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RAPID ASSESSMENT OF THE PHASING OUT OF HAZARDOUS PESTICIDES IN DHORAJI, GUJRAT

Introduction

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Authors: Prerna Mukharya, Paramjeet Chawla and Malvya Chintakindi.

Background

Monocrotophos (MCP) is an acutely toxic pesticide, recognized by World Health Organizations (WHO) as Class 1b category pesticide (highly hazardous pesticides), which is commonly used in cotton farming in India despite being banned in several nations for all purposes (46 Nations as per 2009 WHO Report). In India, however, MCP has been banned only for its use in vegetable farming / cultivation. As per the WHO South Asian Office Report on ' Health Implications from Monocrotophos use: A Review of the Evidence in India' (2009), MCP can makes its way into the human body via ingestion, inhalation and skin contact, and can directly impact the central nervous system, causing immediate and visible health problems, such as poor vision, respiratory issues, dizziness, diarrhea, nausea, psychosis, irregular heartbeat, and with intense exposure, may lead to respiratory failure or cardiac arrest, leading to death in certain cases.

MCP has adverse effects, which go beyond the human body. It is known to be fatal for birds, bees and other wild species, which are beneficial for cotton farming. It makes its way into the animals' body when it consumes grass, crop or fodder that was exposed to MCP and contaminates the byproducts of the animal used by human beings, such as milk. Once sprayed on the crop, the soil quality and water sources also deteriorate. In terms of cotton farming specifically, MCP delays the flowering and fruiting of the cotton plant, which delays the maturity of the plant, making it more vulnerable to late season pests.

MCP's usage has continued in India despite its ban in vegetable farming. As per the WHO South Asian Office Report on 'Health Implications from Monocrotophos use: A Review of the Evidence in India' (2009), it is not patented, therefore easily available and hence becomes an affordable pesticide for the farmer. Despite its harmful effect on human health, the usage of MCP has continued due to the low cost as well as general lack of good quality advice and

effective outreach from state agriculture extension services regarding its harmful impacts and regarding alternatives. MCP usage indicated a significant rise in 2015 because of the dominant problem of pink bollworm infestation in cotton farming in India, even though MCP is not effective against pink bollworm, the lack of knowledge on part of the farmers can be a plausible cause for it. Additionally, MCP is a broad-spectrum pesticide and is known to be effective in destroying other types of pests as well, such as chewing, and sucking pests.

MCP, as a pesticide has other offerings that encourage its usage. It has a tonic/ hormonal effect on the plants, which makes the plants greener, misleading the farmer with regard to the health of his crop.

BCI's intervention

BCI carried out an intervention in Dhoraji situated in the Rajkot district of Gujarat during the cropping period pre-dating 2014-15, to address issues of hazardous pesticides usage across cotton farmers. The intervention was rolled out in the form of meetings with farmers, training programs and field demonstrations by AFPRO. The intervention began with the purpose of spreading awareness of the toxicity of various pesticides. It sought to inform farmers about hazards, with the goal to alter their pest management practices for a healthier and safer environment. Demonstrations were carried out by AFPRO to portray the positive impact of other less hazardous alternatives such as Neem Oil. The demonstrations were accompanied with the distribution of health and safety kits to 200 farmers across 2 Producer units (PU), to inculcate a practice of prevention and safety against probable hazards of chemical pesticides.

AFPRO's Role

The study recognizes that AFPRO has played a pivotal role in phasing out the use of MCP in the context of the two villages under study and potentially on a bigger scale.

Direct communication with farmers

The constant communication maintained between AFPRO and the farmers, aids the process of dissemination of information and spreading awareness, which has been seconded by KVK officials. AFPRO reported that irrespective of the agenda of the intervention conducted, AFPRO staff ensured that they include a brief discussion regarding the perils of using hazardous pesticides such as MCP. These reminders have proven effective in the phasing out of pesticides such as MCP.

AFPRO has been able to spread awareness with the help of IEC materials, distributed in the form of pamphlets, videos as well as one-on-one meetings with farmers. The demonstrations carried out by the AFPRO officials regarding the use of bio controls such as Beauveria Bassiana (BB), neem oil and pheromone traps, on select farms, have convinced farmers in altering their general practices regarding pesticide usage. AFPRO has not only spread awareness but has also brought together multiple stakeholders, like JAU and KVK, that has further pushed the right information to farmers.

AFPRO inducted multiple field facilitators who are given special training regarding the intervention, especially in terms of integrated pest management practices, thereby creating a chain of information, where the field facilitators are easily available on calls for other farmers, for any queries /help.

Provision of inventory to the farmers

AFPRO has provided notebooks in the form of field farmer books (FFBs), wherein the farmers are required to note down the seed inputs, pesticide usage and the costs involved in cotton farming for the current season. However, there have been discrepancies regarding regular tracking, wherein it has been understood that on one hand, the tracking has helped farmers understand the profitability of the crop. On the other hand, some farmers are not motivated to keep track, which prevents them from updating their field books from time to time. FFB, as such has not been a successful endeavor.

Interventions across sectors

During the cotton season, AFPRO works directly with cotton farmers. However, during the picking season and spraying of pesticides, AFPRO claims to work with labourers, implying that their reach is not limited to the farmers. However, discussions with farmers revealed that AFPRO's reach to labourers is limited since the information regarding hazards of MCP and safety gear does not reach them (labourers).

Junagadh Agricultural University (JAU)

Junagadh Agricultural University (JAU) is an agricultural university at Junagadh in the Indian state of Gujarat. It offers education in agriculture and allied sciences, i.e. agricultural engineering and fisheries.

The University is home to seven multidisciplinary Main Research Stations, five Main Research Stations for various crops and eleven sub-Research Stations/Testing Centres for the development of new varieties/hybrids of crops, vegetables and fruits. These centres work for the development of economical and sustainable production technology packages for newly developed varieties and hybrids with modification each year.

JAU's Directorate of Extension Education works with various KVKs, NGOs and organizations in the region to serve farmers and those involved in agricultural activities. It is through this directorate that JAU conducts its IEC activities with AFPRO and disseminates their technology to farmers.

JAU's Contribution

JAU has setup an outlet for farmers to purchase biological control products, and an avenue for farmers to seek consultation. It provides on-farm and off-farm trainings to AFPRO's field facilitators and agricultural experts working in the region. For instance, in 2017, JAU scientists visited Boriya village to curb the white grub insect. JAU scientists also provide scientific recommendations focusing on integrated pest management (IPM).

