CASE STUDY ON ORGANIC VERSUS CONVENTIONAL COTTON IN KARIMNAGAR, ANDHIRA PRADESH, INDIA

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ABSTRACT

Cotton (*Gossypium hirsutum* Linn..) yields, profits and pest incidence at fields of farmers partaking in an export oriented organic cotton production program are compared with yields of conventional cotton production in the same village during a bad cotton season (2004). Late season drought reduced actual yield by 42% compared to the estimated yield in October 2004 and usual average yields. Organic cotton yielded on par at 232 Kg seed cotton /acre against conventional cotton at 105 Kg/acre. Organic cotton was more profitable at plus Rs 559/acre (approx. US $ 13) (1 US$ = Rs. 44) versus minus Rs 1307/acre (minus US$ 30) in conventional cotton and had significantly less problems with *Helicoverpa armigera* (Hubner) Lepidoptera, Noctuidae and *Pectinophora gossypiella* (Lepidoptera: Gelechiidae). Pest control in organic cotton was about Rs. 220 (US $ 5) per acre (5% of total production costs of organic cultivation) as against Rs. 1624 (US $ 37) per acre (30% of total production costs of conventional cultivation) in conventional cotton. Pest management in organic cotton was based on prevention: balanced nutrient management, intercrops and early spray of HaNPV.

Thirty-four farmers, part of a large organized group (over 200 farmers), volunteered to test organic cotton on part of their farm, allotting 79 acres for organic farming though owning about 296 acres. For certification purposes a contiguous area of about 40 acre should go organic. The 34 farmers were organized in two groups for training, credit and savings, maintenance of certification administration and marketing purposes. Farmer Field School sessions (FFS) were conducted on weekly basis during the season but also after the season to deal with

post harvest handling and marketing. As a result of this year's experience all participating farmers will bring their total cotton under organic management, another 70 farmers will join and 10 neighboring villages are interested, but have been asked to wait because of lack of training manpower. Farmers of the old and new groups will be trained to become farmer trainers.

Packages used for training are based on the FAO IPM- FFS and long term experience of ETC India and its staff in cotton cultivation in Southern India. Linkages are maintained with CIPMC, national cotton research programme and universities. The latter mainly for the selection of varieties. Inputs are purchased from the private sector. Yearly a meeting will be organized in which representatives of farmers from the whole organic cotton program (240 in 2004) will interact with researchers, input suppliers, banks, ginners and spinners. This is meant to create synergy in the whole chain.

INTRODUCTION

Profitability of cotton production systems under rainfed conditions in Andhra Pradesh in India has drastically come down due to loss of soil and soil fertility, imbalanced nutrient application, lack of soil organic matter, and finally, indiscriminate pesticide application. Cotton production in India involves about 9 million hectares (5.5% of arable land) and 4 million marginal, small and large farmers. The production level is about 13 million bales (lint, 170 Kg/bale) per year (GOI) or about 20% of global production. The major problems in cotton production in India are low productivity, mixing of varieties, low profitability, lack of adequate knowledge at farm level, indebtedness of farmers due to high interest rates at the hands of private moneylenders (up to 85% per annum) and finally contamination of cotton with non-cotton materials both at the field level and off the field. According to the Central Institute of Cotton Research (CICR, Nagpur, India), cotton productivity in Andhra Pradesh (AP) has been declining steadily from about 265 kg seed cotton per acre in 1995 to about 162 kg seed cotton per acre in the year 2003.

FAO and ETC implemented IPM, Non Pesticidal Management (NPM) and organic cotton programmes from 1997 onwards. Then it was observed that these methods of cotton production are usually more profitable for farmers growing rain-fed cotton with seed cotton yields up to about 1.2 tonnes/hectare Organic cotton production entails the use of cultural preventative methods (like intercropping, border cropping, drainage, variety selection), use of natural fertilizers (Farm Yard Manure (FYM), compost, bio-fertilizers, poultry manure, etc..) and biological controls (NPV, Trichogramma, Trichoderma, etc…) rather than synthetic fertilizers and pesticides/fungicides.

