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ENHANCING BIOLOGICAL CONTROL'S CONTRIBUTIONS TO INTEGRATED PEST MANAGEMENT THROUGH APPROPRIATE LEVELS OF FARMER PARTICIPATION

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ABSTRACT

Most recent development literature calls for greater farmer participation in agricultural research and technology transfer. Interestingly, biological control specialists do not seem to be involved in the trend. Four methodological models for developing and implementing biological control are proposed and then analyzed for their applicability to the Caribbean and Central America. Profit-generating biological inputs can be developed without farmer involvement, but grower involvement is required in the implementation phase. Inoculative releases and classical biological control do not require farmer involvement in the implementation phase, but may benefit from farmers' support and participation in the research and development phase. Alternatively, conservation and manipulation techniques require extensive farmer involvement in both the research and implementation phases. Unfortunately, biological control researchers generally ignore farmers as collaborators, even when their participation is key for implementation in heterogeneous agroecological and socioeconomic environments. Biological control in developing neotropical countries is seriously limited by financial and personnel constraints; a series of difficult strategic and operational decisions must be made if biological control is to contribute significantly to IPM in the area.

RESUMEN

La literatura de desarrollo reciente hace un fuerte llamado para una mayor participacion de agricultores en la investigacion agricola y transferencia de tecnologias. Sorprendentemente, los especialistas en control biologico parecen no estar involucrados en la discusion. Se proponen y analizan cuatro modelos metodologicos para el desarrollo e implementacion del control biologico por su aplicabilidad en la zona del Caribe y Centro America. Se puede desarrollar productos biologicos que generen ganancias sin involucrar al productor en la fase de implementacion. Las liberaciones inoculativas y el control biologico clasico no requieren de la participacion del agricultor en la fase de implementacion, pero puede beneficarse del apoyo y participacion de los agricultores en las fases de investigacion y desarrollo. Alternativamente, las tecnicas de conservacion e implementacion requieren de la participacion extensiva del agricultor en las fases de investigacion e implementacion. Desafortunadamente, los investigadores en control biologico generalmente ignoran a los agricultores como colaboradores, aun cuando su participacion es clave para la implementacion en ambientes agroecologicos y socioeconomicos heterogeneos. El control biologico en los paises neotropicales en desarrollo esta seriamente limitado por la falta de recursos financieros y personales; se precisa tomar una serie de decisiones estrategicas y operacionales para que el control biologico pueda contribuir significativamente al MIP en el area.

Regional IPM has a mixed record of accomplishments. There have been several major success stories in Central America, most notably in capital-intensive export crops such as sugar cane, coffee, and bananas (Hansen 1987, Andrews & Quezada 1989). However, there has been virtually no impact on small producers. This appears to be true of the Caribbean as well. This may be due to a conspiracy of inimical socioeconomic factors such as inadequate and discontinuous research and outreach efforts, poor infrastructure and inappropriate macroeconomic and social policies (Andrews & Bentley 1990). However, we consider that the fundamental problem has been inappropriate strategy and *modus operandi* of past and existing IPM research and extension programs.

In this paper, we make several suggestions as to how biological control may contribute more to IPM, focussing on methodological issues, especially farmer participation. Programmatic statements about farmer participation in agricultural innovation were provided by Biggs & Clay (1981), Chambers & Jiggins (1987), Rhoades (1987), Richards (1989); see Amanor (1989) for a list of hundreds of other references. Symposia edited by Youngberg & Sauer (1990) and Bentley (in press c) focussed on farmer participation in agricultural development; the latter includes several references to plant protection.

Farmer Participation in Pest Management Implementation

Pest management techniques can be categorized as a function of the degree to which farmers participate in their implementation.

1. The *Farmer Bypass Model* attempts to use standardized technologies which are applicable over wide areas. This model supposes minimal farmer involvement. It is best represented by the sterile insect method which requires only imposed compliance on the part of farmers. It is also exemplified by the approach taken by plant breeders. Farmers' involvement is limited to merely choosing the seed variety to sow. Perhaps the most extreme form of the farmer bypass model is classical biocontrol, requiring absolutely no farmer involvement. The introduction and establishment of exotic natural enemies is something done for and to farmers' production systems, and it does not require their active participation or sanction. Similarly, inoculative releases of natural enemies carried out by government or industry—for example, a sugar mill—also benefit farmers without involving them.

