Reducing Cotton Footprints through widespread Implementation of Better Management Practices (BMPs) in Pakistan

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K E Y W O R D S

Pakistan Sustainable Cotton Initiative
Better Management Practices
Better Cotton Initiative
Farmers
Freshwater ecosystem
Farmer Field School
Agro-ecosystem analyses
Facilitator

A B S T R A C T

WWF aims to help make agricultural commodities like cotton cultivation, part of a sustainable industry so as to make its production environment friendly and to reduce its footprint on priority ecosystems. There has been a growing concern among different stakeholders of cotton supply chain and consumers about the impacts of its cultivation. Inefficient crop management practices in cotton production contribute to water losses led to significant degradation of freshwater resources, biodiversity and the services that rivers provide. Besides this, intensive and indiscriminate use of chemical pesticides and fertilisers, contributes to serious environmental, social and economic problems in areas where it is cultivated. WWF - Pakistan and IKEA have been collaborating under "Pakistan Sustainable Cotton Initiatives (PSCI)" since 2005 for the development and promotion of site-specific Better Management Practices (BMPs) and building capacities of resource deficient smallholders to apply these BMPs as per their requirements. As a result of horizontal and vertical expansion, more than 50,000 farmers participated in the programme and were trained to grow better cotton over an area of about 200,000ha during 2011. These farmers made crop management decisions which led to 37.5 % reduction in water use, 47 % in pesticide use and around 41 % in fertiliser achieving 1:2.3 cost-benefit ratio compared with 1:1.1 by non-BMP farmers.

Introduction

In Pakistan, around 1.3 million farmers (out of total of 5 million) cultivate cotton on 3 million hectares, covering 15 % of cultivable area in the country (Pakistan Agricultural Statistics, 2009). Majority of the cotton growers in Pakistan are smallholders who face several social and economic problems resulting in insecure livelihoods which are further aggravated due to lack of access to credit facilities, information and extension services. In most cases, this situation results in indiscriminate utilisation of irrigation water and agro-chemicals. About 75 % of the total imported pesticides are used on cotton crops which is a serious threat to the ecosystem and health of the communities. The pesticide usage in Pakistan increased from 665 tons in 1980 to more than 50,000 tons during 2007 with 75 % of all the imported pesticides applied on cotton crop (PAPA, 2009). The excessive uses of agro-chemicals have led to enhancing green house gases emission resulting in increasing carbon footprints.

Increased exploitation of freshwater has led to significant degradation of freshwater resources, biodiversity and the services that rivers provide. While agriculture currently uses approximately 90-97 % of the water from the Indus River system, only an estimated 30-35 % reaches the crop and the rest is lost from irrigation channels as a result of groundwater seepage and as run-off from fields.

Traditionally, the major factors of low cotton yields include inadequacy of irrigation water and attack of different insect and disease pests. Overcoming these obstacles has been the central element of strategy of increasing yield and economic benefits to the growers with limited impacts on environment. However, this approach has resulted in increase in cost of production, lower gross margins and adverse impacts on farm workers' health and environment. There has been a substantial knowledge development in ecological crop management. However, much of this knowledge remains within research institutes or progressive growers and does not reach majority of cotton growers. Moreover, there are too many farmers and few extension people and, practically, it is impossible for these few extension workers to contact each and every farmer under the limited resources available.

Knowing the facts that cotton production is a burden on the environment, WWF - Pakistan launched Pakistan Sustainable Cotton Initiative (PSCI) in 2005 with the objective that the cotton farmers apply BMPs and an enabling environment created to facilitate and encourage the uptake and long-term use of BMPs at national and international levels (WWF, 2005-2011).