When ETC was asked by Solidaridad (that promotes the Made-by fashion label in the Netherlands: guaranteeing fair trade and organic products), to implement an organic cotton programme it accepted the challenge and decided that detailed data collection should be done at organic and conventional farms. The main objective of data collection was (1) To be able to compare the yield, income and profitability of organic and conventionally grown cotton and judge whether organic cotton production is a viable proposition. (2) To find out about the effectiveness of organic nutrient and pest management methods, among others the use of

NPV for managing *Helicoverpa armigera.* (3) To compare the quality parameters of cotton lint with management regimes of individual organic farmers. (4) To identify issues for further detailed studies needed.

MATERIALS AND METHODS

The study comprises of 34 farms/farmers, from 2 villages (Arapally and Repaka) in the district of Karimnagar in the state of Andhra Pradesh in India, who form a part of the larger group of 239 farmers involved in cotton cultivation in an export oriented organic cotton production programme. The local NGO (KRUSHI) was working in these villages for quite some years prior to the introduction of the organic cotton programme. This made the selection of farmers within the village easier. Farmers volunteered after a series of introductory meetings in the concerned villages. In these meetings the concept of organic farming was explained, risks and advantages as well as conditions (contiguous area of 40 acres organic farming, certification, data collection and recording, group sales of cotton…). Farmers feared most loss of production due to complete elimination of chemical fertilizers. The elimination of pesticides was considered less of a problem by the farmers, partially due to the fact that they had been exposed to IPM technologies to a certain extent. Project staff provided an alternative cropping system and a comprehensive outline of crop management, which showed that the same levels of nutrient application could be achieved through organic means and that various tested organic options for disease and pest management existed. This convinced farmers that they would not end up in loss.

Land for cotton production was from a contiguous area of approximately 40 acres in each of the two villages. Cotton was grown on 79 acres of land out of a total of 273 acres of land allotted for organic cultivation. Within the contiguous area 49.5 acres land came out of a long-term fallow (> 3 years) and 28.5 out of a short-term fallow (<1 year). Soils were very light black cotton soils

Farmers were organised in groups of about 20 farmers along the lines of Self Help Groups (credit and saving groups). These groups received an interest free revolving fund equal to Rs 4,000 per member either in kind or cash. This had to be repaid by individual farmers to the group with an interest of 17% as decided by the group (compared with 86% when obtained from money lenders). They mobilized inputs as a group based on the nutrient management package worked out by ETC. The groups would also receive FFS training on a weekly basis. After harvesting, they would store harvested cotton in a common facility and market their cotton produce as a group.

Seeds were procured locally by farmers from their regular commercial seed sources. Cotton seeds were treated and pelletted with nitrogen fixing bacteria Azospirillum, Azotobacter and Phosphorus Solubilizing Bacteria and an antagonistic fungus - *Trichoderma viride* mixed in fresh cow dung slurry before sowing. A comprehensive intercropping package was proposed to control pests. One of them was intercropping with pulses. All farmers chose to grow soybean but only a few farmers agreed to let it grow till maturity (soybean was not

proposed as the preferred intercrop by the ETC team). The main reason that they decided not to let the soybean mature was that they had never intercropped cotton and feared a negative influence of the intercrop on the yield of cotton, also they felt that inter-cultivation, which they consider important for enhancing cotton yield, was impeded by the intercrop of soybean. Nutrient management practices were worked out for a yield level of 6 quintals of seed cotton per acre and adjusted later on during the season based on weather conditions. Farmers generally decided not to apply the recommended nutrient management package, due to lack of availability but also due to costs involved, particularly with regard to the topdressing with poultry manure. Table 1 gives the nutrient management practices that were suggested to farmers during the year, while Table 2 gives the actual quantity of different nutrient sources applied based on actual field conditions. Fig. 1 shows mixing of bio-fertilizers with seed.

Table 1. Manure requirement for a yield projection of 6 quintals of cotton per acre.

