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FEEDING THE FUTURE: CROP PROTECTION TODAY

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ABSTRACT

Crop protection includes a variety of strategies used to decrease crop damage due to pests and diseases. These methods include the use of pesticides, cultural practices, biological control organisms, Integrated Pest Management (IPM), genetically modified plants (GMO) and insect pest and disease resistant crop varieties and cultivars. More sustainable alternatives to current pest control practices should be researched and developed such as organic farming. Only by improving these areas will India be able to feed its growing population and eradicate extreme poverty and hunger.

Key words: Crop, Disease, Eradicate, Farming, Organic, Protection.

INTRODUCTION

Crop protection, increasing food availability

One of the things that both the ICRISAT Kothapally watershed project and the Earth Trust Eco clubs have in common is their focus on increasing and improving crop production in local communities. It is critical that agricultural production be increased to levels sufficient to feed India's growing population. Currently 48.83% of India's land is under annual crop production, while 2.8% is under permanent crop production (2005 est.) leaving little land area for agricultural expansion. Crop yields can be increased without increasing land usage using a variety of methods. Higher yielding crop varieties and hybrids can be planted, crop yields can be increased by improving soil health and crop loss can be reduced by improving crop protection (decreasing crop loss due to pests and diseases). Although no recent estimates of total crop loss in India due to pest and diseases could be found, it is widely recognized that pests and diseases cause substantial yield losses in many regions of India particularly in regions lacking sufficient or adequate post-harvest storage facilities. In this paper, I will discuss current crop protection methods being used in India, the role of universities, the government and Non-Governmental Organizations (NGOs) in promoting crop protection and what can be done to improve crop protection in the future.

EXPERIMENTAL

Crop protection methods

Crop protection includes a variety of strategies used to decrease crop damage due to pests and diseases. These methods include the use of pesticides, cultural practices, biological control organisms,

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Integrated pest management (IPM), Genetically modified plants (GMO) and insect pest and disease resistant crop varieties and cultivars. Cultural control practices which involve modifying or using production practices to make the environment less favorable to the pest[1]. These involve practices such weeding, tilling, flooding, intercropping (planting different types of crop plants together) and crop rotations (Biological control uses living organisms, including microorganisms, parasites and predators) to control pest populations[2]. While Integrated pest management (IPM) seeks to integrate these crop protection strategies to enhance or maintain producer income while minimizing health risks and environmental damage[3]. Organic and biodynamic farming employ different crop protection strategies in addition to some of those listed above (cultural practices, biological control, IPM and improved crop varieties) but do not use synthetic chemicals or GMO crops.

Where crop protection is today

While visiting India along with Cornell University student, I had the opportunity to observe first-hand how Indian farmers protect their crops from pests and diseases. During this trip I interacted with a wide range of researchers at government research centers, NGOs, universities and an international research center. In addition to interacting with researchers, I also talked to farmers and interacted with graduate students from both TNAU. In many cases, I will rely on my personal experiences from my trip to India as I discuss crop protection adoption in India and the role of universities, international research centers and governmental organizations in improving crop protection in India.

Pesticides

According to a survey conducted by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), 93% of Indian farmers use only chemicals to control insect pests and crops receive between 1-15 pesticide sprays prior to harvest[4]. In cotton alone, it is typical for growers to spray 15-20 times during the growing season for the cotton bollworm, *Helicoverpa amigera*[5]. Despite the heavy use of pesticides farmers still lose 11-40% of their crop due to pest damage[4].

Pesticide overuse has other non-economic side effects as well. Frequent sprays lead to insecticide resistance, thereby decreasing the efficacy of pesticides. Pesticides also kill insect natural enemies. Reduction in the natural enemy populations can allow minor pest populations to explode, leading to secondary pest outbreaks[5]. Frequent use of these pesticides not only causes environmental damage but also poses serious human health risks and can result in acute and chronic health problems[6,7]. The Indian government has banned the use of a number of pesticides for use in agriculture including DDT and BHC, however government policies are not being strictly enforced so many of these pesticides are still widely used in agriculture[4]. Additionally most Indian farmers do not wear protective clothing or use proper spray equipment and do not understand how to properly use and apply pesticides[4,7]. I witnessed this lack of knowledge first hand while visiting the model village of Kothapally, where I observed a farmer spraying his fields with a backpack sprayer while wearing no protective equipment. The fact that this event occurred in a village where farmers have received extensive training and access to agricultural resources and university extension researchers is a telling indication of the widespread use of pesticides and the lack of awareness concerning their potential harmful effects on both human and environmental health.