JAU's vast communication network is their strong suit and they are implementing a communications project for farmers wherein they use texts or SMS for instant mobile communication.

Developments and recommendations for Cotton Farming

JAU scientists are currently developing a wax-based paste that would eliminate the need to spray any kind of pesticide or insecticide to curb the pink bollworm. They have also developed 14 different strains that are effective against different pests including thrips, whiteflies, aphids, etc.

Additionally, JAU scientists recommend the practice of de-topping the cotton crop from 75 to 80 days. Through this practice, the cotton crop's horizontal growth has increased, and its vertical growth halted which increases the number of bolls produced per plant.

The JAU scientists also recommend drip-irrigation and the usage of plastic mulch to suppress weeds and conserve water in crop production. Several plant growth regulators are also recommended to farmers. One such recommendation is to couple 3 grams of plant regulators with 10 liters of water to increase the yield by 20-22%.

By 2015, JAU had developed an alternative, a bio control called Beauveria Bassiana (BB) which was aimed at solving the problem of pest infestations, especially serving as a solution to resolve the predominant issue of pink bollworm. JAU scientists have also claimed it to be effective against sucking pests. The focus of the intervention thereon switched to spreading the word around this alternative, which would serve a two-fold purpose; a) it would be effective in solving the issue of pink bollworm across cotton farming, as pink bollworm attacks were quite extensive in 2015, b) it was an effective solution in the form of biological control, the promotion of which would also reduce the usage of other chemical pesticides.

Krishi Vigyan Kendra (KVK)

Krishi Vigyan Kendra (KVK) is a district level farm science centre, sponsored by the Indian Council of Agricultural Research (ICAR). Junagadh Agricultural University (JAU) collaborates with the KVK in Pipaliya as a part of their extension activities. As per OI's discussion with KVK, it was understood that the organization was a facilitating factor in the intervention carried out by AFPRO-BCI.

KVK was started in 1974 and is responsible for conducting on-farm testing for identifying technologies, organizing frontline demonstrations on crops to generate production data and feedback information, identifying technologies in terms of location specific and sustainable land use systems. KVK also organizes training to update the personnel as well as vocational training courses for the farmers and the rural youth. The emphasis of these programs lies in "learning by doing" for higher production on farms and in generating self-employment. Integrated Pest Management (IPM) is an integrated part of the priority thrust areas. It would be fair to say that KVK has been one of the many organizations that have aided the intervention by BCI (and implemented by AFPRO) in phasing out of hazardous pesticides.

Interventions with AFPRO

KVK has carried out multiple activities with AFPRO that has aided the progress in phasing out of hazardous pesticides, such as frontline demonstrations to introduce pheromone traps and BB, which resulted in reducing the infestation of pink bollworm in BT cotton and increased the yield.

Interventions with JAU: KVK also works in tandem with JAU to carry out diagnostic tests to certify that the introduction of biological controls has helped reduce the use of hazardous pesticides and introduction of alternatives. They conduct field visits to solve the issues regarding sucking pests and pink bollworm infestation. Under the IPM, pesticides and fungicides as well as BB and pheromone traps were recommended.

KVK Pipaliya has been administering IPMs for dealing with pink bollworm in BT cotton for two years, namely, 2015-16 and 2016-17, which had aided the intervention implemented by AFPRO.

Independent interventions

KVK has independently given demonstrations to 100 farmers with respect to cotton (via provision of pheromone traps). However, the field visits, following the field demonstrations, to gauge the effect, are done for a maximum of 25 farmers, since it is not feasible to assess a larger set of farmers. At the end of the intervention, they ensure that there is a 1 sq. km of a patch of field that is tested to understand the implications of the interventions and field demonstrations. In collaboration, KVK and AFPRO carried out field visits, farmer trainings and exposure visits (including at KVK). Awareness was also created collectively, especially for encouragement of usage of BB and the adoption of pheromone traps, under the IPM required for pink bollworm, and neem oil for sucking pests. Collectively, they were also able to succeed in spreading the word about the hazards of pesticides (which have been banned in multiple countries), encourage adoption of BB, pheromone traps and neem oil, as alternatives.

.KVK runs its own interventions and has been doing so since 2014 due to the rise of pink bollworm. As stated earlier, KVK plays a crucial role in supporting AFPRO's interventions. Their presence helped ease the process of the interventions regarding the use of pesticides and alternatives, and thereby encouraged farmers to adopt IPM practices. The training and work has been done with AFPRO, wherein 1000 posters were put up with the help of KVK across villages to spread the word about the management of pink bollworm.

Constant contact with the farmers: KVK remains accessible and available on call, especially for the 'innovative' and 'active' farmers, since there is a tendency of certain farmers to be more curious and forthcoming regarding integrated pest management practices.

KVK set up 18 training events with the JAU scientists for dissemination of technical knowledge on better crop management for cotton farming.

As per KVK, in 2015-16, the pink bollworm infestation was about 60-70 percent, which now has reduced to 5 to 10 percent in 3 to 4 talukas, attributable largely to the concerted efforts by the aforementioned organizations.