Organic Manure*	N**	P	K	Ca	Mg	S	Zn	Fe
Requirement	48	6	24	18	5	9	0.2	0.9
FYM 4 MT	4	4	14.4	22	16	2.8	0.02	0.06
Enriched FYM (300 kg)	0.36	2.23	1.3	1.6	1.17	0.74	0.001	0.003
Bio-fertilizers (Azotobacter, Azospirillum, each 1 Kg/acre)	10	0	0	0	0	0	0	0
Poultry Manure 2 MT	24	5	18	44	Traces	10	0.1	0
Wood Ash (100 kg/ac)	0.15	0.53	6.5	20	1.25	1	0.0233	0.85
Inter crops	10	0	0	0	0	0	0	0
Total Applications	48.51	11.76	40.2	87.6	18.42	14.54	0.14	0.91

*Data out of compiled database owned by ETC. From various sources: Internet, books, own chemical analysis.
**All nutrients in kilograms

Figure 1. Mixing bio-fertilizers with cotton seeds.

Table 2. Actual quantity of manures applied by all farmers for 79 acres.

Manures	Suggested (kg)	Actually Applied (kg)	% of Suggested
Farm Yard Manure, 4 MT per acre	316,000	14,525	5
Enriched Farm Yard Manure, 300 kg per acre	23,700	7,200	30
Azospirillum	79	86	108
Azotobacter	79	83	105
PSM	79	83	105
Trichoderma viride	39.5	42	106
Poultry Manure, 2 MT per acre	158,000	47,905	30
Wood Ash	7,900	7,650	97

From Table 2, it can be concluded that organic manure was applied at a far lower rate than advised. It was agreed by the farmers that they would take part in the weekly Farmer Field School (FFS) during the cropping season. FFS was conducted for 20 sessions from pre sowing till the commencement of harvesting. Crop management decisions (pest and nutrient) were based on weekly Cotton Eco System Analysis (CESA), which includes monitoring of plant growth parameters, pest predator ratio and local weather conditions. Fig. 2 shows the setting within which the FFS took place.

Figure 2. The setting of a Farmer Field School (FFS).

Table 3 provides the generalized pest management options provided to farmers prior to sowing. Individual pest management practices were modified based on Cotton Ecosystem Analysis (CESA) and farmers' capabilities. Fig. 3 provides a view of how the border crop was actually planted in organic cotton fields.

Table 3. Pest and disease management strategies in organically grown cotton fields.

S. No.	Activities
1.	Seed treatment with Trichoderma viride, for root rot and wilt
2.	Intercropping of short duration pulses - cotton : pulses 1:2
3.	Border crop of Maize or Sorghum 5 - 6 rows
4.	Trap crop of Bhendi 50 plants per acre against Earias vitella
5.	Trap crop of Marigold sown randomly against Helicoverpa armigera
6.	Trap crop of Castor sown randomly against Spodoptera litura
7.	Delta pheromone sticky trap against Pectinophora gossypiella
8.	Bird perches within the fields
9.	250 LE of HaNPV (UV stabilized) applied after noticing egg laying
10.	Yellow Sticky traps smeared with castor oil against white fly
11.	Blue sticky traps smeared with castor oil against thrips
12.	Hand picking wherever possible
13.	Detopping after 15 - 17 sympodial nodes

Figure 3. A border crop of maize in organic farmer's field.

The internal control system (ICS) required for organic certification demands that all operations by farmers are documented: the type and quantity of inputs used, the sources, the costs, the labour required, cotton harvested per picking, quality of the cotton, etc.. These data were documented by the farmers under close supervision of ETC and NGO staff, cross checked by an independent internal inspector and shared with the certifier (SKAL). In addition data collected during CESA were documented. These two sources, ICS and CESA, were used for making the analysis we present in this paper.

Farmers were encouraged to compare cotton grown organically in their fields with cotton grown conventionally within their village at every stage during the entire crop growth period. Their impressions were recorded. However, no systematic CESA was implemented in conventional fields.

The 2004 monsoon in Karimnagar was abnormal (total of about 60% of long term average rainfall): heavy rains end of May and early June, a drought from 10 June till early July and cessation of the rains end of October. Sowings commenced from the first week of June 2004 with the earliest sowing done on 6th June 2004. Sowings continued till the end of July 2004 as and when local rainfall and soil moisture permitted. Bulk of planting was done during the month of July, almost a month later than the normal date of sowing. Temperatures were normal during the growing season especially the early and the mid season. Delayed planting combined with late season drought made 2004 a trying year for cotton cultivation in Karimnagar district.

