S and D technology transfer modality in managing crop pests

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Abstract

The modernization of agriculture through green revolution in 1960s increased level of productivity and this resulted change in the landscape of the agro-ecosytem and eventually brought about problems of pests. An Integrated Pest Management (IPM) Strategy using biological control agents (BCA) is adopted. To enhance the delivery system of BCA in the production system, the two modalities, Techno Gabay Program (TGP) and Community Participatory Action Research (CPAR) were employed. Preliminary research works on the use of BCA are on mealy bugs of banana, coconut leaf beetle, and jackfruit borer. Other works on BCA are to be verified for vegetable crops. To hasten the utilization of BCA, the technology transfer modalities must be sustained.

Key words: technology transfer modality, integrated pest management, biological control agents,

Introduction

The green revolution has brought about tremendous increase in crop productivity in the last five decades. This technological advancement put forth the implementation and development of modern approaches in agriculture to increase level of production efficiency. Without these advances, the food requirements of the rapidly burgeoning population could have not been possibly met. However, after years of massive campaign to implement the green revolution, there was a big setback that resulted in the remarkable effect on the landscape of the agro-ecosystem and concomitantly on the diversity of species. This affected the reproductive ability of the natural enemies and predators, and these friendly insects are one of the main agents to regulate pests and diseases. This agricultural transformation has, however, certainly brought about some related problems including loss of genetic diversity and occurrences of pests and disease epidemics.

A paradigm shift in the agricultural system has been initiated towards sustainable agriculture. An Integrated Pest Management (IPM) strategy was considered which in maintaining the balance in the agro ecosystem. IPM is the coordinated use of pest and environmental information to design and implement pest control methods that are economically, environmentally and socially sound. It promotes prevention over remediation and advocates integration of multiple control strategies to

achieve long-term management solutions. It consists of gathering information, interpreting data, creating a flexible management plan, making timely decisions and taking the proper action. Information gathering include: accurate pest identification, learning about the weak link in a pest's life cycle or biology, scouting and monitoring crops in the fields and greenhouses, using action thresholds to minimize spraying and keeping records of findings to assess the effectiveness of management decisions (http:www.hort.uconn.edu/ipm/veg/htms/vegipmgenl.htm).

On May 3, 1993 the Philippine Government through a Memorandum Order No. 126 launched the National Integrated Pest Management Program (Kasaganaan ng Sakahan at Kalikasan or KASAKALIKASAN) . KASAKALIKASAN is the Philippine Government's commitment to Agenda 21 to the United Nations Conference on Environment and Development in promoting sustainable agriculture and rural development. It aims to make IPM the standard approach to crop husbandry and pest management in rice , corn and vegetables growing areas in the country. The practice of IPM among farmers is achieved through direct training in season- long FarmersField Schools or FFs. It also carries out a program of training and research activities aimed at strengthening the capacity and capability of local government units, non-government organizations and farmers group to carry out effective local IPM programs. With this program, to advocate or promote sustainable agriculture, the use of biological control agent (BCA) in the KASALIKASAN is one of the components. The Integrated Pest Management (IPM) concerns farmer education that will empower farmers to become more effective managers and decision-makers. The focus is about IPM by farmers and not IPM for farmers. In IPM, biological control and ecological principles are the founding principles

The national IPM program was implemented with BCA forming the foundation of training of trainors and farmers' field school activities. BCA such as *Trichogramma* species for lepidoptorous pests (e.g. *Heliothis* sp., corn borer, stem borer, and sugar cane borer) have been introduced and mass produced in different regional crop protection centers for mass releases. *Diadegma semiclausum* and *C. plutellae* were also released for diamond back moth (DBM) in crucifers. NPV was applied by some farmers for cutworm and earworm management. *Beauveria bassiana* and *M. anisopliae* were evaluated and used for leafhoppers, rhinoceros beetle, and rice black bug. Trichoderma has been tested for damping-off control in vegetable seedlings. Stufies and field releases of earigs, *Orius sp*. (predatory bug) and predatory mites have also been conducted. But there were challenges for BC of insect pests and diseases such as 1. Need for commercialization of potential BCA for various pests to make theses agents always available for farmers and growers, 2. Farm level production and for farmers to produce their own BCA will reduce the cost of production, and 3. Sustain the participatory action research approach.

Biological control usually refers to "the action of parasitoids (parasites in the original definition), predators and pathogens in maintaining another organism's density at a lower average than would occur in their absence" (DeBach 1964). Implicit in this definition is the desire to understand how these parasitoids, predators and pathogens act on their prey. However, in the last century, this empirical approach was replaced with a desire to discover effective parasitoids and predators for possible

introduction into a new area where a pest has been transported. This approach is called classical biological control.