Biological control

There is very little adoption of biological control in India. Dr. Selvaraj, the lead researcher at his center, advocates the use of the fungal insect pathogens *Metarhizium anisopliae* and *Beauveria bassiana* as part of his organic and biodynamic farming model. Additionally, he makes these fungal pathogens available to farmers in the Nilgris region. However, I saw no other instances of biological control organisms being

used in the field and all of the other researchers I spoke with confirmed my observations. According to the researchers I spoke with the main barrier towards using biological control organisms is the lack of supporting infrastructure (most biological control organisms are very perishable) which limits farmers access to biological control products.

Cultural practices

I did observe several instances where farmers were using cultural practices to control pests. Tilling, hand weeding and flooding (in rice paddies) were the most common cultural practices that I saw (Figure 1A). Weeding is an effective although labor intensive method for removing non-crop plants that does not negatively impact soil health and structure like tilling or use precious water resources as in flooding. Although most removal of weeds is done by hand, mechanical weeders are also available. However, most farmers cannot afford these implements and the cost of hiring someone to weed their fields may be much lower compared with buying weeding implements (personal communication and observation). However, with the increasing agricultural labor shortages it is possible that herbicide usage will increase as it becomes harder for farmers to find agricultural workers. TNAU has developed a low-cost hand weeder that can be used in rice paddies (Figure 1B). This weeder helps prevent back strain and allow farmers to weed more efficiently. However, farmers have reported that extensive use of the weeder causes excess arm strain. TNAU is currently working towards developing a better implement.

I also observed a few cases of intercropping at the model village of Kothapally. One field was planted with tomato, pepper and beet plants while another field had both turmeric and mustard were being grown together. Whether these farmers had purposefully chosen these plant combinations to control insect pests is unknown however, it was encouraging to see a lack of monoculture within these fields. However, examples of monocultures also abounded particularly in the Nilgiris region, which is covered by extensive tea plantations.

(A) **(B)**

Fig. 1: (A) Women transplanting rice in a flooded rice paddy, (B) Man using the TNAU hand weeder

Source: Photographed by Prasann Kumar on 05 Jan, 2012 at TNAU, Tamilnadu

Transgenic crops

The only transgenic crop currently approved for use in India is Bt cotton (Figure 2A). Bt cotton was created by inserting a gene that expresses a bacterial toxin from the insect pathogenic bacteria, *Baccillus*

thuringiensis. The toxin makes the plants resistant to a range of insect pests; particularly, the cotton bollworm and closely related species[8]. While in India we saw numerous fields of Bt cotton and all of the farmers we talked to either grew Bt cotton themselves or had heard about it. It is estimated that the widespread adoption of Bt cotton has helped reduce the frequency of pesticide sprays by 50%. Additionally, there has been a 70% reduction in the use of the most toxic pesticides and it is estimated that among small land holders in India, 2.4 million cases of pesticide poisoning per year are prevented[8]. TNAU along with other NGOs and research organizations are developing other transgenic crops but there is currently a moratorium on the use of transgenic crops other than Bt cotton. The primary transgenic crop that TNAU along with other universities and organizations are trying to get approved is Bt brinjal. Brinjal is grown widely throughout India on an estimated 0.512 million ha of land and is susceptible to a wide variety of insect pests[9]. The primary pest on this crop is the brinjal fruit and shoot borer, *Leucinodes orbonalis*, which can reduce yields by 70%. Typically, brinjal is sprayed 25-80 times per season to control for *L. orbonalis* making *L. orbonalis* resistant Bt brinjal an attractive solution. Bt brinjal has been approved by the Genetic Engineering Approval Comitee however its release has been baned by the environmental ministry. Despite numerous studies, asserting the safety of Bt crops for human consumption researchers at TNAU reported strong public opposition towards the adoption of transgenic food crops[8] (personal communication). However, despite the benefits that could be obtained from growing Bt brinjal there is still lots of resistance from farmers and the public and a general lack of knowledge about transgenic technology.