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Methodology

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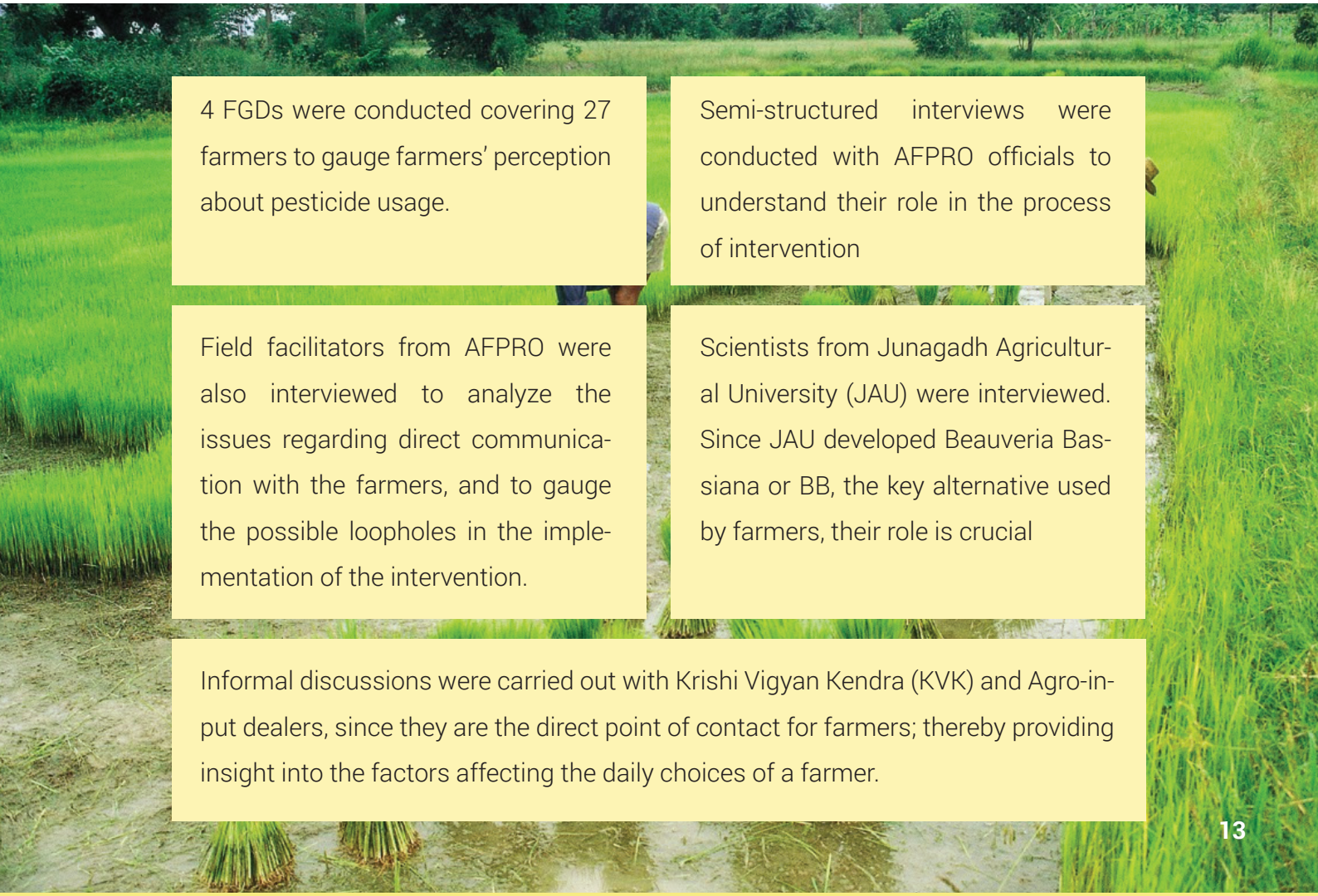
The primary approach to this study has been qualitative, adopted to understand the multitude of issues related to phasing out the usage of MCP in cotton farming across Gujarat. This involved a case study of two pre-selected villages in Dhoraji, Gujarat.

A desk review of information provided by BCI and AFPRO have guided the data points essential for this study. Additionally, datasets on the use of MCP from the 2014-15 to 2016-17 seasons have been used for the quantitative analysis. These datasets, provided by BCI to Outline India, contain details regarding farmers' use of MCP in Gujarat and the data is limited to a few villages.

Qualitative Components

To explore the multiple intervening stakeholders for this dipstick, detailed qualitative tools were designed by Outline India team. These included focus group discussions (FGDs), in-depth interviews (largely, semi-structured interviews) as well as informal discussions with other relevant stakeholders who were not officially listed, but were found to be key, as revealed in due course of carrying out the fieldwork.



4 FGDs were conducted covering 27 farmers to gauge farmers' perception about pesticide usage.

Semi-structured interviews were conducted with AFPRO officials to understand their role in the process of intervention

Field facilitators from AFPRO were also interviewed to analyze the issues regarding direct communication with the farmers, and to gauge the possible loopholes in the implementation of the intervention.

Scientists from Junagadh Agricultural University (JAU) were interviewed. Since JAU developed Beauveria Bassiana or BB, the key alternative used by farmers, their role is crucial

Informal discussions were carried out with Krishi Vigyan Kendra (KVK) and Agro-input dealers, since they are the direct point of contact for farmers; thereby providing insight into the factors affecting the daily choices of a farmer.

Quantitative Components

A second component was added to the methodology, involving a simple statistical analysis of the secondary data provided by BCI. The intention was to gauge and validate data collected from farmer field books with that of the data received by BCI. This component could not be included properly in the study due to constraints in gathering data which are elucidated below.

Location Rationale

The study was carried out in two villages of Dhoraji block, in Rajkot district of Gujarat.

As per AFPRO's guidance and BCI's approval, 2 villages were selected, namely Boriya and Nani Parabadi. The sustained presence of AFPRO in phasing out of MCP since 2014 is crucial here. Though AFPRO's project offices have expanded to numerous other districts, blocks and villages in Gujarat, Dhoraji block has showcased a significant shift away from the use of MCP and hence, its selection as a site for the study.

Stakeholders and Respondents

The stakeholders and respondents for the study were identified in conjunction with BCI and AFPRO. This includes farmers, field facilitators, AFPRO staff members, KVK, agro-input dealers and scientists from JAU. The identification and sampling of the respondents are detailed in the following section.

Farmers

Number of Respondents: 27

Identification: Two learning groups, one from each of the two villages (Boriya and Nani Parabadi) were chosen. Each learning group comprises of 30 farmers. A total of 7-8 farmers were sampled for each focus group discussion (FGD).

Sampling of the farmers: The villages and the learning groups were chosen by AFPRO. The selection of farmers for the first FGD was carried out via a random selection in the presence of the whole learning group.

The second FGD was based on a random selection from the list made available by AFPRO (the list AFPRO staff use for attendance purposes), wherein every third farmer was chosen from the list for a selected learning group. The random selection was skipped for absentee farmers in the meeting organized by AFPRO.

The third FGD with farmers was set up via the same process. An organized selection for the fourth FGD was not possible due to the presence of a limited number of farmers.

Field Facilitators

Number of Respondents: 2

Field Facilitators (AFPRO's project staff), one each from Boriya and Nani Parabadi were interviewed at the AFPRO Dhoraji's office.

