From pest control to ecosystem management: how IPM training can help[1]

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Summary

In order to bend high-external input agriculture, having faced the many unfavourable sides of its technologies, towards more sustainable systems, Integrated Pest Management (IPM) is an appropriate first step to follow. IPM both allows the ecosystem to regain its natural balance, and teaches farmers ecological principles through easily observable, thus easily comprehensible, ecological processes. This understanding tends to open farmers' eyes to how they can benefit from natural processes in their farm management, and makes them increasingly interested to learn. The Farmer Field School model provides appropriate learning mechanisms for farmers to enhance their problem solving and decision making capacities, and become skilled and independent managers of the agroecosystem.

Introduction

In many parts of Asia, the Green Revolution has induced radical changes in the output of food production, but also in farmers' practices and their perception to the crop, the environment and nature. Since the mid 1960s, per capita food production in Asia increased by about 40% (FAO, *passim.*), for the greater part due to increased yields resulted by new, improved varieties and cultivation technologies. Through persistent extension messages, demonstrations, and aggressive promotion by formulators, farmers have learned to apply high levels of external inputs, such as pesticides and chemical fertilisers. The side effects of the "modern" technologies, however, are widely known: environmental pollution (e.g. Conway and Pretty, 1991), health hazards (e.g. Rola and Pingali, 1993), increased use of non-renewable energy sources (e.g. Leach, 1985), social discrepancies (e.g. Collier *et al.*, 1982), and, in general, the creation of unsustainable farming systems, both from an ecological and an economic perspective. Moreover, as a result of the top-down transfer-of-technology methods concomitant to the Green Revolution programmes, over one generation farmers forgot a wealth of indigenous knowledge and practices (Van de Fliert, 1993), and unlearned to consider the actual needs of the crop and to benefit from natural processes.

A solution to break through this vicious circle does not necessarily imply that farmers have to go back to traditional farming systems, since the increasing world population requiring increasing food production would not allow the lower production levels inherent to such systems. However, a regeneration of agriculture is needed (Pretty, 1995), a consolidation of "modern" agricultural technologies with ecological principles successfully applied in many traditional and alternative farming systems, to sustain an acceptable level of food production through a healthy environment. This would require different attitude, skills and practices of farmers from those taught by conventional extension. Experiences have shown that to instill such behaviour, a different extension approach is needed, i.e. one allowing farmers to develop a sound problem-solving capacity (Röling and Van de Fliert, 1997).

Pest management is one of the elements causing major problems in high-external-input agriculture, but also the field in which some revolutionary changes have taken place leading towards more sustainable systems. Integrated Pest Management (IPM) underwent a drastic evolution during the past two decades, from which we can learn much on how to deal with the other elements of sustainable agriculture, by recognising, and benefiting from, natural processes. This paper attempts to outline the evolution of IPM and how it can support ecological agriculture, despite the conflicting acceptance of pesticide use in IPM.

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In addition, the paper elaborates on the extension mechanisms appropriate to convert transfer-of-technology package adopters into independent ecosystem managers.

Pest control, IPM and ecological agriculture

As long as human kind has been cultivating crops, it had to deal with competitors wanting to have their share. The animal and plant species that reduce crop output and are, therefore, called "pests", have been subject to a wide array of more and less successful control measures over the ages. With the discovery of DDT's insecticidal capacity, those days perceived a miracle weapon, traditional control measures were abandoned as being ineffective and old-fashioned (Van den Bosch, 1978). Even though we now recognise the other side of the coin of chemical control, the first successes and the aggressive promotion tactics applied by the chemical industry induced a different perception among farmers all over the world towards the competitors in their crops. Farmer have come to believe that no signs of insects, weeds or diseases can be tolerated in their fields, and that with the slightest symptoms the crop is considered "sick" and needs to be cured. In many local languages, pesticides are called "medicine", providing a positive connotation to these ingredients that should actually be called "poison". Despite world-wide acknowledgment of the hazardous effects of chemical control, and the increasing acceptance of IPM as an alternative control strategy, farmers continue to be reliant on pesticides, not in the least due to the continuing and highly effective promotion by the "pro-pesticide consortium" not wanting to lose their business (Van den Bosch, 1978).

