millet.

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 is 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.

INTRODUCTION

Cotton in Uganda is grown across a range of farming systems by an estimated 300,000 smallholders. This diversity has important implications for cotton management. In some systems, cotton may compete for scarce resources with food crops. Among poorer smallholders, lack of working capital may limit access to purchased inputs, such as seed and insecticides. Consequently, the productivity of cotton varies between farming systems and between growers within the same farming system.

The purpose of classifying smallholder cotton growers is twofold. First, at a tactical level, identifying differences between producers should lead to more effective targeting of technical interventions to raise productivity. What are the main constraints on productivity among different groups, and how suitable is the new technology on offer? Second, at a strategic level, the classification is useful for assessing the role of cotton in meeting the national objective of eliminating poverty. Uganda's strategy of "modernising agriculture" is designed to reduce poverty through encouraging production of marketable crops. The classification can identify poor producers, their contribution to cotton production, and the potential scope for improvement in their management practices.

The general objective of this Working Paper is to classify cotton producers in Pallisa and Kasese districts, where IDEA has demonstrated new cotton technology and where the cotton IPM project is conducting on-farm trials (OFTs). The specific objectives are to:

1. Identify producer groups using cluster analysis.

2. Compare their cotton management and socio-economic status.

3. Measure the importance of socio-economic factors for cotton pest management.

The second section of this paper describes data and methods used in the cluster analysis. Section 3 presents results, which are discussed in Section 4. Section 5 concludes.

DATA AND METHODS

Data

The data is drawn from a survey of a random sample of 120 cotton growers from Pallisa and Kasese district (Orr, Kayobyo, and Wathum, 2002). The sample was stratified according to whether growers were "demonstration farmers" with 1-acre IDEA cotton demonstrations on their fields. Of the sample, approximately half (31 in Pallisa and 32 in Kasese) were demonstration farmers. The survey was conducted by trained enumerators in November-December 2002, before the harvest of the 2002 cotton crop.

Methods

Selection of cluster variables

Cluster variables were selected that captured key features of the farming system in each district.

Pallisa represents the Teso farming system, based on the production of annual crops in an environment characterised by light and infertile soils, heavy precipitation in the two rainy seasons and a fairly prolonged dry season from November-March (Parsons, 1970). The main features of this farming system are:

- Cotton is followed by finger millet, the staple food crop;
- Land is prepared for cotton using ox-ploughs;
- Cotton is valued not only for cash income but also as a way of preparing land for millet; and
- Weeding and harvesting of millet reduces labour available for tillage and planting for cotton (Hall and Belshaw, 1972).

Kasese represents a montane farming system, where growers grow coffee and foodcrops in the Rowenzori mountains and rent land on the plain for cultivation during the cotton season, after which they return to the hills. Cotton is a recent introduction. The main features of this system are:

- Cotton is single-cropped, with foodcrops grown in the hills.
- Land for cotton is usually prepared in blocks using tractors.
- Cotton growers grow coffee as a second cash crop.
- Hired labour from neighbouring districts (Bushenyi) is available for weeding.

Cluster analysis

Cluster analysis was used to classify growers into similar groups. The analysis was made in three stages:

1. Bivariate correlation analysis was used to identify variables that were strongly correlated, and remove them from the analysis. Choice of variables for clustering was limited by missing data for some variables. The results identified five cluster variables for Pallisa and four for Kasese.

2. Hierarchical cluster analysis was used to identify cluster groups (SPSS, 1994). In this method, all cases are considered as unique clusters and gradually combined until all the cases are members of a single cluster. Ward's method was used as the method for linking clusters and squared Euclidean distance as the measure for distance between clusters. Because the input variables had different units of measurement they were standardised to *Z* scores with a mean of 1 and a standard deviation of 0. Because of small sample size (n=60), the three-four cluster solutions were specified. The four cluster solution was selected for Pallisa and the three-cluster solution for Kasese.

3. The cluster groups were "profiled" in terms of non-cluster variables to compare differences in cotton management and socio-economic status.

Socio-economic factors determining pest management strategies

Frequency of insecticide sprays (WTSPRAY) for cotton was hypothesised to depend on access to cash, knowledge of cotton production, ownership of a sprayer pump, and the grower's target yield. These hypotheses were tested using regression analysis using Ordinary Least Squares.

RESULTS

Cluster groups

Table 1 shows the results of the four-cluster hierarchical analysis for the sample growers in each district. Tests of significance on the cluster means (*F*-test) were significant at $P < 0.0001$ for all five variables.