AFPRO staff members in Dhoraji, Gujarat

Number of Respondents: 2

Two AFPRO project staff (Producer Unit Managers) were interviewed at AFPRO's Dhoraji office. These are the official representatives for AFPRO's project in Boriya and Nani Parabadi

Scientists at JAU

Number of Respondents: 2

The two JAU scientists interviewed were identified by AFPRO. These JAU scientists have been credited by the farmers and AFPRO alike for their work in providing alternatives to MCP and have played an important role in supporting AFPRO's activities in general.

KVK

AFPRO directed the OI team towards the KVK situated in Pipaliya. Its selection is premised on convenience, given its proximity to the AFPRO Dhoraji Office and thereby, the intervention region.

OI researchers conducted an informal discussion with KVK related to their work in agriculture, more specifically on pesticide usage across cotton farmers in Dhoraji. The focus lay on the supplementary as well as complementary activities of the KVK aiding AFPRO's work.

KVK
Krishi Vigyan Kendra

Agro-input dealers:

OI researchers interacted with agro- input dealers in a pesticide shop in Dhoraji region to understand the trends related to pesticide sales in the region.

Limitations of this study

Outline India deems it necessary to bring out certain limitations to the study, in light of its planning, execution, availability of datasets and stakeholders, such that the results may be seen, observed and understood with context.

The selection of sample villages, and respondents across all stakeholders was done by AFPRO. Owing to selective exposure, at the implementing partner's behest, the findings might not be representative of the reality in these villages.

Inconsistencies in the selection of farmers for the FGDs, is another limitation to the representativeness sample. There was no uniformity in the selection or the criteria for selecting farmers across learning groups. This happened largely due to the irregularity in farmers' attendance which can be attributed to externalities such as lack of electricity and water supply issues.

The data regarding the use of MCP for 2016-17, provided by BCI, could not be validated since the FFBs were not maintained by farmers and were not brought to the venue during the FGDs, despite multiple rounds of intimation to AFPRO, and their Field Facilitators.

This report offers an overall understanding of the current scenario regarding 4 learning groups in Dhoraji. There are a total of 376 learning groups under AFPRO Dhoraji's office. Therefore, the findings may not be representative of the intervention overall, given the small sample.

The methodology of a 'case study' limits the tracking of the actual cost-benefit analysis taken into consideration by the farmers. It is difficult to estimate the exact costs incurred by the farmers in switching from chemical pesticides to biological controls. The available data of cost estimates vary across different learning groups.

It is difficult to isolate the singular contribution by AFPRO in the study. The most effective methods that have been recognized are the collaborative efforts between AFPRO and other organizations such as KVK, JAU etc. as well as the decentralized structure of AFPRO for dissemination of information. Based on OI's understanding, other than AFPRO, there are other organizations working together to bring about a behavioral change among farmers and other key stakeholders.

Findings and Analysis

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Farmers Awareness & Perceptions regarding Hazardous Pesticides

Information, Education and communication (IEC) activities

The general awareness about hazardous pesticides/insecticides has increased among farmers, as stated by farmers themselves, and seconded by AFPRO officials. This was confirmed in the FGDs when farmers mentioned their ability to classify pesticides based on the color of the label (red, yellow or green), specifically understanding the significance of 'red label' pesticides, which are the deemed most hazardous. Farmers were aware of the intensity of the hazards and the dangers associated with MCP.

This may be a positive impact of the IEC campaigns that are rigorously carried out by AFPRO in association with JAU and KVK.

JAU and AFPRO stated the importance and effectiveness of roles played by the other organizations in spreading awareness among the farmers.

JAU provides relevant information via posters in Gujarati to farmers on topics of farmers' interest and regarding pesticide usage. JAU has published 12 pocket books for cotton farmers offering guidance on controlling pink bollworm, minimizing the use of water, benefits of following integrated pest management (IPM) practices, implementing organic farming methods, using plant growth regulators and so on.

JAU reported that AFPRO uses their information materials for distribution among farmers. AFPRO testified to using IEC materials provided by JAU and suggested that they often alter the IEC material and make additions according to the agenda of the next activity/ interaction with the farmers.

It is fair to hypothesise that JAU has also aided AFPRO's intervention and has had a significant involvement in AFPRO's training sessions, meetings, rallies and demonstrations.

MCP

Based on our conversations with AFPRO, farmers, JAU scientists and other stakeholders, farmers are positively inclined to completely stop the use of MCP

AFPRO's project to phase out MCP in Dhoraji commenced in 2014. Farmers have been long accustomed to using MCP (for past 10 years approximately), thereby necessitating a need for persistent efforts to change a long-standing habit in pesticide usage across farmers, by relevant stakeholders.

Post-AFPRO's field demonstrations (where farmers were asked to use MCP and BB on consecutive rows of the crop for the sake of comparison), farmers have claimed that they have been able to clearly spot the differences between plants where MCP and BB have been used in terms of the flowering, boll growth and the incidence of pests. The live demonstrations have provided tangible evidence to the farmers and helped AFPRO establish trust within the farmers' community. It is important to note since pink bollworm has been a major issue in 2015, BB has been introduced as a solution for pink bollworm though, in different concentrations, it is also effective against sucking pests.

According to the KVK officials, it was pointed out that MCP is used only with acephate. MCP and acephate are purchased by farmers separately and are mixed together before spraying. When the mixture of MCP and acephate is leftover, it is sometimes sprayed on the vegetables. This is however a trend that has been noticed by KVK for general farmers in the area and not BCI farmers specifically. This brings to the fore an issue of mixing of chemicals by farmers, which can further accentuate the hazardous impact of chemicals.

Another dangerous trend noticed by KVK is the continued as well as indiscriminate use of pesticides such as MCP by the farmers, as the first response to any threat of pest. The spraying of MCP at the first go damages the crops from the very beginning, reducing the effectiveness of the pesticide in managing a bigger pest attack at a later stage. This shows a lack of awareness of good and integrated practice of pest management by the farmers, an issue that needs to be addressed.

According to KVK, MCP has no effect on the current pests, and the only purpose it serves is making the plants greener, thereby misleading the farmer with regard to the health of his crop. In fact, by delaying maturity of the crop, MCP increases vulnerability of the crop to attacks by late-season pests like pink bollworm. MCP targets chewing, sucking and boring pests, but the main pest attack during the intervention has been of pink bollworm (which remains unaffected by MCP). This in turn implies that MCP usage possibly reducedbecause MCP was not effective against pink bollworm, the major pest attack in 2015.

It is also fair to point out that **KVK officials speak of farmers in general, and not of BCI farmers specifically,** leaving scope for doubt regarding farmers' pesticide usage practices.