The natural enemies most commonly selected against insect pests in modern classical biological practice are specific or relatively specific parasitoids. Although predators also clearly play an important role in reducing pest numbers (and have achieved considerable successes against scale insects and mealybugs) the majority of predators attack a wide spectrum of hosts.

There appears to be a widespread view that, when biological control alone results in a spectacular reduction in pest populations (as it often does) it is very worthwhile, but a lesser reduction is of little or no value. Nothing can be further from the truth, since far lower levels can have a major impact when integrated with other means of pest control. This applies particularly to integration with the use of plant varieties that are partially resistant to the pest (Waterhouse 1993a).

In any biological control program it is essential that appropriate procedures are adopted in relation to the selection of suitably host-specific natural enemies, the gaining of approval for introduction and release from the national authorities and safe procedures for eliminating the unwanted species.

Technology modality pathways

Through the years of giving priority to advocate the pest management program, it is inevitable that it also uses insecticides as one of the components. This component has been claimed to pose hazard to the agro-ecosystem and health of the populace. An environmentally safe and less risk option of using biological control agents is being preferred by some agricultural farming communities over the use of insecticides. However, the slow effect on the control of pests using BCA as a component of an integrated pest management programs made a barrier in the adoption by the growers. In order to enhance the technology uptake, the delivery system of integrating the technologies into the crop production system was done in two modalities.

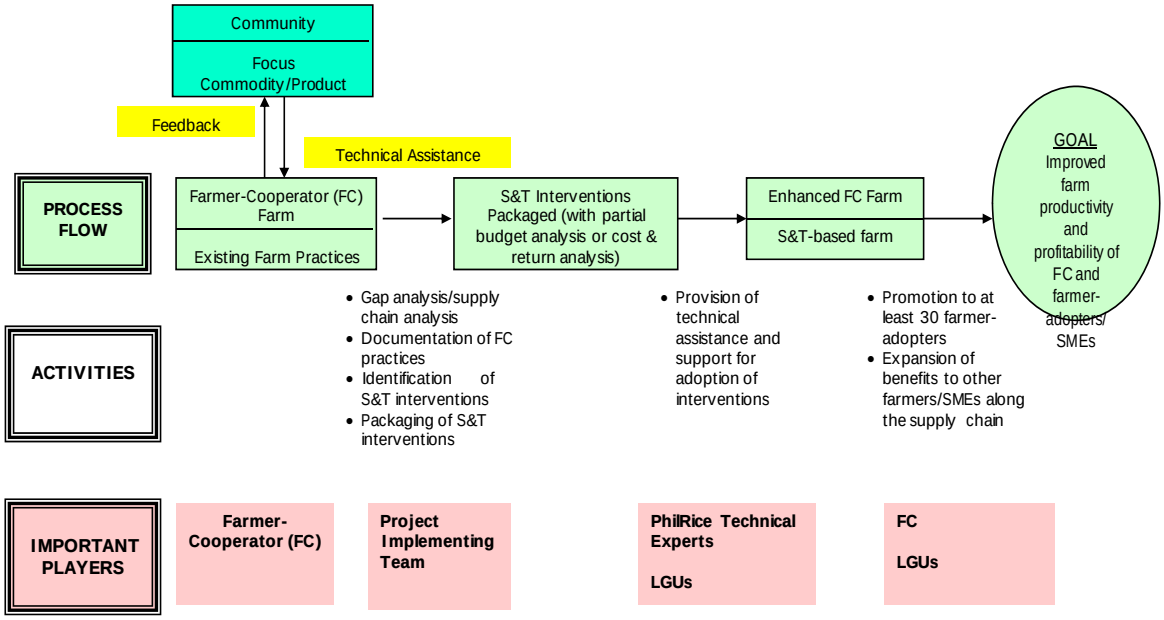
A. The Techno Gabay Program (TGP)

TGP is one of PCARRD's banner programs (Fig 1). It aims to bring the science-based information and technology services in the agriculture, forestry and natural resources (AFNR) sectors. It is a dynamic interplay of interrelated modalities to provide a continuous flow of appropriate science and technology (S and T) information between clientele and other stakeholders. Its four component modalities are the Farmers' Information and Technology Services (FITS) Center; Magsasaka Siyentista (Farmer Scientist) and the S and T-based Farms (STBF); the Information, Education, and Communication Strategies; and the Information and Communications Technology (ICT). Through the conduct of STBF, one or two S and T interventions generated from science based approach are verified and tested vis-a- vis farmers practice in a one hectare farm.