Table 2 defines the variables used in the cluster analysis. As noted above, these were selected to capture the key features of each farming system.

Cluster profiles

Tables 3-8 "profile" the cluster groups in terms of cotton management, socio-economic status, and liquidity (an economic term defined as the ease with which an asset can be exchanged for money). In this discussion, it is used as shorthand to describe the amount of ready cash that households have available for cotton production. Because of small

sample size in the clusters, no tests of statistical significance were made for the mean values of the variables between clusters.

Frequency of spraying
Table 9 groups the sample households from both districts into terciles, based on the number of sprays, weighted by the area sprayed. The results showed that growers who sprayed more frequently gave first spraying earlier, weeded more frequently, gave earlier second weeding, and had higher productivity than other growers. They were also more likely to be demonstration farmers. However, they did not plant earlier or plant more cotton than households that sprayed less frequently.

Table 10 defines the variables used in the regression analysis and their expected signs. Table 11 presents the results. The specification explained only 16 percent of the variation in the frequency of spraying. The F-value was statistically significant. Despite its low explanatory power, four of the independent variables were statistically significant, as indicated by the t-test.

ASSETSCORE was significant at $p < .07$, and showed a positive sign, indicating that richer households sprayed more frequently.

LIVSCORE was significant at $p < .04$. and displayed a negative sign suggesting that households with fewer livestock assets sprayed more frequently.

W2HIREPER was significant at $p <.06$ and displayed a positive sign, indicating that households that sprayed more frequently used more hired labour for second weeding.

PRODLAST was significant at .01 and displayed a positive sign, indicating that farmers with higher target yields sprayed more frequently.

The variables representing knowledge of pest management (DEMO, KNOWDEM), ownership of a spray pump (OWNPUMP), and the dummy variable for differences between districts (DCODE) were not statistically significant.

Table 11 shows that higher frequency of spraying was significantly associated with other aspects of cotton management, including frequency of weeding and timing of weeding.

DISCUSSION

Producer groups in Pallisa

The four cluster groups in Pallisa may be described as:

- **Large growers** (6.1 acres), with over half their cultivated area planted to cotton and followed by cereal crops, low use of family labour for weeding, and relying on ox-ploughs for land preparation.

- **Medium growers** (2.69 acres), with more than half of their cultivated area planted to cotton, low use of family labour, and relying on ox-ploughs for land preparation.

- **Medium growers** (2.17 acres), with less than half of their cultivated area planted to cotton and followed by cereal crops, high use of family labour, and relying on hoes for land preparation.

- **Small growers** (1.04 acres), with a smaller share of their cultivated area planted to cotton and followed by cereal crops, high use of family labour, and relying on ox-ploughs for land preparation.

The large, medium, and small grower categories are based on area planted rather than on cotton production. However, information collected for the season before the survey (2002A) show a strong positive correlation between these two variables (Pearson r = 0.76). Consequently, area planted to cotton can be taken as an index of cotton production.

This analysis suggests that, in terms of cotton management:

- Significant differences existed between large, medium, and small growers.

- Large growers had relatively less family labour for weeding.

- Tillage with ox-ploughs was common in all grower categories.

- One group of medium growers relied primarily on hoes for tillage.

Producer groups in Kasese

The three cluster groups in Kasese may be described as:

- **Small growers** (1 acre +) with about half their cultivated area planted to cotton, half land preparation for cotton by tractor, and with 1.5 family members/acre available for weeding cotton.

- **Medium growers** (2 acres +) with about half their cultivated area planted to cotton, almost no land preparation by tractor, and with 0.8 family members/acre available for weeding cotton.

- **Large growers** (4 acres +) with more than half of their cultivated area planted to cotton, about two-thirds of cotton land prepared by tractor, and only 0.3 family members/acre available for weeding cotton.

In terms of cotton management, therefore, this classification suggests that:

- Significant differences existed between large, medium, and small growers.

- Large growers had relatively less family labour for weeding.

- Tractor ploughing was common among large and small growers.

- Medium growers relied on hoes for land preparation.

Cotton management in Pallisa
Productivity (yield/acre) was highest among large producers (246 kg/acre) and small producers (196 kg/acre). Among the medium producer group, productivity was lower in the group that relied on hoes for land preparation (cluster 4). Income from cotton among this group was also lower (89,000 UGS in 2002A) than among other medium-sized growers (103,000 shillings) (Table 3). Although the productivity difference between medium producers was not very large, for analytical purposes we can distinguish between "higher-productivity" and "lower-productivity" medium growers.

