Brassica IPM adoption: progress and constraints in south-east Asia

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Abstract

The Integrated Pest Management (IPM) programme for brassicas in many countries of south-east Asia follows a generic model whose basic components are: (i) Regular scouting of pests, namely the diamondback moth (DBM) and its major natural enemies to ascertain their population levels to justify insecticidal treatments; (ii) Use of pre-determined economic threshold levels (ETLs) and (iii) Incorporation of other non-chemical control measures, such as the release and conservation of parasitoids, use of trap crop and yellow sticky traps. The current empirical level of adoption by growers of this programme ranges between 50 to 100% and reasons given by growers for adopting IPM include: (i) Financial gains (higher net returns, decreased costs of control), (ii) Reduction in damage by pests, (iii) No unwarranted problems due to pesticide residues and (iv) Reduction of risks in terms of yield. However, despite the widely acknowledged benefits of the programme, the grower adoption rate in many countries has been rather slow. The major constraints to adoption were (i) the difficulty to comply with procedures determining economic threshold levels (ETLs), (ii) lack of management consideration for the other pests complex besides DBM and (iii) the weak support provided by extension agencies. The strategies to increase adoption have been outlined and these include overcoming the various current technical and non-technical constraints, such as simplifying the ETLs, strengthening the linkage between research and extension and formulating technological baskets rather than technological packages. The need to crystallise inputs from social and behavioural scientists at the formulation stage of the programme was underscored.

Introduction

The Brassica crop system and components of the IPM programme

In south-east Asia, a wide range of Brassica vegetables is cultivated practically throughout the year both in the highlands and specialised areas in the lowlands (Talekar & Shelton 1993). Although these vegetables are traditionally grown in the open, recently, in many countries, cultivation has shifted to rain or insect protected structures. Irrespective of the system, growers use intensive cultivation practices to produce the vegetables in areas averaging less than two acres.

The Brassica Integrated Pest Management (IPM) programme is amongst the most well-worked IPM programmes for a particular pest problem (in this case, the diamondback moth and associated pests) in the world. In south-east Asian countries, the diamondback moth, Plutella xylostella (L.) is a pest of common concern and, considering the magnitude of its resistance problem against a wide range of synthetic pesticides, it was only natural that some of the earliest efforts in IPM were initiated in countries namely Malaysia (Loke et al. 1997, Sivapragasam et al. 1985), Indonesia (Sudarwohadi 1996), Thailand (Piyarat et al. 1997), Vietnam (Lim 1992) and the Philippines (Eusebio & Rejesus 1997). Some of the leading countries in south-east Asia and the key components of their Brassica IPM programmes are shown in Table 1.

Table 1. Key components of the Brassica IPM programme in major Brassica growing countries of south-east Asia

<table>
<thead>
<tr>
<th>Country</th>
<th>Key Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malaysia</td>
<td>Economic thresholds, incorporation of parasitoids, cultural practices, use of biopesticide, Bacillus thuringiensis (Bt)</td>
</tr>
<tr>
<td>Philippines</td>
<td>Economic thresholds, incorporation of parasitoids, IPM selective insecticides</td>
</tr>
<tr>
<td>Thailand</td>
<td>Economic thresholds, incorporation of parasitoids, use of microbial insecticides, yellow sticky traps</td>
</tr>
<tr>
<td>Indonesia</td>
<td>Economic thresholds, incorporation of parasitoids, use of microbial pesticides</td>
</tr>
<tr>
<td>Vietnam</td>
<td>Economic thresholds, Bt and other microbials, intercropping, crop rotation (cucurbits and crucifers) and cultural practices</td>
</tr>
</tbody>
</table>
Essentially, the IPM programme in many of these countries follows a generic model and relies on the basic components such as: (i) regular scouting of pests, namely the diamondback moth (DBM) and its major natural enemies, to ascertain their population levels to justify insecticidal treatments; (ii) use of pre-determined economic threshold levels (ETLs) and, in some cases, (iii) the incorporation of other non-chemical control measures, such as the release and conservation of parasitoids, use of trap crops and yellow sticky traps. Besides these key components, other control components have been gradually added to the IPM ‘basket’ or repertoire, depending on the local pest requirements and geographical location, i.e. whether it is highlands or lowlands.

Status of Brassica IPM adoption
Although studies on adoption of agricultural innovations are many (see Rogers 1968), there are only a few studies done investigating the adoption of IPM innovations by farmers (Grieshop et al. 1988). However, despite the abundance of information on Brassica IPM, studies investigating the adoption process of the Brassica IPM programme by growers in the countries of south-east Asia are significantly lacking. Thus, to gauge the number of farmers adopting the IPM approach, a cursory survey was done by way of providing the relevant questions via a questionnaire to key IPM personnel in the countries of the region. Responses obtained from the four major countries are shown in Table 2.