Material and Methods

Use of different participatory approaches such as Farmer Field School (FFS), Participatory Technology Development (PTD), Training of Trainer (ToT) and Training of Facilitator (ToF) have been demonstrated as effective means of BMPs dissemination. These approaches are field-based and participatory and each setting has its own problems and solutions, and farmers must be equipped and skilled to best address their problems. Under the ToT/ToF, 25-35 participants were trained over a cropping season to become Master Facilitator and they in turn facilitate widespread dissemination of knowledge to fellow farmers. The course contents were developed on the basis of problems and issues identified by experts and farmers collectively to address all aspects of farming as well as taking into consideration the socio-cultural aspects. The FFS activities were based on discovery learning process through non-formal adult education techniques involving simulation and group dynamic exercises. This model aims at helping farmers to discover and learn about field ecology and integrated crop management starting from land preparation to right seed selection, rational use of irrigation, fertilisers and pesticides, harvesting and marketing. Under these FFS, farmers learn how to best utilise indigenous resources and implement best natural resource management strategies based on the financial input.

The key to success of these approaches is empowerment of the farmers with an understanding of the agro-ecology of their own fields.

For widespread dissemination of BMPs, an innovative approach of One Village One Facilitator (OVOF) was widely used which is based on:

1. Continuous enhancement of skills and capacity-building of the farming communities
2. Discovery learning process
3. Outreach and technical backstopping
4. Continuous monitoring and quality assurance activities.

The facilitator was based in a village and facilitated implementation of different BMP activities in collaboration with local activists. Normally, one facilitator facilitated, on an average, around 150-200 smallholders covering an area of about 2,000-2,500 cotton acres. These smallholders were further sub-divided into Learning Groups (LGs) with 25 - 40 farmers in each LG. In case of large holders, a facilitator addressed 1-7 farmers only. The activities normally involve establishment of learning plots, weekly ecosystem analyses by farmer groups, discussion and decision making supported by outreach technical support.

Makhdum *et. al.*, (2002 & 2003) highlighted the importance of in-built mechanism for quality assurance and monitoring and listed criteria for evaluation of FFS. In case of persistent weaknesses, specialised capacity-building workshops were organised by inviting experts from premier research institutions and universities in Pakistan.

Results and Discussion

Over the period of time, several participatory BMPs were formulated and validated in close collaboration with research institutions like Central Cotton Research Institute (CCRI) Multan, Ayub Agriculture Research Institute (ARI) Faisalabad, Nuclear Institute of Biology and Genetics Faislabad, Water Management Institute, Faisalabad, Arid Agriculture Research Centre, Bahawalpur and later on these were disseminated through participatory approaches among farming communities in Bahawalpur, Lodhran, Rahim Yar Khan and Toba Tek Singh in the Punjab and Sukkur and Ghotki in Sindh. (Map). List of BMPs developed and disseminated are attached as Annex 1

Irrigation Management

The major BMPs were focused on modified Flatbed-Furrow Technique (FFT) based on ridge formation after first irrigation. In this technique, sowing is done on flat bed and after first irrigation, 30-40 days after sowing, ridges are made with bull plough or with the help of tractor. This technique helps in saving of around 27 - 33 % of the water.

Another technique which gains popularity among farmers, particularly, smallholders is irrigation on indicators. Five visible indicators based on plant and soil conditions were developed and tested. These include compactness of sub-soil, red streak on plant stem, stiffness of topmost portion of the plant, yellowing of top leaves and appearance of white flower. Comparison of control and experimental plots show that around 30% water can

be saved if the indicators mentioned above for experimental plots are carefully followed. As far as different water saving BMPs are concerned, higher seed cotton yield was obtained under alternate row irrigation (2,473 Kg/ha) followed by irrigation based on water scouting (2,468 Kg/ha) (Fig. 1).

Fertility Management

Several BMPs such as soil testing, side dressing, using fertiliser after irrigation, placing fertiliser, split dosing, nutrient scouting, basal dose, green manuring and composting were tested and widely disseminated. Farmers, usually apply fertiliser before irrigation which result in losses due to oxidation, seepage, drifting of fertiliser particles to corners. The results and experiences show that there could be as much as 21-27 % of the fertiliser saving as a result of application of first three BMPs only. Similarly, in case of placing fertilisers, farmer can save up to 18-26 % fertiliser and nutrient scouting helps saving of around 12-18 % of the fertilisers (Fig. 2).