BCI Farmers, however, claim a change in practice wherein they have shifted from spraying of MCP and acephate early in the cropping cycle (after 30-45 days of sowing) to now spraying hazardous pesticides at the end of the cropping cycle or as and when there is a huge incidence of pests. It is important to understand that the usage of hazardous pesticides has not stopped, however, there is more awareness regarding better integrated pest management, thereby curtailing the use of such pesticides.

The FF in one of the villages under study, reported that MCP causes early wilting post flowering as well as delay in flowering. The farmers however, are aware that even though MCP can make the plant greener, it delays the flowering and therefore, delays the cropping cycle. **This is an affirmation to the uniformity of the information available with farmers and field facilitators.**

Awareness regarding health hazards

Farmers have been able to identify the repercussions of continued usage of MCP in the long run. They claim that MCP causes diseases such as cancer, joint pains, diabetes, high blood pressure, impotency, decrease in life span etc.- afflictions they have experienced over the course of time, discouraging them from further use of hazardous pesticides. Farmers pointed out the case of a farmer in Boriya village who had been diagnosed with cancer due to MCP residues in the soil.

In terms of immediate effect, farmers complained of having experienced itchy skin, nausea, and diarrhea as well as unconsciousness post the spraying of MCP. Farmers also stated that the hazards on health are not limited to just MCP, but attributable to the usage of other chemicals such as Profenophos and Lambda Cyclothrin.

This bodes well in terms of information dissemination, as farmers are able to establish causality between health concerns and the usage of hazardous pesticides.

On a separate note, we found that safety kits are provided by AFPRO, JAU and other private companies, to deal with the hazards of spraying of pesticides. However, in certain discussions, it was clear that only the lead farmer would use the safety kit, whereas other farmers would make do with gloves, boots and a handkerchief to ensure safety. The task of spraying pesticides is sometimes delegated to laborers, however, the information regarding safety gear is not always shared with them. A few farmers do give their safety gear to the laborer, though this is not common, putting the lives of such individuals involved in cotton farming in danger.

This reflects a gap in the spread of information regarding safety gear on the farm, which needs to be addressed by ensuring widespread dissemination of information and usage of safety gear by the farmer, and anyone else working on the field.

Impact on the environment and awareness

Regarding the environmental effects of the use of MCP, a few farmers in Nani Parbadi cited the damage it does to the soil, thereby motivating them to switch to alternatives. However, this was a specific case and the awareness was not observed across all farmers.

The farmers are aware of the detrimental effects of MCP on predatory insects such as the coccinellid beetles and parasitoid wasps that are beneficial for natural forms of pest management in cotton farming. Additionally, the use of pesticides, such as MCP, cause the dispersion of crawlers to neighboring plants, thus facilitating their spread and exacerbating the problem. A majority of the farmers also noted the hazard to their cattle and other animals, and their by-products, as already stated early on in the report.

Regarding water and irrigation factors, the farmers are aware that the use of MCP leads to delayed flowering of the cotton crop leading to excessive water requirements, discouraging them from use of MCP in future.

Integrated Pest Management (IPM) practices and farmers' awareness about other alternatives and biological controls

Biological controls

Beauveria Bassiana (BB), the biological control developed and suggested by Junagadh Agricultural University has been widely accepted by the farmers, AFPRO and KVK, as a solution countering the issue of pink bollworm. JAU has been doing rigorous research in developing biological controls (such as Beauveria Bassiana, pheromone traps) and providing the same to the farmers on a no-profit no-loss basis (as stated by JAU officials).

The following table shows the BB production for 3 years

Year	BB Production (Thousand Kilograms)
2013	3
2014	30
2015	40

Source: As stated by JAU Scientists

JAU reported a substantial increase in the BB production from150 thousand kilograms in 2016 to 175 thousand kilograms in 2017.

A study conducted by JAU revealed that more than 40,000 farmers visited JAU and its outlet last year during the cotton season due to the success of bio pesticides. The supply side for BB was explained by JAU Scientists, whereas the discussion with farmers revealed that the demand for BB exists and is increasing.

Farmers admitted to having an initial lack of awareness on how to use the bio control, implying some information gaps between the farmers and the scientists. BB is available in the powder-form and must be dissolved in water a day before its usage. However, farmers were not aware of the procedure to be followed, leading to clogging of the drainage pipes, acting as an initial deterrent towards adoption of BB. However, with AFPRO's continued interventions & demonstrations, farmers gained clarity on the procedure to be followed for BB usage, and its benefits, which has ultimately led to widespread adoption of BB by farmers.

In terms of the facilitating factors needed for BB to work, it was reported by the FFs that BB is ineffective in high temperature, specifically above 30-35 degrees. The FFs ensured this information was passed on to the farmers.

Besides BB, JAU offers other eco-friendly methods such as predators, parasites, pheromone traps, light traps, bio insecticides and neem-based botanical biological controls. Other biological controls,that are **easily accessible control measures such as yellow sticky** boards to trap pests have been well adopted by the farmers. The farmers in the four learning groups that have been interacted with were familiar with the benefits of biological control measures, as opposed to chemical solutions.

Workshops conducted by JAU scientists have also focused on zero budget alternatives to chemical pesticides, such as the use of fermented cow urine. However, the farmers have continued the use of chemical pesticides as opposed to cow urine due to the higher effectiveness of the chemicals.



BB has been a prominent alternative in the intervention for two reasons

- When prepared in certain formulations or strains, it is effective against Pink Bollworm, which was the major pest attack in 2015. JAU scientists have a locally isolated BB strain for use against pink bollworm which they alter seasonally based on the patterns they observe in the cotton crop.

- BB was a bio control that discouraged the use of chemical pesticides. JAU credits BB and IPM for the healthy cotton crop in Gujarat. Farmers have also acknowledged JAU, KVK and AFPRO for spreading awareness about biological controls in the focus group discussions. Agro input dealers stated that farmers now prefer biological controls over chemical pesticides and have reported an increase in the sale of Beauveria Bassiana and Pheromone traps. Outline India believes that this could be owing to the low severity of pink bollworm infestation in 2017, thereby providing a valid reason for reduced chemical pesticides usage.