S&T-based farms are *Magsasaka Siyentista* (MS) farms or enterprises that showcase the effectiveness of S&T in improving productivity and income of farmers. The farms/enterprises highlight S&T-based

livelihood and business opportunities for particular focus commodity/product in a community. S&T-based farm/enterprise is viewed as a generic term not only referring to production but also to processing, marketing and other requirements based on the supply chain analysis.

Fig 1. S&T-Based Farm Framework



B. Community-based Participatory Action Research

Management To design and implement an integrated production management system in the community, BAR in collaboration with the Agricultural Training Institute (ATI) develops and implements an innovative approach to RDE, the Community-based Participation Action Research or CPAR which is one of BAR's flagship programs. With this approach, it enjoys the active participation of the community to sensitize them to the value of information-based decision-making. Through this, the community is empowered by organizing their production systems. BAR clearly recognizes that to modernize the agriculture and fisheries sector, a new production systems modality must be instituted

and this can be done through an integrated information management system complemented be an equally effective knowledge management system.

The participatory nature of CPAR intends to focus on the holistic orientation of the overall management of production system. This includes: farming systems development, resource management orientation, community-based, whole farm and whole family systems approach, and its complementation and integration. These processes are instituted through a farm model framework that focused on participatory community-based resource management systems.

To strengthen the technology transfer modalities, the following are activities being conducted: 1.) Farmers and agricultural technologists training/workshops; 2.) Short-term trainings for farmers, agricultural technologies and other stakeholders (farmer leaders, municipal and village level officials); 3.) Training of trainers (TOT); and 4.) Farmers' Field Schools.

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S and T interventions using biological control agents

The different modes of technology adoption as described above have been constantly used by the different stakeholders including Local Government Units and other government institutions towards better agricultural productivity. Through S and T research programs for selected crops , IPM technologies particularly on the use of biological control agents were generated and demonstrated to be effective to regulate the use of pesticides, increase income of farmers, protect the environment and reduce the exposure of workers to hazardous chemicals. Preliminary research works on selected crops showed the potential ability of the BCA against specific crop pests.

1. Banana

Banana is an important fruit crop widely grown in the country and has maintained its position in both domestic and export markets. In 2007, banana occupied 436,762 ha producing a total volume of 7.48 M metric tons. Out of the area planted with banana, only 10-15% of which are managed as commercial banana plantations, mostly producing the Cavendish cultivar. The remaining 85-90% is backyard and small-scale farms producing local banana cultivars (Saba, Lakatan, Latundan, Bungulan and others). The production volume of the local cultivars is very low, hence, adoption of appropriate management technologies must be done by smallhold growers in order to enhance the productivity and increase the income of banana growers. One of the major constraints is the occurrence of 3 species of mealy bugs, namely: *Dysmicoccus neobrevipes*, Beardsly, *Rastrococcus invadens* Williams and *Pseudoccoccus jackbeardsleyi* Gimpel and Miller alledgely intercepted from Philippine bananas exported to Japan and alarmed the Australian government in new Zealand gaining entry to their country and become a potential threat to their banana industry. Mealybugs are damaging during dry months in the field, but in the case of bananas, this pest problem continuously recurs even at the height of rainy season. But the constant use of insecticides to control the pest quickly developed resistance and eventually eradicate natural enemies. The use of existing natural agents , like the predatory bugs, predatory ascid and phytoseeid mites are being explored. Navasero, 2010 studied the mass rearing and

biology of the black earwig, *C. morio* . A survey conducted in selected banana growing areas showed that predatory earwig was found preying on mealy bugs on fruits of Saba banana. In terms of its functional response, it was found out that even though the predator fed on all active stages of mealy bugs, *D. neobrevipes* , consumption of first instar was greater. An individual earwig progeny can consume about 1,400 to 1,500 individuals of the first nymphal instar of *D. neobrevipes* within 83 days of life. A protocol for the plastic cage rearing method of black earwig, *Chelisoches morio*, the potential biological control agent was developed. Stock cultures of mealybugs, aphids, predatory mites and earwigs are being maintained

2. Jackfruit

Jackfruit is one of the multi-purpose tree species that has varied uses and economic value in the Philippines. Sacay, et. al. (2004) that the fruit versatility is exhibited in at least 18 recorded uses both commercial and non-commercial purposes. The edible portion is mainly utilized in the food and medical industries nationwide. The flesh or pulp of the ripe fruit can be directly eaten as dessert and can be preserved in syrup or in dehydrated forms. However, the crambid borer is one of the major insect pests attacking jackfruit which affects production of jackfruit in resulting in the formation of poor quality fruits. Borer control is usually achieved by spraying of insecticides, however, many of these have now failed to exhibit more positive effects instead they cause more negative impacts such as the development of insecticide resistant pest species. A number of organisms such as the *Apanteles* sp, *Trichogramma evanescens* and *M. anisopliae* are observed attacking the jackfruit fruit borer in the field.