Improved crop varieties and hybrids

Improved crop varieties and hybrids are grown in many of states throughout India. One of the major breeders of improved crop varieties and hybrids is ICRISAT. ICRISAT is a non-profit, non-governmental research organization that conducts research on dryland agricultural crops in Asia and Sub-Sahara Africa (“ICRISAT mandate crops”). They are primarily focused on developing improved crop varieties, particularly breeding for drought resistance, increased yield, disease and insect resistance. Farmers in India appear to readily adopt improved cultivars and hybrids and ICRISAT has reported widespread adoption of ICRISAT bred disease resistance cultivars including *fusarium* wilt resistant chickpea and powdery mildew resistant pearl millet (“ICRISAT mandate crops”). ICRISAT breeders are currently working towards breeding insect and disease resistant short and medium duration pigeonpea cultivars (Figure 2B). While visiting ICRISAT I met Abdul Rashid, a graduate student who is researching the mechanisms of insect resistance in pigeonpea.

(A) **(B)**

Fig. 2: (A) Bt cotton growing in the Kothapally village, (B) Chickpea growing in a test field at ICRISAT

Source: Photographed by Prasann Kumar on 11 Jan, 2012 at Kothapally village, Hyderabad

Additionally I had the opportunity to visit the Directorate of Rice Research (DRR), a government research center, which breeds for improved rice varieties in addition to developing rice IPM programs ("DRR Technologies developed"). The DRR has produced and released 60 improved rice varieties and 35 hybrids in India. Many of these hybrids and varieties are resistant to an insect pest or plant disease. Some of these varieties are resistant to the brown plant hopper, *Nilaparvata lugens*, whitebacked plant hopper, *Soguatella furcifera* and various plant disease including blast, bacterial blight and rice tungro disease. The DRR0% of the rice cultivated area. The widespread adoption of insect and disease resistant cultivars and hybrids reported by ICRISAT and the DRR suggest that Indian farmers readily adopt improved varieties however researchers at both institutions reported very little adoption of IPM programs.

IPM

According to a recent survey conducted by ICRISAT, 51% of farmers receive their plant protection information from pesticide dealers and only 3.2% of farmers have adopted IPM practices in various crops[4]. While in India I observed a few instances of limited IPM adoption. According to researchers at the DRR the only IPM technique regularly employed by farmers was the use of light traps to monitor pest populations and many farmers are unable to identify pests or distinguish them from natural enemies. It appears that the main barriers towards the use of IPM are a lack of sufficient IPM training for farmers, insufficient or non-existent government control over pesticide use, and non-availability of biological control organisms[4] (personal communication). Underlying all of these issues is the lack of sufficient supporting infrastructure.

Moving forward

The Indian farming community is incredibly heterogeneous and there is no single solution or method that will allow Indian farmers to increase their crop production and in an environmentally sustainable method. Rather regional diversity and individual community needs must be prioritized when designing and implementing policies, extension programs, improved cultivars and pest management strategies. The Indian government, NGOs, research centers and universities need to work together to train farmers how to implement IPM practices particularly those relating to decreasing pesticide use and enhancing and protecting natural enemy populations. They need to improve infrastructure that will allow the transport and storage of temperature and time sensitive microbial control products and natural enemies. Train farmers and school children how to recognize not only pest insects but also beneficial insects and teach them how to enhance/preserve their populations. Additionally, policies need to be enforced and farmers need to be trained to ensure that low toxicity pesticides are being used correctly to prevent pesticide toxicity and insect resistance.

Additionally increased crop production will only help to alleviate hunger and poverty if the crop can be successfully transported, stored, marketed and sold to consumers. While in Hyderabad, I read a recent news article about the arrest of several farmers. The farmers were being arrested because they had dumped their onion crop on a major roadway. They were dumping their produce as an act of protest because they were unable to sell their inions (the local market was flooded with onion). The article was shocking to me, because it was about the arrests and not about the plight of the onion farmers who were throwing away their livelihoods. Although, I did not focus on post-harvest storage and transport in this paper I believe this is a key area that needs to be addressed. Moreover it highlights the importance of improving infrastructure not

only so farmers can have access to biological control organisms but also so they can transport, store and process their produce and feed hungry people rather than causing road accidents.

CONCLUSION

If India is going to reach its millennium development goal of eradicating extreme poverty and hunger, then the government, NGOs, research centers and universities need to focus on improving IPM extension and training, creating reliable infrastructure, enforcing pesticide regulation and improving farmer pesticide knowledge. Additionally, more sustainable alternatives to current pest control practices should be researched and developed such as organic farming. Only by improving these areas will India be able to feed its growing population and eradicate extreme poverty and hunger.

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