Compost acts as a soil conditioner and increases its water holding capacity. Several participatory trials indicated that in the control plot, farmer applied 1,445.86 m^3 of water compared with 1,172.84 m^3 of water where compost was applied at the rate of 800 Kg/ha. Moreover, BMP farmers used 90 Kg/ha of Nitrogenous fertiliser compared with 240 Kg/ha by the control farmers, thus showing reduction of 62.5 %. BMP farmers got seed cotton yield of 2,170 Kg/ha by applying 750 ml of pesticides compared with 1,996 Kg/ha by applying 1,650 ml of pesticide by the control farmer (Table 1).

Plant Protection

Several BMPs such as conservation of beneficial, understanding ecosystem, using alternate materials (botanical pesticides), sanitation, pheromone and light traps and redistribution of beneficial, using pesticides based on pest-beneficial interaction were tested and widely applied. Roshanzada *et. al.,* (2001), reported the success of farmer led IPM programme and our experiences show that if these practices are applied as a package can help in reduction of pesticide use up to 60 %. Community cotton insect pest tracking system which was introduced couple of years back has now become a permanent practice and being implemented successfully for pre-sowing ecosystem management

Table 1: Use of fertilisers, water and pesticides in the plots where compost was applied

	Water (m^3)	Pesticide (ml/ha)	Synthetic Nitrogenous Fertilisers (kg/ha)	Yield(Kg/ha)
BMP Farmer	1,172.84	750	90	2,170
Control Farmer	1,445.86	1,650	240	1,996

of important insect pests, by removing alternate host plants. This is a community mobilisation activity, which are provided with basic training on insect identification and community members are encouraged to report about the incidence of pests. This has helped to report and eradicate major populations of mealy bug this year (Fig. 3).

The pesticide consumption in BMP plot ranged from 955 - 1,375 ml per acre compared with 2,400 - 3,000 ml in the control plot (Fig. 4).

Widespread dissemination of BMPs

During 2011, widespread BMP dissemination activities were carried out with more than 47,479 farmers over an area of around 204,400 ha as per following detail (Table 2).

Regarding adaptability of different BMPs for fertility management, maximum adaptability was observed in split dosing followed by use of nutrient indicators. In case of irrigation management, maximum adaptability was observed in case of water scouting followed by flat bed and ridge formation after first irrigation. Similarly, in case of pest management, conservation of beneficial followed by sanitary and phyto-sanitary activities and using alternate material were the most popular among the farming communities.

The BMP cotton farmers made crop management decisions which resulted in 41 % reduction in synthetic fertilisers, 37.5 % in irrigation water and 47 % in pesticides (Fig. 5 & 6) with a cost-benefit ratio of 1:2.34 for BMPs as compared with 1:1.12 of non-BMPs. The average gross margin for BMP farmers was 70 % compared with 52.86 % for non-BMP farmers, making a difference of 17.14 %.