Table 2. Initial and current adoption values of Brassica IPM in four south-east Asian countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Initial</th>
<th>Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malaysia</td>
<td>Low (30–49%)</td>
<td>Moderate (50–79%)</td>
</tr>
<tr>
<td>Indonesia</td>
<td>High (80–100%)</td>
<td>Moderate (50–79%)</td>
</tr>
<tr>
<td>Thailand</td>
<td>Moderate (50–79%)</td>
<td>High (80–100%)</td>
</tr>
<tr>
<td>Philippines</td>
<td>Moderate (50–70%)</td>
<td>High (80–100%)</td>
</tr>
</tbody>
</table>

Depending on the country, the current empirical level of adoption by growers, as perceived by the implementers from each country surveyed, ranged between 50 to 100%. Detailed studies, however, need to be initiated to quantify whether the values given actually reflect the situation on the ground, especially for countries such as Thailand and Philippines which indicated high adoption values.

These values do not categorise the farmers on the level of adoption based on the number of components farmers use in their programme. Based on the United States Department of Agriculture (USDA) standards, in IPM-based fields, adoption was categorised into three levels namely, (1) low adoption where scouting (S) and pesticide applications based on thresholds (T) for one type of pest are advocated; (2) medium IPM adoption which involved S + T plus 1 or 2 additional IPM practices being implemented and (3) high IPM adoption when S + T plus 3 or more additional IPM practices are used within the farm (Benbrook et al. 1996). Based on these criteria, the level of adoption of Brassica IPM tended to be moderate with most of the countries using at least 1 or 2 other additional components besides S and T (Table 1). With the exception of Malaysia (vide infra), no specific data are available in the literature to ascertain any trend in the adoption rate (e.g. S-curve, Rogers 1968) since the beginning of the IPM programme. Based on the survey, the reasons given by growers for adopting the IPM programme (% of respondents) include: (i) financial gains such as higher net returns and decreased costs of control (20%), (ii) reduction in damage by pests (27%), (iii) personal interest (13.5%), (iv) easy to use (6%), (v) little risk involved in terms of yield etc. (27%) and (vi) other reasons such as no residue of pesticides (6%). It is interesting to note that the latter reason did not feature prominently with the growers as, to most researchers and government policy makers, the problem of residues is an important driving force for initiating the IPM programme.

Constraints to adoption
Some of the reasons from respondents for the lack of interest shown by farmers in adopting the IPM programme included: (i) lack of confidence in the technology, (ii) difficulty in complying with the procedure of monitoring and counting insects based on the pre-determined economic threshold levels (ETLs), (iii) time consuming procedure and (iv) lack of understanding of the benefits of the programme.
Difficulty in complying with scouting for pests and their natural enemies
Likewise in many other IPM programmes, sampling populations and treating them according to the pre-determined ETLs is basic to the implementation of the \textit{Brassica} IPM programme. However, counting of insects and determining the ETLs were noted to be significant problems faced by growers. Essentially, the system of monitoring insects should not be too laborious in nature since regular scouting requires labour and trained personnel–resources that are in short supply in many developing countries. In fact, the \textit{Brassica} IPM programme in many countries has moved towards one of increasing complexity towards the determination of ETLs. This is exemplified by the programme in Malaysia whereby the system has evolved from one of basic threshold determination based on pest counts only (e.g. DBM larvae) (Sivapragasam \textit{et al.} 1985), to that which included the counts of parasitoids (Loke \textit{et al.} 1992) and eventually to one that incorporated the other key pests besides DBM (Jusoh 1997). Although these features evolved out of the inevitable necessity to portray as realistically as possible the vagaries of the \textit{Brassica} system, unfortunately this process of ETL determination poses a crucial impediment to the wide adoption of the \textit{Brassica} IPM programme in that country. Compounding this, Talekar and Shelton (1993) suggested that in many countries, the adoption of \textit{Brassica} IPM is also hindered because many farmers cannot differentiate pests and beneficial organisms. Although alternatives to physical counting had been looked into, such as the yellow trap and pheromone trap, these tended to have limited predictive utility.

Dearth of consideration to counter a complex of pests
Another constraint inherent in most of the programmes is that these programmes are skewed towards the specific management of the diamondback moth (DBM) and lack the necessary control technological inputs to manage the other pests and pathogens. Therefore, a holistic approach to tackle the other occasional and recurrent pests will be crucial if the ultimate objective of maximising yields is to be achieved. For example, in Malaysia, \textit{Brassica}, especially head cabbage cultivation, is limited in the lowlands by the presence of the cabbage webworm, \textit{Hellula undalis}, flea beetle, \textit{Phyllotreta} spp. and recently, \textit{Spodoptera exigua}. A similar situation exists in the other Southeast Asian countries such as Thailand and the Philippines where \textit{H. undalis} is a major problem. In addition, pathogens, \textit{Erwinia craccivora} causing bacterial soft rot and \textit{Xanthomonas} spp. causing bacterial wilt are major problems to \textit{Brassica} cultivation both in the lowlands and highlands in many of these countries.