Issues faced by farmers in the phasing out chemical pesticides

Inclination to continue the usage of chemical pesticides (MCP)

A few farmers have not stopped using MCP and cited multiple reasons for it. Firstly, it makes the plant green and tender, providing them short term satisfaction about a healthy crop. Secondly, the farmers are still largely un-informed and therefore use chemical pesticides to counter the attack of pink bollworm. As reported by AFPRO staff and farmers, there has in-turn been an increase in the use of Profenofos, Deltamethrin, and DDVP which are, sprayed at the end of the cropping cycle since these are high intensity chemicals. This is indicative of the increased use of other hazardous and 'Red Label' chemical pesticides as an alternative to MCP.

This is a contradiction to what a majority of farmers claimed, wherein they had reduced usage or having discontinued the usage of MCP altogether. However, in situations of distress such as a spread or attack by the pink bollworm, they did resort to other harmful chemicals (including MCP for greenery and vegetative growth).

KVK stated that bio controls have limited benefits for farmers since the farmers do no engage in using them since they would prefer quick results. Biological controls such as BB take longer to have an effect on the crop, in contrast to chemical pesticides which give immediate results.

Behavioral change of farmers in switching to alternatives

Farmers are of the opinion that post-intervention there has been a significant decline in their usage of hazardous pesticides, especially MCP.

However, the looming concern remains that an approximate of 30 to 40 percent farmers (as stated by a farmer) in the vicinity of Dhoraji still use MCP. Outline India's field visit suggests that a complete removal of the hazardous pesticides will **pan out in phases and in due course, the evidence will be more obvious.**

AFPRO claims that convincing farmers during early stages of the intervention was difficult since establishing trust across farmers is a herculean task. However, over a period of time, because of interaction of farmers with KVK and JAU, facilitated by AFPRO; and the interaction of FFs & lead farmers with other farmers, it has become easier to establish trust and communication. AFPRO has also facilitated behavioral change by encouraging FFs to carry out discussions at the end of the day with farmers on a regular basis, which allowed for the availability of information to be more decentralized.

Role of IEC in spreading awareness

AFPRO's regular communication, training programs and field demonstrations with the learning groups has had a positive impact on farmers, which can be seen in the form of active adoption of alternatives, as stated by farmers. Though there are cases of continued use of chemical pesticides, Outline India researchers observed that farmers do not receive any information on the hazards of pesticides from agro-input dealers.

Source and availability of alternatives to MCP

There are certain transitional barriers that farmers face while moving away from hazardous pesticides to the alternatives suggested by BCI and AFPRO. A major impediment here is the availability in limited outlets of these alternatives (particularly Beauveria Bassiana). BB is distributed via two sources - an outlet available at the University (wherein the costs involved are reported to be high), and the second source is the NGO i.e. AFPRO which sells the same at discounted rates.

At the time of interview, Outline India was informed that AFPRO made the biological controls easily available by providing BB at 10% discount rates at their office. AFPRO reported that they procured 1 ton of BB in 2016 from JAU due to an increased demand by the BCI farmers. AFPRO has been able to spread awareness among the farmers regarding the economic feasibility of using BB, other organic or bio pesticides, while MCP per pump may cost between INR 30 to 35, BB per pump costs roughly INR 10 to 15.

Role of AFPRO here is key- Given its discounted price point for BB, **farmers have taken note. This saves the farmers the time and the expense of visiting the University outlets to purchase BB**. This has been identified by some farmers as an opportunity to avail bio controls easily.

Farmers also raised a concern regarding the multiple brands under which BB is commercially available across agro-input dealers (namely Gujarat Life Science and Agri Land). According to them, these are made available at exorbitant prices and their use on the crop leads to varied results. This is contrary to the results that have been shown by BB from sources such as JAU and AFPRO.

Economic costs

Regarding the costs involved in switching to alternatives, farmers told OI researchers that MCP costs around INR 400 – 500 per liter, whereas BB costs INR 150 if purchased from JAU, and INR 135 if purchased from AFPRO. A majority of the farmers stated that **BB is a cheaper alternative,** while highlighting its effectiveness in solving the issue of pink bollworm.

A few farmers told us that as a collective, they had purchased bio controls (specifically BB) worth INR 16,000 from the JAU outlet, implying farmers' preference to use BB

Trends

MCP use trends based on BCI's datasets provided

The data shared by BCI regarding the use of MCP among farmers from 2014-2015 and 2016-2017 had certain gaps and inconsistencies. Information was unavailable for certain farmers, with no units of measurement explicitly mentioned, capping the flexibility to run analysis on the entire dataset. Using correlation studies, the sample was therefore limited to those select farmers, 81 in this case, for whom data points were available across all three years, namely, 2014, 2015 and 2016.

The mean of MCP (Figure 1) for all three years shows a gradual decline in its value from 0.35, 0.31 and 0.08 in 2014-2015, 2015-2016and 2016-2017 respectively.

In 2014, the value of Standard Deviation is higher as compared to 2016 which supports the fact that awareness among farmers regarding MCP in 2016 is higher compared to their awareness in 2014.

At the same time, the value of range shows a decrease from 2014-2015, 2015-2016 to 2016-2017 supporting the decline in the amount of MCP being used among farmers, since the range falls with a declining mean. In 2014, the range for MCP use was 1.12, while in 2015 it was 0.72, which further decreased in 2016, reaching a 0.45. (Refer Annex 1)