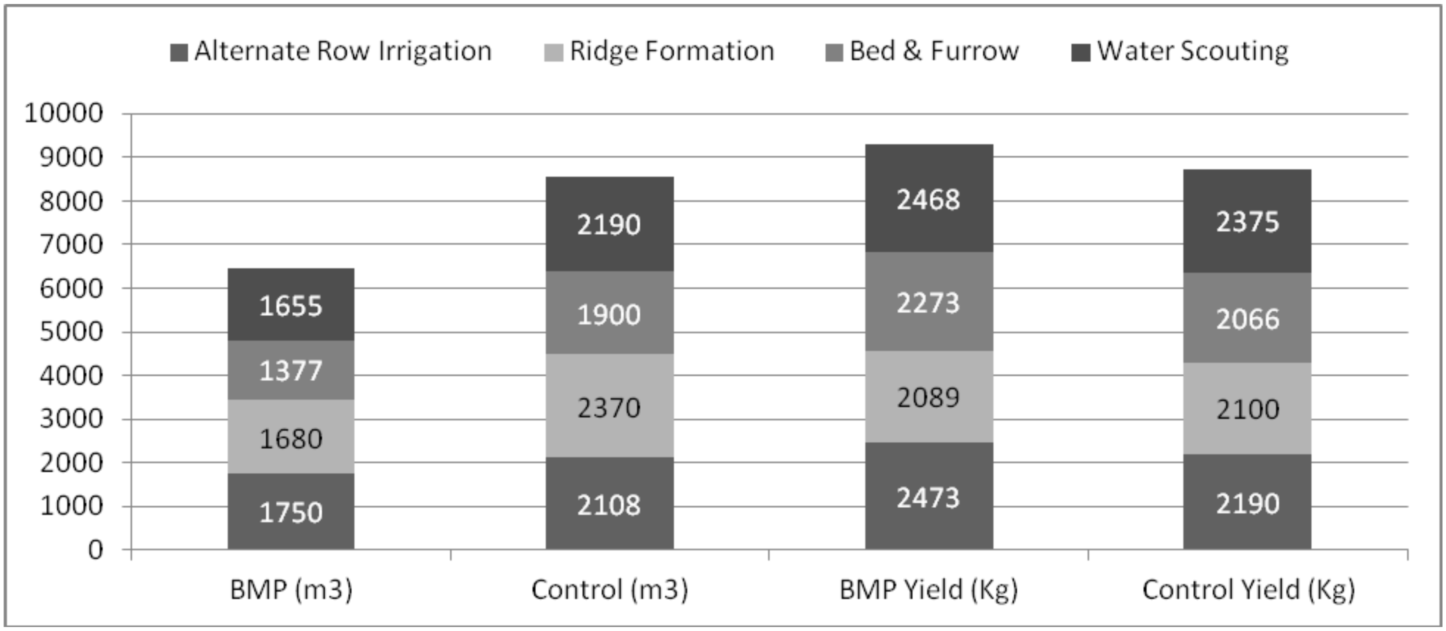

Figure 1: Quantity of irrigation water in cubic meter and yields in kg/ha in BMP and control plots under different irrigation BMPs