Some farmers (3 out of 34 cotton growers) had a ratoon crop of cotton. The data of these farmers have been excluded from the analysis, as their yields were substantially lower. One organic farmer used critical sprinkler irrigation and obtained significantly higher yields than average. This farmer too was excluded from the analysis. Then there is one farmer who grew a relatively unknown variety and who had very low yields. We attributed that to the variety and excluded the farm from the analysis. So in all a data set of 29 organic farmers is compared with a data set of 11 conventional farmers. The conventional cotton plots were selected near the organic cotton plots based on similarities in soil conditions and varieties grown.

RESULTS AND DISCUSSION

VARIETIES AND YIELD

Farmers used many different, mostly hybrid, varieties. We checked whether any indication existed that varieties were yielding differently. There are insufficient data to test the hypothesis that there is no difference. The fact that yields of different varieties planted at the same day are similar suggests that yields did not differ because of variety issues. Between organic and conventional farmers, similar varieties were used. Thulsi, Bunny and Dyna are most frequently used varieties by both groups of farmers. Thulsi is planted by 30% organic farmers and 40% of the conventional farmers. The other 2 varieties make up another 20 to 30%. The rest of farmers grow a bouquet of varieties, of which Sundeep (grown only by organic farmers) appears to be promising due to high yields that are observed at organic farms.

DATE OF SOWING AND YIELD

Organic cotton plots were on average sown three weeks later (12-07-2004) than the plots of conventional cotton (25-06-2004). One would expect yield to be affected by date of sowing, especially under rainfed conditions, resulting in lower yields due to late planting. We tested this for organic plots and found an insignificant correlation. We also tested the effect on date of sowing on yields of conventional cotton and found again a weak correlation. Thus we concluded that we could use the whole population of organic and conventional cotton fields for analysis.

ORGANIC COTTON YIELDS ON FIELDS AFTER LONG TERM FALLOW (> 3 YEARS) COMPARED WITH SHORT TERM FALLOW (< 1 YEAR)

Analyzing the data we noticed that a number of farmers, especially in Arapally, seemed to have lower than average yield. When checking the background data, we observed that these farmers had decided to try out organic cotton on fields they had not used for quite some time: from 3 to 15 years. When we tested whether the difference in yield was significant, we found that to be not the case. We also tested the hypothesis that yields of ST fallows were significantly different from the yields of conventional fields and found that yields are not significantly different.

However, we concluded that income of organic cotton on short term and long term fallow fields are significantly higher (p=0.05) than the income of conventionally grown cotton (Table 4). The reduction in cost of cultivation of organic farms is the main factor contributing to the higher net-income.

Table 4. Comparative table of yield, income and profitability of short and long term fallow (within organic farms) with conventional farms.

	Organic fields			
Particulars	**L.T. fallow (n=12)**	**S.T. fallow (n=17)**	**Conventional (n=11)**	**Remarks**
Seed cottonYield, Kg/acre	224**	240 **	205	Thus income from cotton alone not significant different
Total income per acre, Rs/acre	4617**	5233**	4105	Income of cotton and intercrop
Total costs, Rs/acre	4212 * ($p < 0.005$)	4517 * ($p < 0.04$)	5412	
Net income, Rs/acre	402* ($p < 0.035$)	716* ($p < 0.008$)	-1307	

* Significant; ** Not Significant

This leads to the next question as to which aspect of cotton cultivation takes up the major chunk of cost. Table 5 provides the break up of costs of cultivation.

Table 5. Cost of cultivation per acre (Rs/ac) for organic and conventional cotton cultivation.