There are several major successes which can be attributed to these techniques; all of them have involved minimal extension. In fact, it can be argued that the success of the farmer bypass model is due to the straightforward research uncomplicated by outreach. This technique looks at bugs and not very much at people; it can be highly cost effective when successful.

2. *Farmer as Protagonist Model.* An alternative approach recognizes the ecological and socioeconomic heterogeneity of agroecosystems. It is impossible to extend inflexible, standardized technologies over large areas. Efforts to centralize delivery and use of IPM procedures and services like scouting and spraying are incompatible with the need to make and implement rapid, fine-tuned site specific decisions at the farm level (Goodell 1984). Those who know the Caribbean and Central America understand the problems confronting IPM specialists in the region because farms located only a couple of kilometers from one another are often more different than those located at the far ends of the US cornbelt (Andrews & Bentley 1990).

This approach makes use of flexible technologies which are applied locally, and farmers are viewed as the protagonists of change, that is the implementors of the technologies. Most IPM programs focus on field-level control and management and require some form of scouting as the basis for making decisions regarding the use of chemical, mechanical or cultural practices. Inundative releases and the use of microbial pesticides also view the farmer as protagonist. Conservation and manipulation efforts depend on local initiative to be successful.

The literature reports some successes using the farmer-as-protagonist model, especially among large scale, capital intensive farmers. However, many of the successes are based on the existence of pest management advisors who serve as key links, and in fact are more the implementors than are the farmers themselves. Among small holders we find few non-chemical successes despite extensive (although sometimes flawed) extension efforts.

Farmer Participation in Pest Management Research

Biological control research and development (R&D) commonly involves three principal steps: Step 1. Inventory determines which natural enemies exist in the agroecosystem. Step 2. Evaluation determines, generally quantitatively, what these natural enemies are doing to regulate pest populations. Step 3. Sometimes referred to as manipulation, but probably better called action, this step involves research to develop technologies to improve the impact of the natural enemy complex. It can take three forms:

a. Conservation/manipulation involves the protection and enhancement of naturally occurring biological control through modification of the habitat;
b. Augmentation takes place through the liberation of mass reared natural enemies;
c. Classical biological control involves the introduction and establishment of exotic natural enemies

There are at least six general justifications for farmer participation in R&D efforts. All of them seem generally applicable to biocontrol.

Knowledge. First, farmers are viewed as a source of indigenous knowledge (Thurston 1990, Farrington & Martin 1987). Farmers are knowledgeable, especially about cultural practices, germplasm and botanical insecticides (see Ileia Newsletters No. 6 and 4(3), Glass & Thurston 1978, Altieri 1986, Litsinger et al. 1978, Risch 1981, Matteson et al. 1984). Interestingly, these authors make little mention of farmer knowledge of biological control. Could it be that farmers have little to contribute to biological control research and development efforts? Huang & Pei (1987) reported that Chinese farmers consciously and effectively manipulate ants for control of pests in citrus trees.

Asian farmers use ducks to control paddy pests (NAS 1977). Altieri et al. (1977) contended that farmers often selectively weed fields in a way that leaves plants that improve naturally occurring biological control. Vertebrate predators are consciously protected and birds are creatively manipulated by rice farmers in Sri Lanka (Upawansa 1989). Not withstanding the previous three Asian and one Latin American examples, we hypothesize that biological control is rarely, if ever, an important element of traditional farmers' paradigms. Unfortunately, few conventional modern farmers appreciate it either. Virtually all references to small farmer biocontrol (e.g. Hellpap 1986, Hansen 1987) focus on their use of research-derived techniques, not indigenous practices. The idea that proliferation of some insects is desirable is counterintuitive (Goodell 1984).