As indicated above, farmers perceive pest control as a continuous battle against the competitors. Their level of tolerance to crop injury has become very low, after having learned to primarily observe the deadly effects of pesticides to their targets, and unlearned to observe crop development and capacity for compensation of damage. Pesticide promotion teaches them simple cause-effect relations: you have problem A, spray product X, And if X no longer works against A, the farmer asks the salesman who advises to mix X with Y and Z, or apply the double dose. There is always another weapon available in the kiosk, so no need to worry. However, many farmers begin to experience, that they are at the losing end: the pests become more and more resistant, and the cost-benefit analysis of their enterprise very marginal. Since they have not been taught to analyse the cause of the problem, and only know how to tackle pests with the one weapon that no longer works effectively, they are stuck in a vicious circle.

Integrated Pest Management (IPM) tries to break through this vicious circle farmers have found themselves in, although we should distinguish first between the several generations through which IPM has evolved over the past decades. IPM existed long before it became popular and was introduced into the literature by Stern *et al*. (1959), for the first time describing `integrated control' (as it was called those days) and using economic threshold as an operational concept. In 1968, IPM was defined by the UN's Food and Agricultural Organisation (FAO, 1968), giving it official status in the international agricultural world. In line with FAO's definition, focusing on pest occurrence and suitable interventions to suppress the pest populations, IPM developed as a strategy to control pests by relying on natural control factors, and using pesticides as a last resort. Rather than exploring how natural control factors could be exploited, IPM research and extension in the 1970-80s gave predominant attention to the judicious application of the last resort. The focus was on the development and application of observation techniques and economic threshold levels (ETL) as tools to be used in deciding when to apply pesticides. The ETL for a certain pest is the level of pest occurrence estimated to cause an economic loss of yield equal to the assessed cost for chemical control. To be able to apply the ETL, one has to monitor a representative crop sample and calculate the average pest occurrence, usually expressed in percentage incidence, or individuals per plant, per square meter, or per hectare. When the observation data reveal a pest population level that exceeds the ETL, a (chemical) control measure should be taken.

The application of the ETL concept at the farm level has long been questioned (e.g. Zadoks, 1985). Flaws identified invalidating the concept include the following (Van de Fliert, 1997):

1. Prices for harvested product and pesticides tend to fluctuate over the season and regionally;
2. Natural enemy populations are not considered in the ETLs;
3. Many other factors that farmers usually consider in pest control decision making are not included in the ETL concept, for instance:

- weather conditions;
- vigour of the crop;
- availability of irrigation water;
- availability of cash or credit facilities;
- other investment opportunities; and
- effects of indigenous/cultural practices.

Despite these flaws, most IPM programmes continued to teach ETLs to farmers. It is, however, not likely that farmers will apply the ETL methodology as such in their daily farm management, for several reasons:

1. Observation techniques required to obtain a representative sample are often complex and laborious;
2. Pest population assessment methods apply units that farmers may not be familiar with, such as percentage, square meter, hectare;
3. An ETL applies only for one pest or disease, whereas farmers face a complex of pests and diseases in their crops; having to consider more than one ETL at a time is too complicated.

Having learned from ten years of experience in rice IPM development and implementation in over ten Asian countries, the FAO's Inter-country IPM Programme[3] piloted a new approach in Indonesia in 1989. This approach was unconventional with regard to both its technical contents and its extension methodology. Rather than teaching sophisticated observation techniques, ETLs, and a set of possible measures to be applied for control with high emphasis on the "judicious" use of pesticides, four principles were introduced to rice farmers (Kenmore *et al.*, 1995):