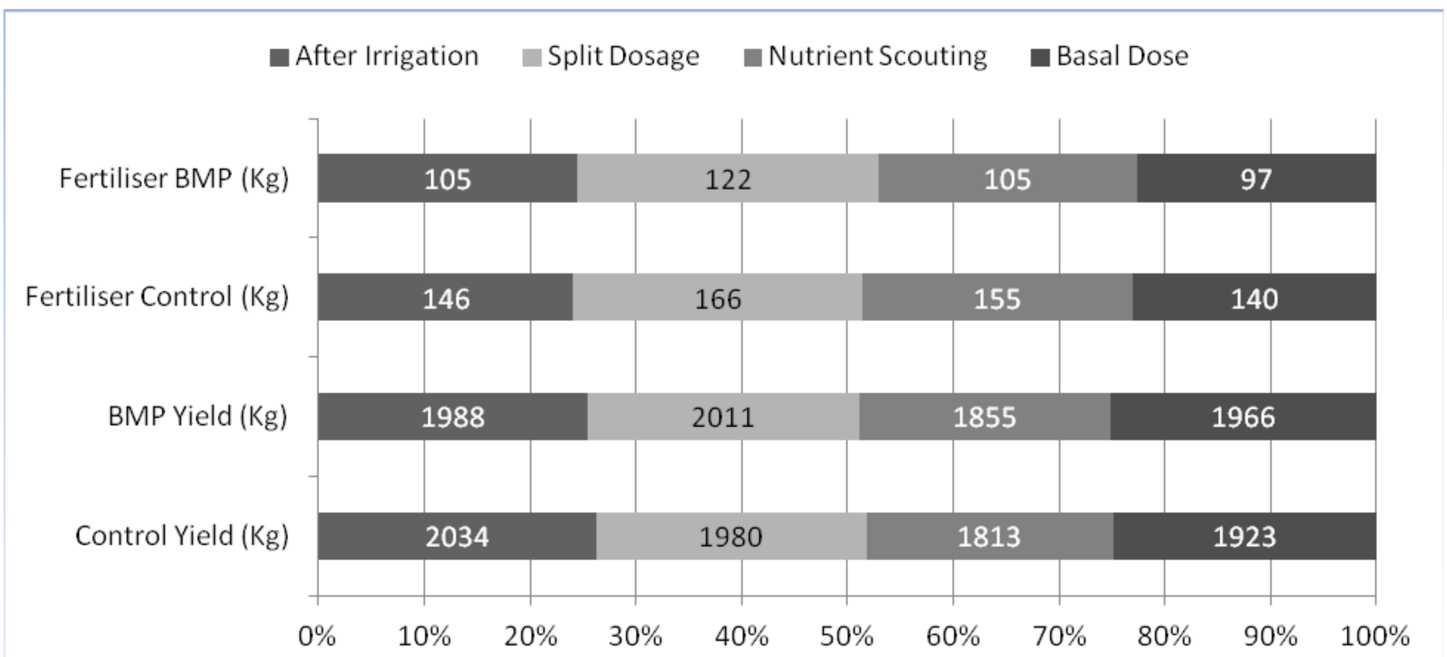

Figure 2: Use of synthetic fertilisers and yield in kg/ha in BMP and control plots

Conclusion

The programme taught smallholders to better understand biodiversity, interaction between beneficial and harmful organisms, minimising pesticide use and promoting botanical pesticides to improve environmental health and learn how to reduce water and fertiliser use by wisely using irrigation and fertility indicators, altering application techniques and enhancing use of organic manure and compost. Comprehensive analyses of the results show that cumulative irrigation water application by BMP farmers was 0.8 billion m^3 compared with 1.3 billion m^3 by the same number of control farmers over the same acreage of cotton cultivation. There is a difference of 0.5 billion m^3 of water which will help in improving the ecosystem services. Similarly, in case of synthetic fertilisers, cumulative application was 49,497 Metric Tons (MT) compared with 83,336 MT by the same number of control farmers over the same acreage. Thus, there is a saving of around 33,839 MT of synthetic fertilisers. In case of synthetic pesticides, total solution used by BMP farmers was 0.79 million litres compared with 1.48 million litres by control farmers over the same number of acreage.