Empowerment. The second justification for involving farmers in research is that disenfranchised farmers may be empowered through this activity. It is important to show the positive aspects of traditional systems, to realize and fully document what farmers are doing right, and recognize that it may be very difficult to farm better under the marginal conditions that they confront. Innovative, participative R&D activities can help rural people to develop confidence and pride in their own knowledge systems and technological capabilities. With an enhanced sense of worth and power, farmers are better able to select and adapt from among exogenous technologies offered them, and consciously preserve desirable elements of their endogenous technologies (Richards 1985, Altieri 1989, Thrupp 1989).

We need to make it clear when we talk about legitimizing traditional systems, we are not supporting the simplistic notion that modern day poor farmers should continue to use the same technology that they used generations earlier; rather, tradition must co-exist with innovation. Farmers constantly reinterpret traditional knowledge in an ever-changing world and innovate. Farmers are conservative only insofar as they maintain technologies that work (Rhoades 1987, Richards 1989, Bentley 1992). Johnson (1972) goes so far as to say that farmers are too willing to change, and adopted green revolution technologies too quickly.

Empowerment through effective participation has strong political dimensions since it can help marginalized people develop a sense of solidarity and collective political bargaining power (Thrupp 1989). This attitude appears to us to be a prerequisite for genuine development in the polarized, inegalitarian societies of the Caribbean and Central America.

Focus. Third, farmers' participation in planning and evaluation of R&D helps to focus that research. Farmers can contribute to discussions that lead to strategic decisions regarding what investigation is to be done, what this experimentation should accomplish, what evaluation criteria are most important, and what is the time frame to be used for judging the productivity of the program. Farmers also can help to identify opportunities for change as well as constraints to that change. Their participation may help to evaluate progress. The underlying assumption is that researchers trying to develop workable, cost-effective technologies are more effective when they are accountable to producers. This is the opposite attitude to that expressed to the senior author by an unnamed University of Florida Institute of Food and Agricultural Sciences administrator who reported that his job was "to isolate his researchers from grower pressure".

Advisory and commodity boards may provide intellectual support for short and long term research efforts. Wealthy producers may use their political power to allocate public funds and orient researchers' work. The autonomous or semi-autonomous Commodity Research Institutions which work on behalf of coffee and sugarcane producers in the region have been highly effective in developing IPM programs. This may be due to the political and financial strength of the beneficiary farmers which assures that their needs and priorities are responded to by researchers and technical people. Finally, in the transnational fruit companies which have operated in Central America and the Caribbean for nearly a century, researchers do not act in isolation from the people in charge of production; both answer to the same boss. Therefore, researchers are accountable to the production managers who participate in strategic planning and orientation of research and development efforts; just as the researchers have to keep their research practical, the production people are compelled to implement the research results (Andrews in press).

Unfortunately, smallholders are rarely involved in strategic planning of investigation. The failure to involve them may be the most important factor limiting IPM R&D in developing neotropical countries. Unless farmers are involved in strategic planning it is unlikely that technologies useful to them will be developed. Certain alternative groups (e.g. non-governmental private voluntary organizations) may stimulate strategic participation routinely; unfortunately these groups generally lack scientific expertise to make full use of the farmers' suggestions and respond fully to their needs.

Support. Fourth, farmer participation in R&D efforts can be justified in terms of the financial, logistical and intellectual support they provide to the operational aspects of experimentation. Farmer collaborators often provide inputs, labor and land to support experimentation. Commercial farmers may provide partial support for research, as in the case of commodity boards. Farmers may also provide intellectual input in the field. This may include plot selection, development of evaluation criteria, or interpretation of experimental results. Who knows better than the farmer if a new variety has desirable agronomic characteristics or if a proposed cultural practice fits into the production system (Bentley & Melara 1991). Farmers rarely adopt technologies without modification; they adapt technologies by creatively combining elements of existing and proposed technologies (Horton 1984, Rhoades 1987). The participation of farmers in on-farm trials is very common in Central America; it is in many ways the essence of the farming systems research and extension approach (Hildebrand 1986). It may be highly cost effective and desirable. However, with small-holders it may be a serious imposition. It costs farmers considerable time, effort and resources to participate in this way. We feel that it is difficult to justify this category of involvement if at least some of the cooperating farmers or their representatives have not previously participated extensively in the strategic orientation of the research program. Ashby (1986) discussed different mechanisms for including small farmers in on-farm experimentation involving seed and fertilizer trials.