Differences in productivity are the sum of differences in cotton management. A comparison of management practices between producer groups revealed that:

- Small growers planted later than other groups (4^{th} week of July).

- Lower-productivity medium growers sprayed later than other groups (6 and 9 weeks after planting for first and second spraying, respectively).

- Large growers weeded earlier than other groups (2 and 5 weeks after planting for first and second weeding, respectively).

- All groups gave roughly the same number of chemical sprays and the same number of weedings.

There is no obvious explanation why small growers should plant later than others. Earlier weeding among large growers might be explained by greater use of hired labour. Four-fifths of the area planted to cotton by large growers was weeded with hired labour (Table 5). Among the lower-productivity, medium growers, late weeding cannot be explained by lack of family labour. This group used the largest amount of family labour per acre (Table 1). Similarly, late spraying cannot be explained by lack of access to sprayers, because the share of households owning sprayers was the same as in other groups. Therefore, to explain low productivity among this group, we must consider socio-economic variables.

Cotton management in Kasese

Productivity was highest among small growers (531 kg/acre) and similar among large and medium growers (474 and 470 kg/acre, respectively) (Table 4). Income from cotton in 2002 was obviously highest among the large grower group.

A comparison of management practices revealed that:

- Planting time was similar across all three groups

- Small growers sprayed and weeded more frequently than others.

- Time of spraying and weeding was similar across all three groups.

- Higher productivity among small growers may therefore be due to more frequent spraying and weeding, while overall management may be easier on smaller areas of cotton. Small growers had the highest amount of family labour available for weeding (1.5 family members/acre) (Table 1).

Socio-economic differences in Pallisa

Table 5 shows no obvious differences in the number of female-headed households, family size and composition, whether the household hired out agricultural labour, whether the farmer had a demonstration plot, or in the number of months the household purchased its staple food.

But there is a striking difference in the number of assets owned by the household. Assets are a proxy for wealth. As expected, the highest asset score was found among the large grower group. By contrast, the households with the lowest asset scores were lower-productivity, medium growers. Hence, the lower-productivity, medium cotton growers represented the poorest cotton growers. This group accounted for 14 % of the area planted to cotton in 2003. Medium growers as a whole accounted for 44 %

The small grower group had a higher asset score than either of the two medium-grower groups (Table 4). This group also had higher productivity (yield/acre) than medium growers (Table 3). This is an important finding, suggesting that small producers (1-acre or so) are relatively good managers and that the scope for improving productivity is greatest among medium growers planting more than 2 acres.

Socio-economic differences in Kasese

Table 6 shows no striking differences in the share of female-headed households, family size and composition, or household food security. But the asset score was lower for medium growers (1.5) compared to large and small growers (2.3). The livestock asset score was highest for large growers (3.6) and lowest for small growers (1.1). The share of demonstration farmers was similar across the three groups.

These findings suggest that, as in Pallisa, the poorest producers were medium rather than small growers. This group accounted for 39 % of the area planted to cotton (Table 4).

Income and cash expenditure in Pallisa

Since lower-productivity, medium growers represent the poorest households, they have fewer assets than can be turned into cash and less access to cash income.

Table 5 shows that this producer group had the lowest share of off-farm income, (eg. from wage-labour, trading, or remittances). They also rented-in less land than other medium growers or even small growers. They also used much less hired labour for land preparation and weeding compared to other growers, including small growers. Finally, they used hoes for land preparation rather than hire ox-ploughs. We conclude that this group weeded later than other medium-sized growers, and sprayed later than any other producer group, because they lacked the cash to hire labour for weeding and buy insecticides on time.

Why do lower-productivity, medium growers plant more cotton than they can weed and spray on time? The likely answer is that these households have few alternative sources of cash income. As we have seen, 85 % of their income is earned on-farm. Their best option (in the absence of off-farm income) would be to grow other cash crops that required less expensive inputs and less weeding. Some have already done so - a relatively high proportion among this group reported that cotton was *not* their most important cash crop (Table 4). However, suitable cash crops may not be available or, if available, market conditions may not be ripe for crop diversification. In particular, demand for other cash crops may be weak and prices unstable.