Weak and non-sustainable extension link and transfer of technology
One of the major constraints faced by IPM implementers is the difficulty to sustain the interest of those already ‘converted’ to the programme. The situation is compounded by pesticide sales pressure, lack of sustained support from the relevant change agents and dearth of external funds. More recently, probably as a result of increasing costs for legal pesticides, there are rampant sales of cheap illegal pesticides in the market. One effective mechanism to counter many of these problems will be to strengthen the existing extension component of the IPM programme. Wearing (1988) stated that “problems with the transfer of IPM technology are today identified as a principal bottleneck limiting progress with IPM worldwide despite rising pesticide costs and resistance problems.” He also stated that the lack of extensive educational programmes is a major barrier to IPM adoption. It has been underscored that promoting area-wide adoption involves key elements of training, extension and transfer of technology (Saharan \textit{et al.} 1996). The pertinence of a strong extension component in the adoption process is exemplified by the situation in the Cameron Highlands, Malaysia. Figure 1 shows the rate of adoption by growers of the \textit{Brassica} IPM programme initiated on an area-wide basis with strong extension support.

The general trend of the adoption curve, up until 1994, revealed the typical S-shape (Rogers 1968), but after that time decreased and has remained somewhat at that level ever since. One of the key contributing factors to the downward trend is, by and large, related to the significant absence of the extension component which resulted from the termination of the IPM project in that area with the desirable management of the pesticide residue problem. Currently, it is common to see growers applying pesticides on a routine basis and the IPM adoption level stands at around 30% from a peak of almost 70% with the significant presence of the extension component. It seems obvious that the strengthening of the extension component within the adoption process could alleviate some of the major constraints faced by farmers such as their lack of confidence in the programme and its perceived benefits.
The management of diamondback moth and other crucifer pests

Figure 1. Rate of adoption of the *Brassica* IPM programme by farmers in the Cameron Highlands, Malaysia. Trend curve (-----) is best curve by computer.

**Recommendations and needed shifts to increase adoption**

It is clear that not all growers adopted the *Brassica* IPM programme. In fact, in some cases, the adoption rate is on the decline and growers continue to apply pesticides on a routine basis. This is despite the numerous advantages shown in studies with regards to the benefits of the *Brassica* IPM programme (Sudarwohadi 1996, Eusebio & Rejesus 1996, Loke *et al.* 1992, Sivapragasam *et al.* 1985). The benefits include, decreased or the same costs of control, higher net returns and reduction in risks as measured by variability in quality or average level of net return is the same as or lower than that found with the conventional approach. Norton (1982) underlined that research and development in pest management does not always lead to practical improvements. The issues generally fall into two categories, namely, (1) design, whereby R&D is aimed at the wrong questions or at developing inappropriate practices and (2) delivery, whereby despite the product being well targeted, the results are not getting through to be implemented by the pest managers and their advisers (Figure 2).

![Diagram](image)

**Figure 2. Process flow from IPM development to adoption and diffusion**

Both these issues are relevant in the current context of the *Brassica* IPM programme. Besides the fact that some farmers do refine and adapt the technology to suit their specific needs, two of the key determinants for increasing the adoption of the *Brassica* IPM programme are in the refining of the design (e.g. simplifying...
ETLs, considering pests complex) and the delivery mode of the IPM programme. In the latter instance, which could be pivotal to sustain the desired level of adoption, it is necessary to either apply the Supply-Push strategy (e.g. pesticide residues and health related issues) through legislation, enforcement or simply political will or the Demand-Pull strategy whereby the inherent advantages of adopting the IPM programme (financial, risks reduction etc.) are perceived by the farmer as desirable towards meeting their farming objectives (Figure 2).

It is also important to recognise the fact that IPM involves “a complex set of behaviour, decision-making procedures and methods, technology and values organised to provide efficient alternative methods to pest management” (Apple & Smith 1976). Therefore, to improve the level of adoption, it will be necessary to understand the social aspect, namely the perception of growers and the adoption process which could prove useful for designing and dissemination techniques relevant to IPM. Figure 3 shows the perceptive factors involved in the grower’s decision making process (Heong 1981) which need to be harmonised during the formulation of the IPM programme if the farmer’s ultimate objectives of yield and net revenue are to be met.