Parameters	Organic LT (n=12)	Organic ST (n=17)	Conventional (n=11)
Yields	225	240	205
Seeds	626**	581* (p < 0.014)	720
Fertilizer/manure	1204* (p < 0,04)	1285**	1566
Ploughing	972* (p < 0.0001)	917* (p < 0.0002)	482
Weeding	526**	704* (p < 0.04)	360
Inter-cultivation	293	391	290
Pest Management	203* (p < 2.16E-07)	237* (p < 3.54E-09)	1624
Harvesting cost	390	403	371
Total costs	4214* (p < 0.005)	4518* (p < 0.04)	5413

* Significant; **Not Significant

There is no significant difference between the costs of fertilizers between organic and conventional farms, though conventional farmers spent more than those organic farmers who used land that came out of a long term rotation. On the other hand, cost of ploughing (primary and secondary) is significantly higher in organic farms. The cost of weeding shows a mixed picture. One would have expected the fields that come out of a long term fallow to have the higher costs, but they are significantly higher in plots that have not been under long fallow. There is no significant difference between the cost of intercultivation between organic and conventional farms. The cost of pest management is significantly higher in conventional farms. While in organic farms, the cost of pest management was an average of Rs. 220 per acre, the cost of pest management in conventional farms has been as high as Rs. 1624/ acre.

EFFECT OF RATE OF NITROGEN APPLICATION ON YIELD

We assumed that yields would increase with higher levels of nitrogen application. This hypothesis was tested within organic cotton data set but also between organic and conventional farming. Within the organic cotton data set, only a very weak positive correlation could be established. In conventional farms the nitrogen application level is 2.5 times higher than in organic farms (52 against 20 Kg N/acre, Table 6). Even then, we do not find any significant

difference in seed cotton yield between organic and conventional farms. The fact that rains stopped so early, could have caused that the higher nitrogen availability could not be expressed in the final yield. Water was apparently a more serious constraint than nitrogen.

NUTRIENT MANAGEMENT AND YIELD

For high productivity of cotton good nutrient management is necessary. We were worried that organic cotton would under perform due the very low doses of Farm Yard Manure applied. Thus nutrient management regimes were compared between organic and conventional farms. Nutrient management was calculated purely based on applied nutrients. Soil testing was not done for the first year. Table 6 gives the nutrient management regimes for organic as well as conventional farms. Nutrients have been calculated based on the source of nutrients actually applied as indicated in Table 2 on a per acre basis.

Table 6. Applied nutrients (kg per acre) at organic and conventional farms.

Nutrients	Organic kg/acre	Conventional kg/acre	Remarks
Nitrogen	19.82	52.11*	P < 0.0001
Phosphorus	9.11	40.76*	P < 0.001
Potassium	18.12	23.47**	
Calcium	52.48	0	
Magnesium	5.24	0	
Sulphur	6.65	0	
Zinc	0.25	0	

* Significant; **Not Significant

Nitrogen and Phosphorus application was significantly higher in conventional farms than in organic farms ($p < 0.001$ and $p < 0.001$ respectively). There was no significant difference in potassium application between organic and conventional farms.

A simple calculation of nutrient balance (theoretical removal by full crop compared with total nutrients applied, not measuring anything and not taking into account mineralization, fixation, leaching or vaporization) was done comparing conventional and organic farms. Table 7 provides the average estimated nutrient balance of all the farms in conventional and organic.

Conventional farms appear to have a positive nutrient balance of Nitrogen, Phosphorus and Potassium, while there is a negative balance of secondary and micronutrients. (Ca, Mg. S and Zn). Organic farms have a negative balance on Nitrogen only. Interpretation of these figures is hazardous, but it can be safely assumed that in organic farming more attention needs to be given to nitrogen application and in conventional farming to secondary and micro-nutrients. We can also conclude that the application levels by the organic farmers have been sufficient for the yields realized mainly because water availability was a problem.

Table 7. Comparison of nutrient balance between organic and conventional fields (kg/ac).

Nutrients	Conventional Balance left in soil (kg/acre)	Organic Balance left in soil (kg/acre)
Nitrogen	35	-2.5
Phosphorus	39	4.62
Potassium	14	7.84
Calcium	-7	39
Magnesium	-2	1.56
Sulphur	-3	3.11
Zinc	-0.07	0.11

* Significant; **Not Significant

INTERCROP EFFECT

Soybean was sown (at various dates after sowing cotton) as an intercrop by most of the farmers in both villages involved in the programme. Some farmers have gone in for 2 rows of soybean and some farmers for a single row of soybean. Fig. 4 shows how intercropping was done.