Income and cash expenditure in Kasese

As in Pallisa, we expected to find that the poorest group (medium growers) had less access to off-farm income and less cash expenditure on cotton production than better-off groups.

However, off-farm income was only a small share of total household income in all three groups. This may reflect the lack of off-farm opportunities in remote, mountain areas and the availability of coffee as a second cash crop.

In contrast to Pallisa, where cash expenditure on renting land was lower among poor producers, medium growers in Kasese rented-in a higher proportion of their land than other groups, and their absolute cash expenditure on rent was the same as for large growers. This is because the majority of cotton producers in Kasese are seasonal migrants who rent land in the plains. Like other groups, therefore, poor households who want to grow cotton must rent land on the plain.

Medium growers used much less hired labour than other groups for land preparation and for weeding. On average, 80% of land was prepared and weeded exclusively by family labour. By contrast, small growers used hired labour quite extensively for these activities. On average, half the area planted to cotton by small growers was prepared by hired or a mixture of hired and family labour, while hired and hired/family labour accounted for 65 % of first weeding and 32 % of second weeding on small cotton farms. Thus, the primary way in which poor cotton farmers in Kasese saved cash was to use family rather than hired labour.

Socio-economic determinants of cotton pest management

The analysis of cotton management revealed variations in pest management between different producer groups. In Pallisa, "lower-productivity" medium growers gave the same number of sprays as other groups, but sprayed later (Table 3). In Kasese, medium growers gave fewer sprays than other groups but there was no difference in the timing of first or second sprays (Table 4). These differences were attributed to poverty. It was argued that both these groups had lower asset scores than other groups, and consequently had less cash available to buy insecticides for spraying.

An alternative explanation, however, is that less frequent or less timely spraying reflected a lack of knowledge about the correct number or timing of sprays to be applied to cotton.

Table 9 provides some evidence that frequency and timing of spraying were a function of farmer knowledge. Households that sprayed more frequently gave first spraying earlier and were significantly more likely to be IDEA demonstration farmers. IDEA selected demonstration farmers for their experience and knowledge of cotton cultivation.

However, knowledge was not a significant determinant of frequency of spraying after controlling for economic factors. Regression analysis showed that frequency of spraying was not significantly related to any of the variables representing "knowledge" of pest management but significantly related to variables that captured wealth and the availability of cash income. Frequency of spraying was positively related to:

- The total physical assets owned by the household;
- The ability to hire labour for weeding;
- The "target yield" wanted by the grower.

Frequency of spraying was *negatively* related to:

- The total number of livestock assets owned by the household.

We had expected livestock assets, like physical assets, to be positively related to frequency of spraying. However, if households liquidate livestock assets to buy insecticides for spraying, then the expected relationship would be negative. Hence, this result is consistent with the argument that frequency of spraying is related to the available stock of assets.

These results confirm the finding that poverty – specifically, lack of ready cash – was an important determinant of cotton pest management, and the ability to control cotton pests using insecticide sprays. Poor households had more difficulty finding cash to buy insecticides and so sprayed less frequently than others.

Households that sprayed more frequently also weeded more frequently and gave second weeding earlier. Productivity was also higher than in other groups (Table 9). This suggests that frequent spraying is part of the "culture" of good cotton management, along with other practices that directly increase yields.

CONCLUSIONS

Table 12 summarises the key findings from the cluster analysis. Based on these findings, we conclude that:

- Growers in both districts can be differentiated into groups based on area planted to cotton, cotton's share of the area cultivated, and labour availability for weeding.

- Large growers accounted for about 50 % of the area planted to cotton in both districts. They used oxen or tractors for land preparation and made extensive use of hired labour for weeding. They did not weed or spray more frequently than small growers. Productivity was highest among this group in Pallisa but in Kasese their productivity was similar to that of medium growers.

- Small growers accounted for about 10 % of the area planted to cotton. Productivity among this group was higher than among medium growers. Small growers relied less on hoes for land preparation than medium growers, had more labour available for weeding than medium or large growers, and made greater use of hired labour for weeding.

- Medium growers accounted for about 40% of the area planted to cotton. They relied on hoes for land preparation, used family labour for weeding. In Pallisa, medium growers were divided into two sub-groups, with the higher-productivity group using ox-ploughs and employing more hired labour for weeding.

- The poorest growers (those with fewer physical assets) were medium rather than small cotton growers. They hired less labour for land preparation and weeding. In Pallisa, they also rented-in less land. This suggests they had less working capital for cotton cultivation.