Besides these, the socio-economic profile of the growers also provide pertinent information on their perceptions, actions and needs. As pointed out by Grieshop et al. (1988), using the Tomato IPM programme as a model, factors such as age, education level, size of farm holding, land ownership, type of enterprise (whether family owned or otherwise), growers sources of information and previous experience with IPM, are important socio-economic considerations that affect the decision making process and the eventual adoption rate of the IPM programme. For example, land ownership, whether it is owner cultivated or rented based on the temporary occupation of land (T.O.L.) scheme could be a major determinant on the way in which that particular land is used. Usually, farmers on T.O.L., unlike owners, tend to intensify and maximise their yield output from the unit land given their limited time frame, without consideration to the entailing risks of pollution by pesticides.

To date, many evaluations of the effectiveness of IPM by research personnel typically have focused on the economic considerations. However, Allen and Rajotte (1990) added that, although economic considerations are significant in the decision making process related to the use of IPM, non-economic factors such as the complexity of the innovation (as with the use of ETLs), compatibility of control measures (compatibility of pesticides against pests), ease of use and the ability to respond to the risks of uncertainty to pest attacks are
important to the adoption of an innovation such as IPM. It is, therefore, not surprising that insecticides, which are a product unlike IPM which could be construed as a process or information, fit well into the mould of a good innovation easily adoptable by growers.

To improve the adoption of the *Brassica* IPM programme, some of the following shifts could be considered:

Technology packages to technology baskets
To tackle the problem of a complex of pests in a realistic manner, there is a need to consider the management of a multiple pest complex present on the crop. Thus, there is a need to apply the system analysis and decision tools approach to develop ‘technology-baskets’ rather than ‘technology packages’ which are suitable and flexible for problem solving at different locations. In this context, therefore, there is need to equip farmers with a repertoire of knowledge to manage these multiple pests in an integrated manner. Intricately linked to this is the grower’s inability to distinguish between the pests and beneficial organisms. Currently, there is an abundance of information on the various components of the *Brassica* IPM programme. The challenge is in the intelligent application of those that are already present in a sound political, social and economic manner. In this context, there is a need to ensure that the IPM programme is well beyond the technical realm and needs to be complemented by social, political scientists and resource economists.

 Naturally, factors outside the realm of pests should also be considered in the formulation and eventual implementation of the IPM programme. In this context, a shift towards a crop-based management system will, by and large, encompass the varied needs of all stakeholders of the *Brassica* system. This may eventually lead to the sustainability of the *Brassica* system portrayed as Level III of IPM integration based on Kogan (1998) whereby there is integration of multiple pest impacts and the methods for their control within the context of total cropping system.

Complex ETLs to action thresholds
The difficulty and complexity of determining ETLs could be overcome if adequate training is provided to farmers and if professional services are used, just like in the developed countries. The use of simplified action thresholds based on level of pest damage may be an alternative to actual pest counts and is worth considering (Walker *et al.* 2004).

Broad spectrum to selective insecticide use
Successful *Brassica* DBM-IPM programmes have been dependent on key parasitoids such as *Diadegma semiclausum* and *Cotesia plutellae*. Therefore, if the programme is to succeed with parasitoids, a concerted effort should be made to use insecticides that are compatible with these natural enemies. Otherwise, problems seen in Indonesia for the control of the cabbage head caterpillar, *Crocidolomia binotalis*, using insecticides which induced DBM outbreaks as a result of mortality of *D. semiclausum* (Shepard & Schellhorn 1997), could be repeated. For the moment, *B. thuringiensis* is still used widely. However, with the impending concern about resistance to this microbial insecticide, there is a need to look at compatible alternatives.

Top-down issue focus to bottom-up farmer focus
Since successful IPM programmes generally have a ‘farmer-focus,’ besides the strengthening of the extension arm of the implementation model, non-formal education methods such as farmer field schools (FFSs) and the Area Field Laboratory (ARF) (Ooi 1998) need to be promoted to make farmers literate in pest management practice. Zainal *et al.* (1994) suggested that a strategy to help growers understand reasons for possibly using less agricultural chemicals and inorganic fertilisers is shown to be the single most effective approach for promoting the more widespread adoption of sustainable practices for cabbage production. Research should not only confine itself to the priorities determined based on ‘top-down’ manner. As suggested earlier, it should also encompass the needs, perceptions and socio-economic milieu of the growers, be less compartmentalised and ‘bottom up’ participatory and feedback oriented in nature. The primary focus therefore is to concentrate on the elements of transfer, i.e. simplifying and delivering the *Brassica* IPM programme to achieve a desirable level of adoption. For a start, the strategies include modifying the current implementation method, either as “adaptive implementation” (Wearing 1988) such as refining the current ETLs determination procedures for ease of use by the grower or through “programmed implementation” (Wearing 1988) in which the grower is “educated” adequately to understand the crop and
its environment as it is done based on the participatory approach advocated in the FFSs approach. Unless appropriate IPM component tactics are assembled together into pragmatic IPM programmes, the integrated approach towards pest management will not fully materialise and eventually its rate of adoption will be affected.

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