Figure 4. Intercropping with soybean.

A superficial analysis suggests no influence of growing a soybean crop. However, on closer analysis, it appears that those organic farmers in Repaka who harvested soybean have a significant lower yield than the farmers who plowed their soybean into the soil after some time of growth. (119 kg seed cotton/acre as against 356 kg seed cotton per acre, p= 0.017). Other factors are similar (plant density, N applied, varieties, date of sowing). In Arapally such effect could however not be established because only two farmers harvested the soybean and date of planting of the cotton varied much with the other farmers (one early July, the other end of July).

PEST MANAGEMENT

The major pest problems faced during the season were the boll worms, *Pectinophora gossypiella* and *Helicoverpa armigera*. For pink boll worms, delta sticky pheromone traps were used. In the villages of organic cotton, some farmers had gone in for ratoon cotton. It was expected that pink boll worm infestation would be higher in ratoon crop than other fields. Accordingly enumeration was done randomly to find out the severity of pink boll worm vis a vis the distance from the ratoon crop (Table 8). These observations weren't done systematically and therefore the data presented should be looked at as indicative only.

Pink Boll Worm infestation was about 30% in ratoon cotton, in the organic cotton field used for FFS no Pink Boll Worm infestation was noticed.

Table 8. Enumeration of Pink Boll Worm (PBW).

Date of installation	Date of observation	Period (days)	Counting of PBW adult moths (Nos.)		
			Ratoon crop	Near and adjacent fields	Far away from ratoon crop
12 - 18 Sept., 2004	First week of October	15 days	138	84	68

USE OF HANPV AND NEEM SEED KERNEL EXTRACT (NSKE) FOR MANAGEMENT OF *HELICOVERPA ARMIGERA*

During the season, infestation of *H. armigera* commenced by the first week of September. Based on the Farmers Field School's (FFS) CESA, farmers decided to go in for spraying of HaNPV. Table 9 provides the details of Ha NPV application as soon as the eggs and first instar larvae were noticed in cotton. Fig. 5 shows the preparations towards HaNPV application.

During the season, farmers were encouraged to visit conventional farms also in order to assess the comparative advantage of organic methods especially the use of Ha NPV over synthetic chemicals for managing pests in particular *H. armigera*. Conventional farmers were using costly chemicals, including synthetic pyrethroids, for the control of *H. armigera.* Common beneficial (predatory) insects observed in organic cotton plots by farmers during FFS are presented in Table 10. Fig. 6 shows that also birds liked to have their nests in the organic cotton fields.

Organic farmers who visited conventional fields observed very low levels of natural predators in those fields.

Table 9. Management of *Helicoverpa armigera* using HaNPV and NSKE.

Distribution of Ha. N.P.V to the farmers	10.09.2004
Farmers started HaNPV spray	11.09.2004 (approximately 63 days after sowing)
Farmers completed the spray	30.09.2004
Dose	50 m.l/ acre (5 tanks x 10 lit.) (10 ml HaNPV/ tank)
Time of application	Early morning: 5.00 a.m and Late evening: After 5.00 p.m
Weather condition	On the whole weather conditions were highly favorable after Ha NPV application for epizootic conditions
5% NSKE application	5% NSKE was applied after 6-15 days gap after Ha. N.P.V spray
Ha. N.P.V. Incidences	Observed Ha. N.P.V affected larvae on 21.09.2004 onwards. (i.e., 5th day after spraying)
Mortality rate	High percentage of mortality observed

Figure 5. Preparations towards HaNPV applications.

Table 10. Common beneficial (predatory) insects observed by farmers in organic plots.

Date(s)	Predator Insects on Organic Plots
10.08.2004 to 21.08.2004 (45 - 50 DAS)	*Geocoris* spp (Lygaedae. Hemiptera) *Coccinella novemnotata* (Coccinellidae. Coleoptera): Lady beetle adults, pupae, grubs and eggs *Syrphus* spp (Syrphidae. Diptera)
14.09.2004 to 28.09.2004 (75 - 80 DAS)	*Cicindela* spp (Cicindellidae. Coleoptera): Tiger beetle adults *Zelus bilobus* (Say) Reduviidae. Hemiptera: Reduvid bug), *Orius* spp. (Anthocoridae. Hemiptera) *Chrysoperla* sp. (Chrysopidae, Neuroptera): Chrsoperla adults, *Pantala flavescens* (Fabricius) (Libelludae, Odonata): Dragonfly, Lestus sp. (Lestidae, Odonata): Damselfly
07.10.2004 to 14.10.2004 (> 85 - 90 DAS)	Podosus maculoventris (Pentatomidae. Hemiptera): Spined soldier bug

Figure 6. A birds' nest in an organic cotton plot.