- Poverty had important implications for cotton management. Despite relying on hoes, poorer growers did not plant later than other groups. But in Pallisa first and second spraying were later among poorer growers, and in Kasese poorer growers gave fewer sprays. Poorer growers also weeded less frequently than other groups. This is consistent with a shortage of working capital, especially in Kasese where poorer growers had to find cash to rent land.

- In terms of technology adoption, the key target groups are large and medium growers, who account for 90 % of the area planted to cotton. Raising cotton productivity among these groups will require different approaches.

- Among large growers, the route to higher productivity lies through more intensive use of inputs on the area planted to cotton. They have sufficient cash resources to buy fertiliser. The cash they spend on herbicides would come from savings on hired labour for weeding. The benefits from herbicides 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 incentive for zero-tillage among large growers is more problematic. Since large growers do not plant cotton later than small and medium growers, the incentive would be to reduce the cost of land preparation. But zero-tillage might have hidden costs. In the Teso farming system, for example, where cotton precedes millet, zero-tillage might reduce millet yields.

- Among medium growers, the route to higher productivity lies through planting less cotton but managing it better. Planting a smaller area to cotton might allow more frequent weeding and more frequent and more timely spraying. This would increase yields and compensate for the reduction in the area planted.

- The problem, however, is that "lower-productivity" medium-growers plant more cotton than they can manage effectively because they lack alternative sources of cash income. They might only be willing to reduce the area planted to cotton if another source of cash became available. Thus, improving productivity among this group might depend on opportunities for diversification into other cash crops or into off-farm employment.

- Spraying is universal and all growers would benefit from IPM that reduced the number of sprays required. Large growers would save the most cash in absolute terms. But poorer growers would also benefit. In Kasese, poorer growers spray less frequently than others. In Pallisa, poorer growers give the same number of sprays, but spray later. Fewer and less timely spraying reflects a shortage of working capital among poorer growers. By reducing the cash needed for pest management, IPM would save poorer growers money and improve the timeliness of spraying.

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Table 1. Cluster analysis for cotton growers, by district

Pallisa	Cluster group			
	1	2	3	4
CAREA	2.69	1.04	6.11	2.27
CERSHARE	57	39	54	45
COTTPER	57	39	54	45
WTLABWDACRE	0.76	2.17	0.32	1.29
LPOXSHARE	99	100	97	0.0
N	21	14	14	11
Kasese	Cluster group			
	1	2	3	
CAREA	1.35	4.29	2.13	
COTTPER	42	61	46	
LPTRACTPER	45	72	3	
WTLABWDACRE	1.48	0.34	0.81	
N	14	17	28	

All cluster variables significant at .000 level

Table 2. Definitions of variables used for clustering

Variable	Definition
CAREA	Area planted to cotton in 2003A season (acres)
CERSHARE	Share of area planted to cotton followed by cereal crops (millet, maize) (percent)
COTTSHARE	Share of cultivated area planted to cotton (percent)
WTLABWDACRE	Weighted family labour used for weeding cotton/acre [1]
LPOXSHARE	Share of area planted to cotton tilled using ox-plough (percent)
LPTRACTPER	Share of area planted to cotton tilled using ox-tractor (percent)

[1] Weights: Adult male, 1.0, adult female, 0.8, 15 and under, 0.5.

Table 3 Cotton management in Pallisa, by cluster group

Variable	C2	C1	C4	C3
Cluster description	Small grower	Medium grower, higher productivity	Medium grower, lower productivity	Large grower
Share of area planted to cotton (2003A) (%)	8	31	14	47
Cotton last season (2002A)				
Area planted to cotton (acres)	1.63	1.84	2.20	3.50
Cotton production (kg)	415	315	273	987
Yield (kg/acre)	196	152	135	247
Income from cotton (000 UGS)	67	103	89	326
Land preparation and planting				
Week of land preparation (weighted by area)	4th wk of June	2nd wk of July	2nd wk of June	1st wk of June
Week of planting (weighted by area)	2nd wk of July	4th wk of July	4th wk of June	4th wk of June
Pest management				
Number of chemical sprays (weighted by area)	2.22	2.68	2.69	2.53
Expenditure on chemical sprays (shillings)	5607	6770	5928	26,471
Timing of first spray (WAP) [1]	3.8	4.4	5.7	3.5
Timing of second spray (WAP) [1]	5.7	5.9	8.5	6.4
Owning sprayer (%)	21	24	27	29
Weed management				
Number of weedings (weighted by area)	3.3	3.5	3.1	3.6
Timing of first weeding (WAP) [1]	4.9	2.2	4.5	2.2
Timing of second weeding (WAP) [1]	8.9	6.2	8.9	5.2