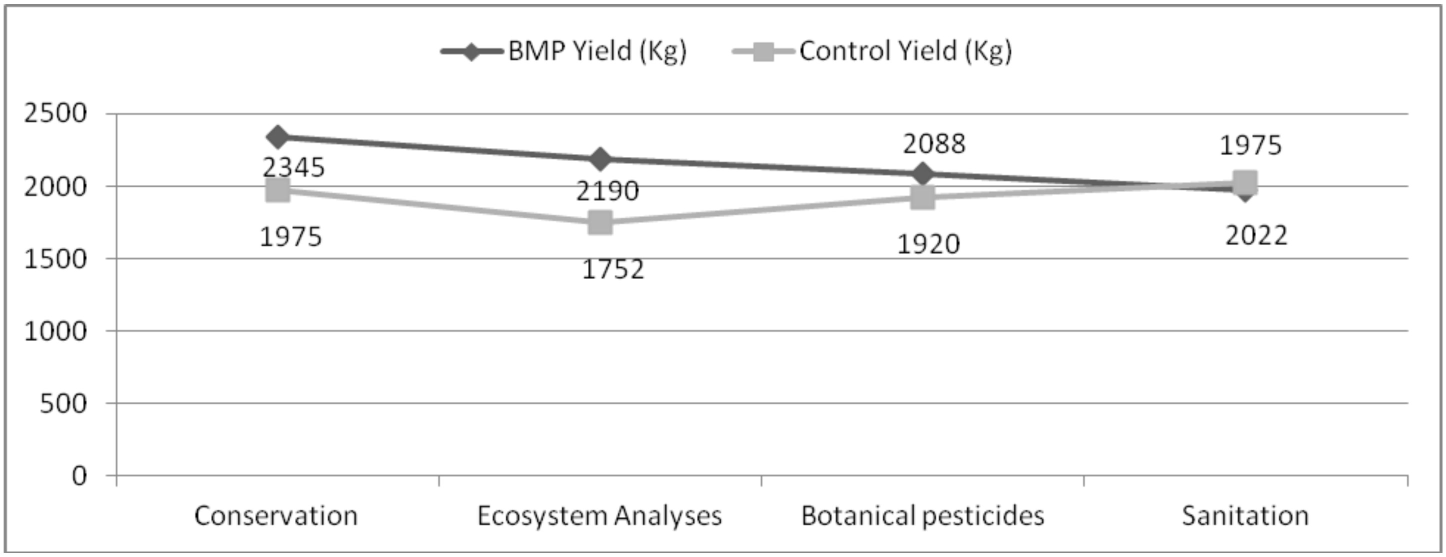

Figure 3: Yield in Kg/ha in BMP plot where IPM techniques applied and in control where pesticides were used

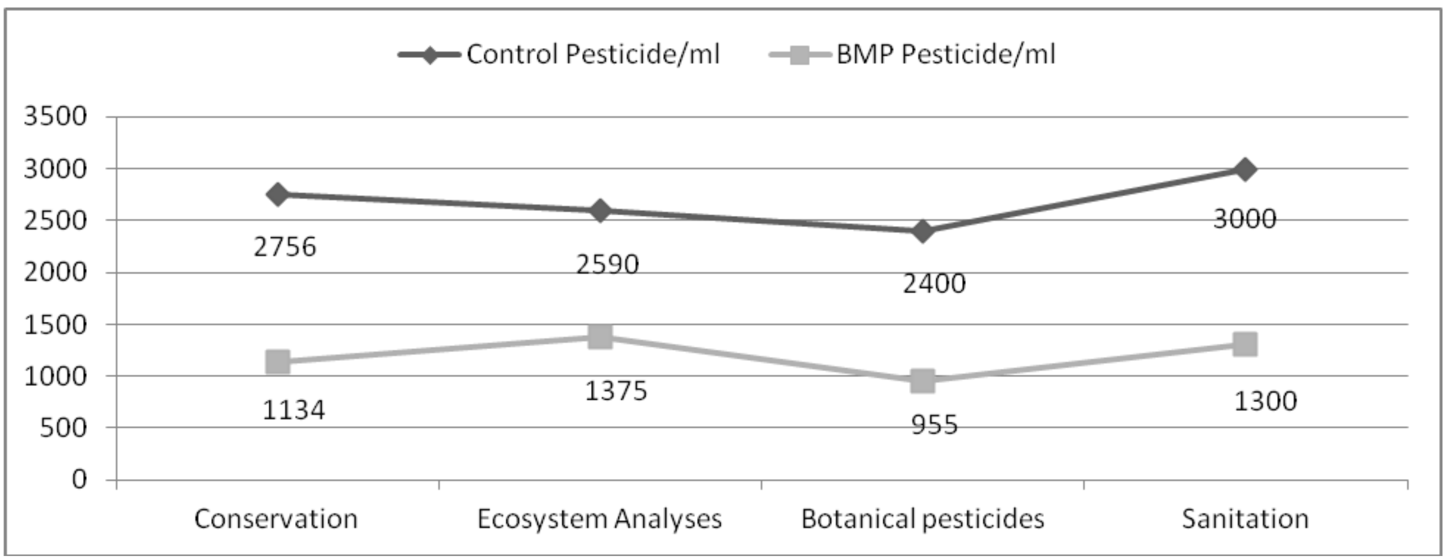

Figure 4: Pesticide application in ml in BMP and control plots

The results clearly indicate that BMP applications help reduce the cotton footprints. However, the estimation of the exact footprint values is very important to prepare response strategy, which will provide a strong foundation for increasing farm resilience in the face of climate change. Increased concentration of green house gases are causing earth's temperature to raise, while agriculture consumption, prices and farm income are affected by these temperature increases. The agriculture industry cannot be held unaccountable for the role it plays in global climate change. The cotton production lets off two sources of green house gases; methane and nitrous oxide and concentration of these gases can be reduced by implementation of BMPs.