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3. Coconut

The coconut industry is the leading sector of the Philippines economy. Out of 12 M has of farmlands, 3.25 has is devoted to coconut and planted with 300 bearing tress. Despite of this magnitude, the coconut productivity is declining due to the occurrence of coconut leaf beetle (CLB). The coconut leaf beetle, *Brontispa longissima* (Gestro) is an invasive and very destructive pest of coconut and other palm species (Leibregts, 2006). The larvae and adults inhabit the unopened spear leaf where they feed on the leaf tissues. Complete defoliation may result if severe attacks are left untreated leading to loss in productivity or death.

The pest was recently introduced into the country and is now ravaging many coconut growing areas. As of December 2008, around 1.5 M coconut trees plus quite a sizeable number of ornamental

palms were affected by this pest in 255 provinces, 44 municipalities and 12 Regions (Luzon, Visayas and Mindanao).

Initially, the infestations were sporadic but the absence of any control program led to a wider area of infestation. The Philippine Coconut Authority spearheaded a *Brontispa* Action Program in order to determine the extent of infestation and level of damage of *Brontispa* in the country, initiated an aggressive and sustained information campaign, conducted emergency control activities using pesticides, and trained extension personnel and farmers on available control strategies.

Although, the use of pesticides, either as trunk injection for bearing palms or spear leaf spray in young palms, provided temporary relief in the multiplication of the pest and the severity of damage to palms, not to mention its economics and the environmental impact, recurrence and reinfestation of pests occurred as soon as the effect of the pesticides wore off. The biological control, therefore, is an alternative approach that can effectively and sustainably manage Brontispa population.

The identification of the predatory earwig, *Chelisoches morio*, and entomopathogens *Metarhizium anisopliae* and *Beauveria bassiana* was one of the first steps at utilizing biological control strategies as a control option. However, the success of using predators and pathogens depends on specific environmental and biological conditions in the field such as high population density for predators and high relative humidity and low microclimatic temperatures for entomopathogens.

4. Vegetables

An Industry Strategic Plan (ISP) is crafted for the vegetables focused on 'salad' types and 'pinakbet' types . The goal is to increase production and consumption with objectives of increasing per capita consumption of vegetables, enhancing access to high quality and safe vegetables, and improving the efficiency and sustainability of vegetable farming. Two main programs for implementation are on BCA-based pest management system for sustainable production of highland vegetables and IPM on crucifers, cucurbits and solanaceous. The target pests and diseases are whiteflies, cutworm, mole crickets, powdery mildew, rootknot nematode, and potato cyst nematode. The expected BCA products are Beauveria , Verticilium, entomopathogenic nematode, Bacillis subtilis, Trichoderma and Pseudomonas.

CONCLUSIONS

The modernization of agriculture through green revolution program provided impetus in increased productivity which provided good income for the farmers, food security and improved quality of life. However, this paradigm shift in agricultural production resulted change in the landscape of the agro-ecosytem. Concomitantly, the change in the agro ecosystem affected the reproductive ability of the natural enemies and/or biological control agents. An Intergrated Pest Management System was pursued to combat the occurrence of pests and diseases. One of the major components of IPM is the use of biological agents. However, the use of BCA could hardly take off because their immediate effect on target pests and diseases are so slow. To hasten its adoption rate, technology transfer modalities

through Techno Gabay Program and Community Participatory Action Research were employed to showcase the success of utilizing BCA in the production system. Through S and T programs, BCA were identified for different pests of fruits and coconut and potential BCAs are to be searched for vegetable pests and diseases.

The PCARRD S and T Agenda for 2011 to 2016 is a work in progress. The priorities for integrated pest management is subsumed under thematic area Sustainable Development. This area covers specific commodities in the crops sector and the specific programs to be identified will be anchored on four banner programs in Agriculture, Forestry, and Natural Resources is anchored on the four banner programs of PCARRD. This paradigm integrates knowledge and technology generation, utilization of the generated R&D results, policy formulation and advocacy program, and capability building and governance.

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