Farmers may have considerable impact on experiments to evaluate cultural practices, weed management and host plant resistance. However, it is not clear what role they may have in biological control. Ardón et al. (in press) reported that Honduran farmers who collaborated in our cabbage IPM program contributed more than half of the ideas to on-farm experiments when cultural practices were studied. They contributed less than 1/3 of the ideas on biological control and less than 1/5 of the ideas in studies of pest biology. It may be that farmers are masters of cultural practices, weed science (Chacón & Gliessman 1982) and development of new varieties under their particular farm conditions. However, it seems they lack either the paradigm or the research tools to participate extensively in development of useful biocontrol technologies.

Validation. Also, farmer participation in the R&D effort allows researchers to compare technologies' performance under realistic farm conditions including management skill levels that differ from those of experiment stations (Lockeretz 1987). Farmers can play an important role in the local adaptation and popularization of technologies (Horton 1986, Bunch 1982). Their involvement in polishing techniques and applying them effectively to local conditions is a step that only they can carry out. Unfortunately, in the development literature this activity is oftentimes referred to as participatory research. This top-down approach is so common that a recent anthology allegedly on farmer participation in technology generation described little more than case after case of adaptation of fertilizers and new seed varieties in on-farm trials (Matlon et al. 1984). The implication is made that this level of participation is adequate (e.g. Reid et al. 1988). It is not. It is only a final phase in the continuum of activities from strategic to applied to adaptive research. Moreover, if farmer participation is limited to this important stage, they will not significantly influence which research results are made available to adapt.

Modern research organizations, especially those doing strategic and applied research, often fail at the stage of local adaptation. By creating alliances with private voluntary organizations (PVOs) and certain non-governmental organizations (NGOs, e.g. grower groups) research organizations can maximize their effectiveness. PVO and NGO collaborators are excellent community organizers and are capable of stimulating validation and adaptation efforts (Altieri 1989, Farrington & Biggs 1990).

Extension. Finally, participation jump starts extension efforts; it gives at least a few farmers experience with the new technologies, thereby allowing them to adapt and by word of mouth to begin to extend these technologies to their neighbors. Follow up outreach by farmer-experiments is an integral part of the village level adaptive research described by most advocates of farmer participation.

WHEN IS IT WORTHWHILE TO INVOLVE FARMERS IN BIOCONTROL?

In most cases, farmers are the ones who have to do what is necessary to make a given technology work, and in most cases they must repeat it every single year. In order to implement a technology, they need to know of it, understand it, believe in it, want to apply it, and have the resources to use it. (Rogers 1983 provides a longer and more technical list of the requirements for technology adoption and use.) With biological control techniques like conservation and manipulation, farmers have to be reached by linkage farmers, paratechnical people or extensionists. Each farmer has to try out the technologies, then satisfy him or herself on all counts and conclude that the technologies are feasible, efficacious and profitable. However, with the bypass method, farmers are involved in neither validation nor implementation. Because it is so simple it is no wonder researchers and policy makers alike prefer the bypass model! However, how widely applicable is it? In the following section, we judge the potential of each biological control approach as a function of farmer participation required to make it work.

There are two approaches that are subcategories of the farmer bypass model.

1. Nonparticipatory research-Nonparticipatory implementation. This common bypass model is represented by classical biocontrol. Farmers benefit but participate neither in the R&D nor implementation phase. Only researcher-initiated classical biocontrol fits in this category.