1. Grow a healthy crop;
2. Conserve natural enemies;
3. Observe fields regularly;
4. Farmers become IPM experts.

The first two principles emphasise the importance and maintenance of naturally occurring ecological processes and defense mechanisms favouring crop production, that should be taken advantage of by the farmer. Healthy crops can resist pest attack and compensate for incidental damage, whereas a healthy ecosystem with plenty of natural enemies helps to defend against pest attack (Altieri, 1993). A high diversity of genes and species in the crop ecosystem should be encouraged. To do so, farmers have to become ecosystem managers and independent experts in their own fields. Regular observation is the main tool to provide the information needed to take adequate decisions. With these IPM principles, farmers, rather than technologies, become the focal point in IPM programmes, with regard to both research and development of methodologies, and final field implementation. This approach to IPM was readily adopted in many other governmental and NGO IPM programmes in the South and Southeast Asian region. A similar approach to IPM training was developed and experimented independently in Honduras through activities of the Pan American Agricultural School (Zamorano) (Bentley and Andrews, 1996).

The key focus of IPM is now diversity, instead of single pest populations. Increased genetic and species diversity favour the resistance and resiliency of the ecosystem to pest attack, and should, therefore, be enhanced. A genetically diverse crop contains more mechanisms complementing one another to resist pest damage (Worede and Mekbib, 1993). A more diverse composition of primary producers (crops and weeds) prevents specialised pests from becoming abundant, and provides better conditions for the survival of natural enemies (Altieri, 1995). Pesticide use is avoided by prevention of pest attack through the abovementioned mechanisms and reliance on the natural control factors, rather than considered an acceptable last resort. This seems easy for wet tropical agroecosystems with crops such as rice and sweetpotato or mixed cropping systems favouring (relative) diversity of the ecosystem. However, a more difficult situation, when it comes to ecological balance, is usually found in introduced crops with a more artificial ecosystems, such as vegetables and fruits. A message as simple as that for rice IPM may not

[3] In full: Inter-country Programme for the Development and Application of Integrated Pest Control in Rice-growing in South and Southeast Asia, United Nation's Food and Agriculture Organisation

work here. Nevertheless, the four IPM principles as presented above still seem to apply, with even higher emphasis on the expertise of farmers to take adequate decision in these vulnerable agroecosystems.

Despite the fact that IPM still accepts the use of pesticides, the IPM principle based on ecological processes, and IPM's current focus on biodiversity in the agroecosystem, form a strong link towards ecological agriculture. It fits exactly as management strategy to the ecological principle based to Low-External-Input and Sustainable Agriculture (LEISA), defined by Reijntjes *et al.* (1992), of *"Minimising losses due to plant and animal pest and diseases by means of prevention and safe treatment"*. The section below will show how IPM can even serve as a springboard from conventional to ecological agriculture.

Converting package adopters to ecosystem managers

Green revolution technologies were in most Asian countries promoted through the then popular extension model developed by the World Bank, called the Training-and-Visit (T&V) system (Benor and Harrison, 1977). The T&V system applies a "Transfer-of-Technology" model. In this model, information is supposed to be generated by research activities, extended via extension channels, and finally utilised by the farmers. It is highly top-down and linear, in that research agendas are set by the research sub-system, transferred through the extension sub-system to the farmers who are supposed to adopt the recommendations. No direct feedback mechanisms exist. In such a system, farmers are taught "what" to do, but never told "why" and how they can adapt to their specific farm conditions. Those who do not adopt, for whatever reason valid to them, are called "laggards" (Rogers, 1983).

When recognising diversity of farms, farms specific needs and validity of reasons for non-adoption, a different extension approach is required, allowing for intensive feedback mechanisms between researchers, extension workers and utilisers, and focusing on problem solving and decision making capacity building ("why" and "how"), rather than on the adoption of preset technologies ("what"). Particularly in ecological agriculture, farmers should be able to understand, analyse and react adequately to ecological processes existing on their farms, each under specific ecological and economic conditions. IPM extension during the past fifteen years has taught us an important lesson.