[1] **Weeks after planting**

Table 4 Cotton management in Kasese, by cluster group

Variable	C1	C3	C2
Cluster description	Small growers	Medium growers	Large growers
Share of area planted to cotton (2003A) (%)	12	39	48
Cotton last season (2002A)			
Area planted to cotton (acres)	1.33	1.82	3.06
Cotton production (kg)	704	860	1519
Yield (kg/acre)	531	470	474
Income from cotton (000 UGS)	167	226	304
Land preparation and planting			
Week of land preparation (weighted by area)	3rd wk July	3rd wk July	4th wk July
Week of planting (weighted by area)	4th w of August	3rd week of August	4th week of August
Pest management			
Number of chemical sprays (weighted by area)	3.4	2.0	3.0
Expenditure on chemical sprays (shillings)	18,792	17,585	33,882
Timing of first spray (WAP) [1]	4.9	5.1	4.1
Timing of second spray (WAP) [1]	7.4	8.2	6.7
Owning sprayer (%)	14	21	29
Weed management			
Number of weedings (weighted by area)	3.6	2.8	3.3
Timing of first weeding (WAP) [1]	3.8	3.3	3.3
Timing of second weeding (WAP) [1]	6.1	6.3	6.6

[1] Weeks after planting

Table 5. Socio-economic variables in Pallisa, by cluster group

Variable	C2	C1	C4	C3
Cluster description	Small grower	Medium grower, higher productivity	Medium grower, lower productivity	Large grower
Female-headed households (number)	2	1	4	3
Family size (number)	6.9	5.7	5.6	7.4
Adult males (15+)	1.5	1.7	1.3	1.9
Adult females (15+)	1.8	1.6	2.0	1.9
Adolescents (7-14)	1.6	0.9	0.7	1.1
Children (0-6)	2.0	1.6	1.6	2.6
Hiring-out labour to other farmers (number)	2	3	1	0
Months buying staple food (number)	2.3	2.5	2.5	2.3
Asset score [1]	3.29	3.05	2.54	5.57
Livestock asset score [2]	3.2	3.8	3.3	5.8
Demonstration farmers (number) [3]	4	10	5	12
Cotton reported as main cash crop (number)				
Yes	11	17	6	11
No	3	3	5	2

[1] Household scored 1 for each asset owned (bicycle, ox-plough, ox-cart, granary, farm store, tin-roof house, motorcycle, car/vehicle, radio, radio-cassette, television, or telephone).
[2] Total oxen, cows, goats or pigs owned by household
[3] Farmer had IDEA demonstration plot on his/her field.

Table 6. Socio-economic variables in Kasese, by cluster group

Variable	C1	C3	C2
Cluster description	Small growers	Medium growers	Large growers
Female-headed households (number)	0	3	3
Family size (number)	6.4	7.0	6.7
Adult males (15+)	2.1	1.7	2.3
Adult females (15+)	1.6	1.6	1.9
Adolescents (7-14)	1.1	1.8	0.9
Children (0-6)	1.6	2.0	1.5
Hiring-out labour to other farmers (number)	2	8	2
Months buying staple food (number)	4.3	3.2	3.6
Asset score [1]	2.3	1.5	2.3
Livestock asset score [2]	1.1	1.7	3.6
Demonstration farmers (number) [3]	8	14	9
Cotton reported as main cash crop (number)			
Yes	14	22	15
No	0	3	1

[1] Household scored 1 for each asset owned (bicycle, ox-plough, ox-cart, granary, farm store, tin-roof house, motorcycle, car/vehicle, radio, radio-cassette, television, or telephone).
[2] Total oxen, cows, goats or pigs owned by household
[3] Farmer had IDEA demonstration plot on his/her field.