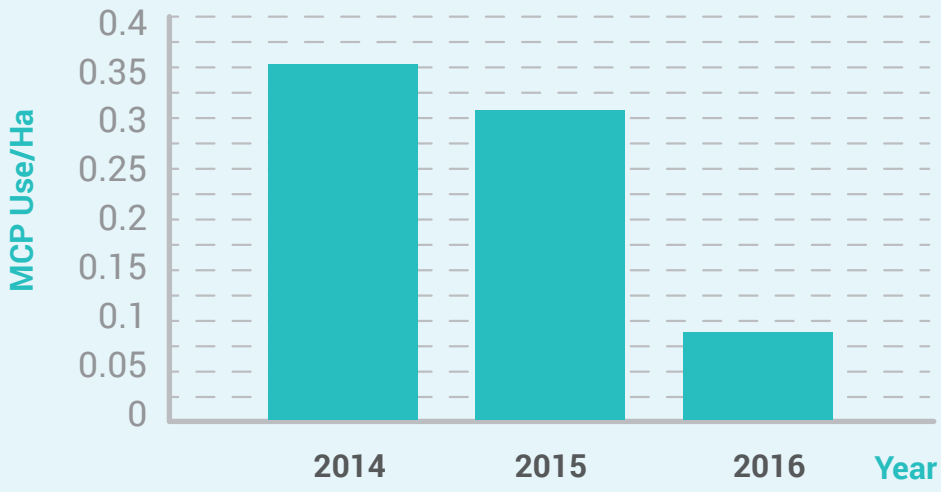
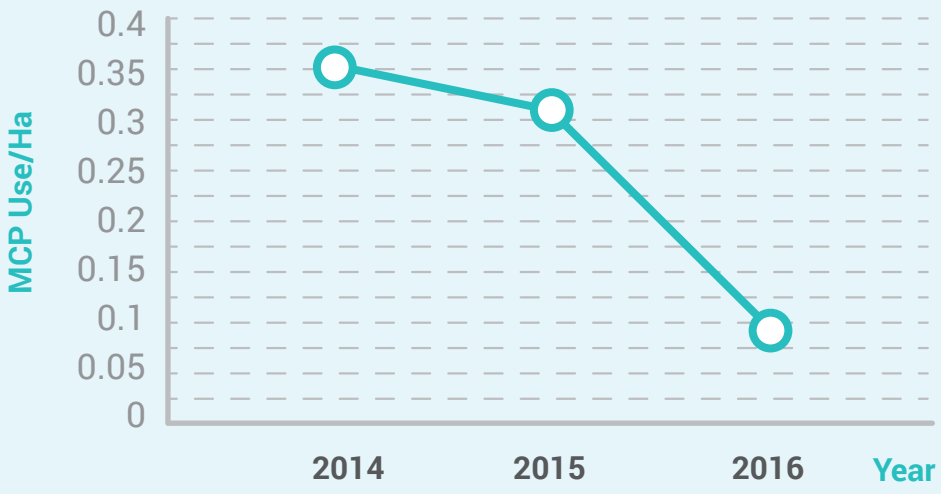


Figure 1: The graph above is a representation of the gradual decline in the use of MCP.

For this next piece of analysis, a sub sheet within the same dataset was used. This sub sheet contains two sample categories - BCI farmers from Boriya and Nani Parabadi and Comparison farmers who belong to the villages near Boriya and Nani Parabadi. The sub sheet contains BCI farmers who joined their respective producer units in 2013.Since the number of comparison farmers was 200 within this sub sheet, the analysis was limited to this figure. From the larger list of BCI farmers, 200 farmers were randomly chosen.

Two sample t-tests assuming equal variance was carried out on this data set. In the t-test, null hypothesis is taken as the application of MCP per hectare (Ha) in the case of BCI and Comparison farmers. The use of MCP was found to be significantly lower in BCI farmers as compared to the Comparison farmers. The difference is at a level of 10% which is statistically significant. The standard deviation is higher in BCI farmers as compared to Comparison farmers indicating that there is a lack of consistency in the use of MCP among BCI farmers, a few reporting no use, while others reporting high quantum of MCP usage. Negative and lower value of kurtosis further verifies that there are no farmers who are outliers. Also, the value of skewness is lower and positive in both the sample series indicating that the distribution of both the series is towards the right side, affirming a gradual decline in the use of MCP. (Refer Annex 2)



From the dataset provided, it is evident that the use of MCP has been declining gradually. This however is the case observed among the select BCI farmers for whom data on the use of MCP is available.

MCP use as reported by the respondents of this study

To understand the trends seen in the dataset provided by BCI, OI researchers offer their explanation to understand the reasons behind a peak in the use of MCP in 2014-15 in Dhoraji, Gujarat, as pointed out by BCI.

It was noted that the JAU scientists had no concrete comments on the use of MCP usage trends and have neither affirmed nor denied the peak or decline of the use of MCP from 2014-2015, 2015-2016 to 2016-2017. JAU scientists stated a greater interest in tracking the farmers who purchase BB from the outlet, rather than in tracking of MCP usage across farmers. One scientist pointed out that the sale of MCP has reduced further, based on his interaction with the agro input dealers.

An AFPRO officer noted that the peak in the use of MCP in 2014-15 could be because of the drought that hampered the crop. Therefore, MCP was used by farmers for its tonic effect that made the plants greener and taller. AFPRO also reported that most villages in Dhoraji had stopped using MCP since 2016 owing to BCI's intervention.

According to the Feld Facilitators for Boriya village, 80% of farmers from the learning groups in Boriya village reduced the usage of MCP. In 2016, all farmers did not use MCP but in 2017, 20% of them sprayed MCP due to high temperature and poor crop growth. As per the same FF, there was no peak in use of MCP during 2014, but in 2013 MCP use has been higher due to a significant sucking pests attack. However, there was still a visible lack of clarity from the FF as he kept contradicting himself regarding this assertion.

The KVK officials have stated that the use of MCP has been declining suddenly since 2014-15. Once the infestation of pink bollworm increased on cotton farms, the use of MCP started declining gradually, as MCP does not affect pink bollworm. This was confirmed by KVK and AFPRO.

Issues related to validity of data

As per OI's secondary research and discussions with AFPRO, it has been established that AFPRO provides **farmer field books (FFB)** to farmers annually. These are used for the purposes of filling and tracking usage of pesticides and other inputs in the process of cotton farming, the quantum used and purchased, and the costs associated with it.

According to OI's findings, these books are usually not well maintained and not kept up-to-date for a variety of reasons.

Poor Skills among farmers- Farmers have stated that they do not possess the necessary skills to maintain track of the costs associated with pesticide usage, in which case the burden to complete the FFB falls on the FF. This remains **a cause for concern**, since farmers who were part of the case study, had cleared 8th or 10th standard or pursued graduation. In such cases, they should have been capable of filling these details themselves, yet they denied being equipped to fill out the field books.
To deal with this concern, FFs are asked to visit farmers every 7-10 days to update their FFBs. However, regardless of the continued efforts, the books were not updated, thereby limiting OI's scope to validate the data.

Lack of awareness among the FF about the FFBs- The FF in one of the villages was unaware of the result indicators that he was supposed to collect to update the FFB. This is in contradiction to AFPRO's claim that the FFB is kept up to date via the intervention of the FF. The FF for the other village reported that the farmer notes the cost of the pesticides in a rough book, keeps the bills or records costs, which further helps FFs to maintain the books.