A full environmental footprint assessment goes beyond calculating GHG emissions and water consumption, in that, it also addresses the sustainability of resource use, as well as allows a business to identify its emission- and water-related impacts and vulnerabilities, and identify potential response actions. The potential for GHG mitigation in the cotton sector is high. A range of mitigation measures will be deployed through the adoption of improved cropland management practices (reduced tillage, integrated

Table 2: Number of farmers and area of cotton cultivation under BMP during 2011.

District	Total Farmers	Total (ha)
Bahawalpur	16,700	90,000
Toba Tek Singh	14,600	26,150
Rahim Yar Khan	5,679	27,850
Sukkur & Ghotki	10,500	60,400
Total	47,479	204,400

nutrient and water management, and conservation agriculture); reduction in the emission of methane and nitrous oxide, through improved animal production, improved management of livestock waste (manure and biogas), more efficient management of irrigation water, and improved nutrient management; and sequestration of carbon, through crop cover and proper composting process.

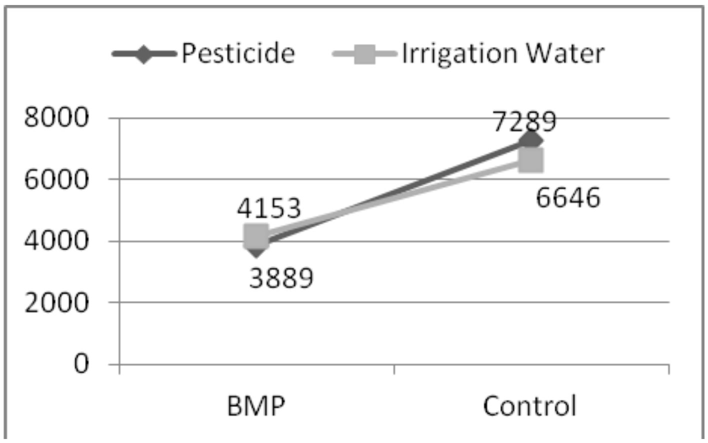

Figure 5: Average irrigation water use in m3/ha and pesticide applications in ml/ha by BMP and control of farmers

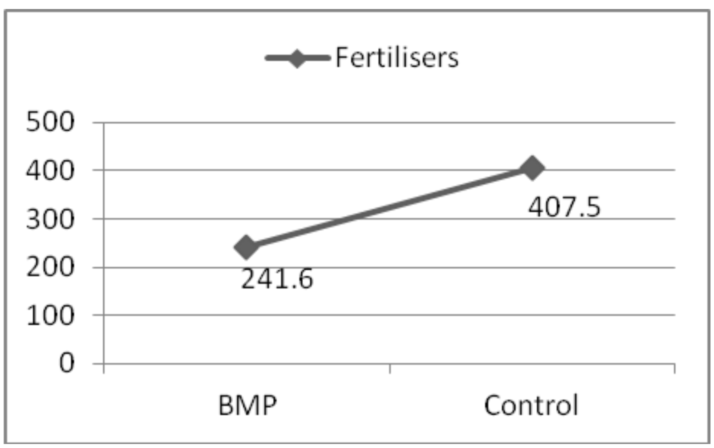

Figure 6: Average use of synthetic fertiliser in Kg/ha by BMP and control farmers

WWF -Pakistan is planning to implement a project to develop tools to quantify cotton footprints to develop their mitigation strategy with the following objectives:

1. Assessed the GHG emission and Water footprint (Environment footprint) associated with cotton cultivation in the cotton growing regions of India and Pakistan;
2. Plan of action with mitigation measures is in place to address the issue of environment footprint.

Convincing farmers to change their practices has been challenging since smallholders do not want to take risks. But on-farm research, and working continuously with these farmers while building their capacities and enhancing their farming skills, strengthening local organisations, convinced farmers that the BMPs make business. BCI and WWF – Pakistan's intention is to make BC a main stream commodity which should be available on existing market prices as conventional cotton.

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