2. Participatory research-Nonparticipatory implementation. This is an uncommon model in which grower participation is required prior to a bypass implementation phase. Farmers may mandate classical biocontrol programs (Van Driesche 1989) and perhaps modify temporarily their agricultural practices to help establish beneficial organisms. This appears to have been the case with the Vedalia beetle in California over 100 years ago. They may cooperate by withholding some or all spray applications while releases are made. After establishment, however, farmer involvement is limited to the role of beneficiary. This approach may also be represented by inoculative releases of natural enemies in which either governmental organizations or grower organizations such as sugar mills make periodic liberations of natural enemies in the farmers' fields and farmers participate only as beneficiaries.

Is this model not the best of all worlds? Farmers provide strategic input and direction to the development of technologies, then sit back and enjoy the fruits of the technologies. However, beyond classical biocontrol and inoculative releases we feel that no other options exist for using this model.

There exist two variants of the farmer-as-protagonist approach.

3. Nonparticipatory research-Participatory implementation. This common, conventional model is top-down and assumes that basic and strategic researchers pass ideas and information to applied researchers who then pass their results to extensionists, and finally the extensionist moves a well-polished product to the user. It is undeniable that this model has been effective when focused on development of inputs such as chemical insecticides. It is probably effective when microbial insecticides or inundative releases of parasitoids or predators are involved. (It is the prevailing model represented in this symposium.) Because chemical and microbial inputs can be packaged and farmers taught to use them in relatively simple ways, this model has been successful. Private companies work closely with public sector researchers to develop the technologies, then undertake massive, profit-motivated outreach programs to make them work.

However, this approach is not effective when information rather than inputs is to be extended. It cannot be useful for the development and popularization of conservation and manipulation techniques. Nor is it an effective approach to use where agroecosystems are heterogeneous because generally, it is impossible for researchers to understand the complex realities confronting farmers and to adjust technologies for all these complexities, repeating the process in each ever-changing agroecological and socioeconomic domain (Biggs & Clay 1981). This model will fail if researchers do not take into consideration all key factors as they carry out their research; unfortunately, many of these factors (especially socioeconomic ones) fall outside the biological control researchers' area of expertise and interest.

Except for research and development of inputs, this approach has been and continues to be a major waste of scarce biological control resources. If we really want biocontrol-based IPM to work in the Third World, biocontrol specialists working on information-laden approaches to be used in heterogeneous environments should avoid this model, using the following one instead.

4. Participatory research-Participatory implementation. This is a costly and challenging approach that may be the only way to develop and implement conservation and manipulation techniques. It assumes local control of the research process, a local focus and local benefit. It is presently extremely uncommon. Is it a fruitful, cost-effective alternative?

Our enthoentomological studies have shown that farmer knowledge can be extensive but partial. While farmers have extensive understanding of wasp and bee natural history and a complex folk taxonomy, they lack the key concept that some insects eat or develop on others, i.e. they lack the basic paradigm for biological control. We have observed, however, that some farmers, when exposed to biocontrol concepts, begin to experiment with large predators (as *Polybia* spp.) and seek ways to incorporate easily observable natural enemies into their systems.

It is our hypothesis now that it is not necessary to provide farmers with finished biocontrol technologies; it may be sufficient to provide them with key missing information (e.g. wasps eat worms that eat crops) and let them apply the new information locally, developing their own local technologies. The key questions to be answered are: will significant numbers of farmers use the information we provide to develop means to manipulate vertebrates, wasps and other large predators? Can similar techniques be used to stimulate farmers' innovations with smaller, less easily observed natural enemies? Can researchers effectively backstop farmers who have been trained in biocontrol precepts? Can the informal research of farmers and the formal research of scientists be cost-effectively linked to develop efficacious, locally useful new biocontrol procedures? In 1992, we will provide biological control training to over 500 farmers and extensionists in the hope that answers to these questions will be positive.

Conclusions and Recommendations

Based on the preceding analysis we arrive at six hypotheses that border on being recommendations:

1. Education of technology users is key. Farmers and extensionists who do not understand the basic precepts of biocontrol and its potential neither adopt it nor participate in its development or local adaptation.