Lack of uniformity in filling the FFBs- As per one of the FFs, there is inconsistency in the facts that are noted i.e. some farmers record costs, while others record sprays and quantum of pesticides purchased. The same FF had also mentioned that he had not observed any discrepancies in the filling up of FFBs in 2017.

Lack of motivation in filling FFBs- A few farmers reported that tracking with FFBs has helped them understand the profitability of their crop. This is a concern for farmers because during bad seasons, the record keeping highlights their extensive costs, which further discourages them from keeping a track for future crop cycles.

AFPRO reported that the only reason why farmers are unable to update FFBs, is when they are faced with a financial/family situation (such as an occurrence of a disease, inability to recruit laborers to work in the farm. This is in contradiction with the farmers' claims, with regard to frequency of updating the FFB and the reasons for the low frequency.

Highlights

Pros

Effectiveness of Field Facilitators: The presence of on-ground FFs aids the process of dissemination of information to farmers and keeps the lines of communication open between AFPRO and the farmers.

Active involvement of AFPRO staff: AFPRO has made concerted efforts to involve trusted organizations and scientists, such as JAU and KVK, which has helped establish trust between AFPRO and farmers. It has also broadened the horizons of the farmers via interactions with scientists.

Impact of on-field demonstrations: The field demonstrations have been pivotal in speeding up the process of convincing farmers, thereby encouraging the adoption of biological controls and inducing a reduction of hazardous pesticides.

Drawbacks

Disparities in information provided by AFPRO: Interviews with the AFPRO staff revealed some disparities in the information provided, specifically with respect to the selection of lead farmer of each learning group. One AFPRO staff member mentioned that the lead farmer is usually changed every year to ensure that everyone in the learning group gets a chance to positively influence their learning group. But the other AFPRO staff member mentioned that the lead farmer is not changed for 2 or 3 years unless there is a societal or financial burden on the lead farmer preventing him from fulfilling his responsibility.

As per an AFPRO staff member, the data in the FFBs is not be updated regularly, however, the data is recorded and available annually, even if it certain data points are updated late. This has raised the question regarding data authenticity of the FFBs.

Difficulties in maintaining FFBs: AFPRO reported that the FFs are to be trained on collecting the result indicator data and help the farmers in maintaining their FFBs. However, it has been found that FFs are not skilled regarding collection/ updating of FFB data.

Confusion regarding categorization of BCI farmers and Comparison farmers: There is no clarity regarding the categorization of Comparison farmers and BCI farmers among AFPRO staff members. There is no consistency in who continues to remain Comparison farmers, as it has been reported that many of the 'comparison farmers' in the consecutive year are involved in the BCI interventions.

Lack of incentives for farmers to switch to Better Cotton: The farmers' expectation from being a part of the intervention is increased profits. The FGDs have highlighted that since the farmers have been concerned about their profits, they do not have any incentive to continue being a part of the intervention apart from the knowledge they receive through AFPRO.

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Recommendations

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In terms of tracking the pesticide usage, the process of maintaining record via FFBs has not worked as effectively as expected, in the case of this IP. Therefore, the following recommendations are made:

a) FFBs need to be simplified so that farmers are tracking their seed input, pesticide usage and cost.

b) A submission of the copy of the bills/ records of the pesticides should be mandated for their continued license as BCI farmers. In this case, even if the farmers are unable to maintain FFBs, the FFs will be able to track via bills/ records

The role of relevant stakeholders, besides the implementing partners, needs to be identified to isolate the impact created by the IP, and thereon delegate responsibilities to the IP to avoid overlaps, to have better coordination with other stakeholders for better outcomes of the intervention.

It is worth exploring the eco-system within which an IP functions since, as observed in this case, the presence of multiple organizations and institutions within AFPRO's region of work has aided the intervention. BCI can also incorporate other relevant stakeholders (JAU, KVK) in the process of their intervention for better outcomes.

There is a dire need to bring uniformity in the information dissemination and work delegation within an IP, as there were inconsistencies observed across AFPRO officials and Field Facilitators. It is also important to ensure that all staff within an IP and their respective Producer Units are on the same page with regard to what each person's role is and how the farmers are organized, which seemed to be lacking based on the contradictions as gauged from conversations with AFPRO employees.

Annex 1

MCP use across the years

2014	
Mean	0.356667
Standard Error	0.034998
Median	0.45
Mode	0
Standard Deviation	0.314982
Sample Variance	0.099214
Kurtosis	-0.28954
Skewness	0.470563
Range	1.125
Minimum	0
Maximum	1.125
Sum	28.89
Count	81

2015	
Mean	0.312083
Standard Error	0.026119
Median	0.36
Mode	0
Standard Deviation	0.235067
Sample Variance	0.055256
Kurtosis	-0.76241
Skewness	0.217526
Range	0.72
Minimum	0
Maximum	0.72
Sum	25.27875
Count	81

2016	
Mean	0.083333
Standard Error	0.017013
Median	0
Mode	0
Standard Deviation	0.153118
Sample Variance	0.023445
Kurtosis	-0.05648
Skewness	1.352063
Range	0.45
Minimum	0
Maximum	0.45
Sum	6.75
Count	81

Annex 2

Descriptive Statistics

BCI Farmer	
Mean	0.096581
Standard Error	0.010831
Median	0
Mode	0
Standard Deviation	0.153178
Sample Variance	0.023463
Kurtosis	-0.84624
Skewness	1.011519
Range	0.495
Minimum	0
Maximum	0.495
Sum	19.31625
Count	200

Comparison Farmer	
Mean	0.312083
Standard Error	0.026119
Median	0.36
Mode	0
Standard Deviation	0.235067
Sample Variance	0.055256
Kurtosis	-0.76241
Skewness	0.217526
Range	0.72
Minimum	0
Maximum	0.72
Sum	25.27875
Count	81

t-test: Two sample assuming equal variances

	BCI Farmer	Comparison Farmer
Mean	0.09658125	0.1242
Variance	0.023463387	0.022468138
Observations	200	200
Pooled Variance	0.022965763	
Hypothesized Mean Difference	0	
Df	398	
t Stat	-1.822483411	
P(T<=t) one-tail	0.034565931	
t Critical one-tail	2.335753585	
P(T<=t) two-tail	0.069131861	
t Critical two-tail	2.588238379	

OUTLINE India

www.outlineindia.com

C-2630, Sushant Lok Phase I , Sector 43, Gurugram, Haryana 122009
Email us at: contact@outlineindia.com
Call us at: 9810062717