QUALITY OF LINT

Of organic cotton was tested by CIRCOT (Central Institute for Research on Cotton Technology) in Nagpur. The average lint length of the samples was 29.1 mm, micronaire 3.1 and tenacity 22 (3.2 mm (g/tex)). No clear correlation can be found between the varieties grown by the farmers and lint quality. It can be concluded that the cotton quality is satisfactory, though the micronaire clearly shows the effect of emergency ripening (we would have preferred between micronaire 3.5 and 4.5).

CONCLUSIONS AND RECOMMENDATIONS

These conclusions are based on one, bad cotton season. All conclusions are thus to be considered with caution. Different rainfall patterns and quantities can lead to very different results. It must be recommended to compare organic and conventional production for a number of years.

In the year 2004 organic cotton yielded generally at par with conventional cotton. In the case of organic cotton grown on fields that came out of a short term fallow, yields were higher than yields of conventional cotton. Profitability of organic cotton was significantly higher than conventional cotton. The main contributing factor to higher profitability was the reduced expenditure on pest management.

We did not ask farmers how much money they borrowed from money lenders. Assuming them borrowing about Rs 4,000 per acre, their additional costs would have been Rs 180-200 per acre (assuming 87% interest rate against 17% interest in the SHG and 9 months of borrowing). When a premium will be paid for organic cotton, farmers will earn an additional Rs 400 per acre over conventionally produced cotton. It can thus be concluded that organic cotton production appears to be financially feasible and attractive.

Quality parameters of organic cotton are good and appear to be similar between the different Hybrids used by the farmers. It would be required however to compare the quality parameters with conventionally grown cotton. This year that was not done because conventional farmers sold their cotton before samples could be taken. More detailed sampling on a larger scale would be required to arrive at final conclusions regarding the influence of varieties on lint quality parameters.

Organic farming requires high doses of organic manure. Farmers did not apply the required levels. Still they performed better than farmers who used only mineral fertilizers. The recommended nutrient management package was based on a yield projection of 6 quintals per acre whilst the average yield was only 2.5 quintals. It is quite possible that if the rains would not have stopped early, the lack of nitrogen (under present yield levels on average already short with 2.5Kg per acre) would have expressed itself in poor maturation of bolls and thus low yields. More work is needed to improve the availability of organic manures, particularly on manures with high nitrogen content like poultry, pig or sheep manure.

Intercropping with soybean and harvesting the produce seems to have a negative influence on yield of cotton. This effect could be caused by simultaneous high demand for nitrogen by both cotton and soybean (even when properly inoculated) or (in this case, 2004) it could be caused by competition for water. Farmers might conclude from the results that weeding and inter-cultivation are important to boost yields. Systematic testing of intercrop versus mono-crop, various intercrops and intercropping methods (1 row or more) and intercultivation should be undertaken to arrive at definite conclusions.

Pest load in 2004 was relatively low, due to the prevailing climatic conditions. Conventional farmers were facing more severe infestation of cotton bollworm than organic farmers according to their own, organic farmers' and our staff observations. Two factors might have saved the organic farmers. One, the predator population in organic fields was high. Second,

early (when few first instar larvae were spotted) and proper spraying of HaNPV (early morning or evening, conditions of high humidity) on a large scale (all organic farmers did it) created an epizootic condition in the fields which controlled the development of the pest. These factors that controlled development of cotton bollworm could only be established because of the FFS approach, which educated farmers properly.

Ratoon crops of cotton are a source of pink bollworm as became evident from our limited study. Further study into the effect of ratoon crops on establishment of a pink bollworm population should be undertaken.