2. We must face a hard question. Where do we have the highest probability of obtaining the greatest benefit for the least research and implementation costs? We must apply our scarce resources there. How many scientists with postgraduate specialization in biocontrol are working (i.e. not administrating) in the entire region which is made up of more than 20 countries and over 50 million people. Where do we start? What should our priorities be? Among the high priority options we identify are:

- Natural enemy complex enhancement with known winners. This approach promises a few large scale success. Quezada (1989) listed 17 of the best candidates for classical biological control efforts in Central America. This approach requires biological control specialists and does not necessarily need farmer participation. It is highly cost-effective when successful. This is a major focus of the work carried out by Zamorano's Center for Biological Control in Central America.
- Conservation and manipulation efforts almost certainly will permit many small, local successes. A few biological control specialists may effectively multiply their impact by working with the many IPM generalists who work with farmers in different agroecological and socioeconomic domains. We need to allocate a substantial proportion of our scarce resources to extension and education to make this approach work.
- Since the private sector is likely to invest increasingly large sums in microbial and other augmentative approaches, resource-limited public sector institutions and development programs should not focus their scarce human and financial resources on what is rapidly becoming a viable alternative due to the efforts of scientists employed in developed countries and by transnational companies. Regional biocontrol specialists should let IPM generalists and pesticide application technologists (who need new ways to contribute) do the screening and fit the new inputs into IPM systems. Unfortunately, the grant money and publication opportunities presented by this area will increasingly tempt biocontrol specialists away from the alternative approaches.

3. Certain social equity issues need to be addressed as we decide how best to use our scarce biocontrol research and development resources. Classical biocontrol is probably one of the most scale-neutral technologies available; it is democratic and is as likely to benefit small scale producers as it is to benefit large ones. Conservation and manipulation techniques, on the other hand, appear to always favor one socioeconomic group or another; what works with large scale, capital intensive producers will not be useful among small holders, and vice versa. We can, therefore, choose to produce conservation and manipulation technology that favors either the privileged or the disenfranchised. Through development of conservation and manipulation technologies we can address in a small way class differences. Augmentation techniques, on the other hand, are probably useful only—or certainly mainly—to the relatively well-to-do. Patented, packaged products which are available only in relatively large villages and in cities are unlikely to help isolated, poor farmers.

4. Farmers should be involved in the strategic planning of all biocontrol research and development efforts. While they may contribute less to biological control than to some other aspects of IPM, their participation in setting research goals and milestones is important. Their participation in integrating various approaches, including biological control, into existing production systems is key. Participation provides significant opportunities for grower education, consciousness-raising and feedback.

5. Even though it is the most common model, the nonparticipatory research-participatory implementation approach is not a viable method in the developing world except for production of inputs to be marketed for profit. It has not worked in the past, and there is no reason to believe that it will work in the future. Each of the other three approaches has a legitimate role and is appropriate to certain expected outcomes.

6. Given the numbers of agrosocioeconomic situations and the limited resources of biocontrol research and development people, if we choose to do conservation and manipulation we had better look for novel research approaches. We must look for allies to facilitate the farmer involvement which is central to the success of conservation and manipulation efforts. Independent farmers, grassroots PVOs and community based NGOs, especially grower organizations, are effective and willing allies. We can provide them with missing information and play a supportive role for their local research efforts; it is time that we give up the alternative idea that they support us in our research efforts.

Farmer participation is not a panacea (Bentley & Andrews 1991, Bentley in press d). Farmer participation in biological control may not be as fruitful as it is in certain other IPM tactics. It may in fact, not be necessary in efforts to carry out classical biological control or certain kinds of inoculative releases. However, effective IPM programs based on conservation and manipulation of existing beneficial enemies are out of the question unless client farmers are involved in the strategic planning, experimentation and implementation phases. To be effective collaborators, farmers need to be educated in the ideas that underlie biological control and believe in them. We are likely to continue to self limit ourselves and make minimal impact among target groups until biological control researchers and policy-makers: 1) spend significant efforts to educate farmers in biocontrol and 2) understand and act on the fundamental difference between techniques that do and do not require participation.

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