Table 7. Income and cash expenditure in Pallisa, by cluster group

Variable	C2	C1	C4	C3
Cluster description	Small grower	Medium grower, higher productivity	Medium grower, lower productivity	Large grower
Source of household income (%)				
On-farm	70	45	85	50
Off-farm	30	55	15	50
Land rental				
Area rented (%)	30	26	8	6
Total rent (UGS)	14,464	16,643	4,091	1,964
Labour used for land preparation (%)				
Family	5	21	88	21
Hired	54	55	4	44
Both	41	24	8	35
Labour used for first weeding (%)				
Family	44	37	86	22
Hired	15	45	10	40
Both	41	18	4	38
Labour used for second weeding (%)				
Family	54	58	89	22
Hired	6	7	6	7
Both	40	35	5	71

Table 8. Income and cash expenditure in Kasese, by cluster group

Variable	C1	C3	C2
Cluster description	Small growers	Medium growers	Large growers
Source of household income (%)			
On-farm	10	12	14
Off-farm	90	88	86
Land rental			
Area rented (%)	34	48	40
Total rent (UGS)	11,821	27,768	27,500
Labour used for land preparation (%)			
Family	51	85	20
Hired	34	8	32
Both	14	8	48
Labour used for first weeding (%)			
Family	35	81	33
Hired	28	12	29
Both	37	7	39
Labour used for second weeding (%)			
Family	68	76	28
Hired	11	16	35
Both	21	8	36

Table 9. Cotton management among growers grouped by number of chemical sprays

Variable	Tercile			Sig.-level
	1 (n=40)	2 (n=40)	3 (n=40)	
Number of sprays[1]	1.5	2.6	3.8	.0000
Timing of 1st spray (WAP)[2]	5.6	4.3	3.6	.0106
Timing of 2nd spray (WAP)[2]	7.1	7.8	6.1	.1405
Timing of land preparation[3]	2nd week July	1st week July	1st week July	.0818
Timing of planting[3]	1st week August	4th week July	4th week July	.2429
Number of weedings[1]	2.8	3.3	3.8	.0000
Timing of 1st weeding (WAP)[2]	3.8	3.2	3.1	.2023
Timing of 2nd weeding (WAP)[2]	7.4	6.6	5.9	.0863
Area planted, 2002A (acres)	2.1	2.3	2.1	.7410
Yield, 2002A (kg/acre)	264	371	387	.0236
Demonstration farmers (%)	32	65	60	.0074

[1] Weighted by area planted
[2] Weeks after planting
[3] Week finished land preparation or planting

Table 10. Definitions of variables used in regression analysis

Variable	Definition
WTSPRAY	Number of chemical sprays applied to cotton, weighted by area planted.
ASSETSCORE	Number of assets owned by household
LIVSCORE	Number of livestock owned by household
W2HIREPER	Area planted to cotton with second weeding done using only hired or hired/family labour (%)
PRODLAST	Yield in previous season (kg/acre)
OWNPUMP	Dummy variable if grower owns sprayer pump (1=Yes, 0 otherwise)
DEMO	Dummy variable if grower has IDEA demonstration plot (1-Yes, 0 otherwise)
KNOWDEM	Dummy variable if grower knows about IDEA demonstration plots (1=Yes, 0 otherwise)
DCODE	Dummy variable for district (1=Pallisa, 2=Kasese)

Table 11. Regression analysis for determinants of number of sprays (WTSPRAY)

Variables [a]	Coefficient	t-value	Significance-level
Constant	1.2827	1.968	.0524
ASSETSCORE	0.1486	1.831	.0707
LIVSCORE	-0.0618	-2.073	.0412
W2HIREPER	0.0044	1.891	.0620
PRODLAST	0.0019	2.851	.0055
OWNPUMP	0.1901	0.654	.5149
DEMO	-0.5771	-1.152	.2524
KNOWDEM	0.4934	1.168	.2459
DCODE	-0.2387	-0.756	.4515
Adjusted R^2	.16		
Durbin-Watson statistic	1.98		
F-statistic	3.11		.0040
Sample size (n)	114		

[a] for definitions, see Table 10.

Table 12. Summary of cluster analysis findings

Cluster groups	Share of area planted to cotton (%)	Poor?	Yield (kg/acre2002)	Cotton management practic			
				Tillage	Planting	Weeding	
Pallisa							
Small	8	No	196	Ox-plough	4th wk July	3.3	
Medium, high	31	No	152	Ox-plough	2nd wk July	3.5	
Medium, low	14	Yes	135	Hoe	4th wk June	3.1	
Large	47	No	247	Ox-plough	4th wk June	3.6	
Kasese							
Small	12	No	531	Tractor/hoe	4th wk August	3.6	
Medium	39	Yes	470	Hoe	3rd wk August	2.8	
Large	48	No	474	Tractor	4th wk August	3.3	