Initially, IPM extension through conventional extension services involved conveyance of research findings (e.g. on ETLs and observation techniques) as a standard package for farmers to follow rigidly. Training of farmers took place in the classroom, often using colour slides, picture books or flipcharts (Matteson *et al.*, 1994). Enlarged picture of insects, however, do not necessarily lead to their recognition by farmers, and their behaviour and function in the field is not demonstrated. Implementation of IPM in rice cultivation in Indonesia during the mid 1980s demonstrated that using ETLs for pesticide-induced pests, such as the brown planthopper, led to a higher pesticide use, triggering resurgence and, hence disastrous outbreaks. The same programme showed that farmers, who had received a two-day training teaching observation techniques, ETLs, identification of pest insects and natural enemies, were not able to make independent pest control decisions based on their observations (Van de Fliert, 1993). Whenever they observed alarming numbers of pest insects, they consulted the extension service.

A training model providing opportunities to farmers to become competent IPM implementors, was developed by the aforementioned FAO Inter-country Programme for rice IPM in Asia (see footnote 3), and piloted in Indonesia in 1989 (Van de Fliert, 1993). The model was called the “Farmer Field School”, intending to send farmers back to school, a place reputed for learning, but one being located in the field, the farmers’ daily work arena. The training strategy, having its foundation in nonformal education principles, emphasises learning by doing, and empowering farmers to actively identify and solve their own problems. Participation, self-confidence, and collective action and decision making are fostered during the experiential learning process. This approach seems highly consistent with the requirements of active ecosystem management by farmers implied by IPM.

An IPM field school lasts for a whole growing season during which a group of farmers meet once a week for half a day. The field school model is designed to allow farmers to learn to take informed pest management decisions based on their own observations and analyses. This ability often gives them more confidence in their own farm management skills, which, in turn, is reflected in an improved, overall farm management. A second important purpose of the field school is that farmer groups are stimulated to take collective action, which in certain cases may be indispensable for effective IPM implementation, particularly for pests such as rodents. A successful IPM field school often results in follow-up activities, spontaneously organised, and funded, by the field school graduates, such as IPM clubs in Vietnam (Eveleens *et al.*, 1996). During these follow-up activities, the farmers may study newly occurring cultivation problems expanding to, for instance, plant nutrition, organise collective control measures, and even get into wider aspects of community development, such as rice-fish culture and collective marketing of produce (Van de Fliert and Wiyanto, 1996).

Why do farmers generally get so excited to learn more after having attended one season of IPM field school? The strength lies both in the IPM message and in the learning methodology of the field school. With IPM, farmers discover that there is more in their field than their crop and its competitors, only. They learn to understand the third trophic level and its ecological consequence. This makes them understand that nature is also for, and not only against, them, and that they themselves can either disturb or benefit from the ecological processes relating to pest occurrence. They feel they are increasingly in charge and can "manage", after having gained analytic and decision making skills. The strength of the experiential learning approach enhances their ability to discover, and reinforces their feeling of "being in charge", because they have learned to learn by themselves. This empowerment process is likely to be highly sustainable. After knowing more about predator-prey or parasite-host relations, being the first but well observable ecological process they come to understand, farmers also want to, and can more easily, understand other ecological processes from which they can benefit, such as nutrient and water cycling in the agroecosystem. The challenge for extensionists is to make these processes also better observable for farmers, so their excitement will not cease.

Conclusions

Learning about IPM in the farmer field school (or any other training model based on experiential learning principles) tends to open farmers' eyes in several ways:

- they discover that ecological processes operate on their farm from which they can benefit, if managed well;
- they learn to appreciate the specificity of the (ecological and economic) conditions on their farm, and to understand that only they themselves can decide what are the most appropriate measures to take; no standard recommendation will exactly suit these conditions;
- they feel themselves being in charge and accepted as independent farm managers, rather than seen as either technology adopters or, worse, laggards.

These changes help farmers to shift information they will receive in the future through the various channels, such as mass media, input promotion brochures, salesmen, and the like. Through IPM implementation, farmers will gradually reduce pesticides applications and, hence, re-establish a natural balance in their fields. Then they should be challenged to apply the IPM principles to a wider range of crop cultivation practices, by regularly analysing the total of crop needs versus the ecological and economic conditions of the farms, as has proven successful in sweetpotato cultivation in Indonesia (Van de Fliert *et al.*, 1997). With better empowered farmers, and more ecologically sound practices, is agriculture likely to become more and more sustainable without having to give in on food production for the world population.

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