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IMPACT OF INTEGRATED PEST MANAGEMENT TECHNOLOGY : AN OVERVIEW

P.K. DASHORA AND O.P. AMETA

Department of Entomology, Rajasthan College of Agriculture, MPUAT Udaipur 313001

At the end of first decade of 21st century when we pinpoint one major problem the mankind is facing, we would all agree without any dispute that population growth is the first major problem globally and in India also it remains the first major problem. With fixed land size we have to ensure that at no point of time in future people fail to meet their food requirements. It is estimated that over the next three decades the food grain production in India has to increase at least 2 million tones per year to meet the food demands of the growing population. Till now we could successfully increase our agriculture production through area expansion, use of high yielding variety, irrigation, fertilizers and pesticides. But the possibilities of augmenting agriculture production now through area expansion is quite bleak. There is hardly any scope to bring additional land under cultivation, the green revolution has given its maximum output, use of additional inputs may not yield optimum results, the problem of insect and pest is becoming severe. According to an estimate about 25% of rice, 5-10% of wheat, 30% of pulses, 35% of oil seeds, 20% of sugarcane and 50% of cotton production is lost due to pests (Dhaliwal and Arora, 1996). If we can ensure the reduction in such losses perhaps we can significantly contribute towards achieving the required increase in agriculture production.

It is believed that despite increase in pesticides consumption there is an increase in pest reduced losses. It is a paradox, the possible explanation given is the rise in pest problem, the technological failure of pesticides and the changes in the production system. No doubt these chemical pesticides are severely criticized by the environmentalists for their adverse effects on the human health and environment. As a result new pest management strategies are searched and use of micro organism and plant products have been advocated. When these are used in combination with other pest management methods can better control of best this kind of integration of different methods for best unarrangement is referred to as Integrated Pest Management (IPM). Before such Integrated Pest Management technique are suggested to farmers it is far more necessary to ensure their viability and superiority.In the want of this, farmers may not adopt it as a regular pest control method.

IPM techniques are primarily used to minimize the economic losses due to pests and to ensure the protection of environment and public health. We can assess the economic benefits in quantified terms. But the assessment of environmental and public health benefits requires considerable scientific and field level information.

Evaluation of Pest Management Technologies at Experimental level

Technical efficacy : Assessment of yield loss

(i) Insecticide check method

In this method the crop is protected by the best available technology and the yield obtained is compared with the yield under natural infestation conditions. The difference is the loss due to pest. The yield or yield loss provides an assessment of the relative performance of different technological options. Lower is the loss better is the technology. This approach is criticized because of its limited applicability under farmers' conditions.

(ii) Constraint experiments

Constraint experiments are conducted to assess the yield loss due to pests under farmers' conditions. Levels of all other inputs in farmers' practices except the pest management inputs are raised to the level of best production trial. The mean yield with best protection is compared with the mean yield obtained on farmers' fields to estimate the yield loss. Different technologies thus are evaluated for their effectiveness by comparing the yield or yield loss. Simple yield comparison generally leads to under estimation of the yield loss, as this compares yields with and without application of technologies. While a considerable proportion of yield is lost, even after protecting the crop with the best available technology. There can be variation in yield from trial to trial at the same level of infestation and pest control efforts. Thus in order to estimate the yield loss we should have an estimate of potential yield. Where potential yield is the yield that could have been achieved in absence of pest infestation. This potential yield is compared with the actual yields under different pest management options to estimate the yield loss.

There may exist a functional relationship between the yield loss and the pest infestation. Regression method can be used to establish the relationship between yield and pest infestation level**.**

The potential yield can be estimated by regressing the actual yield (Yi) on the level of pest infestation (i). The intercept term provides estimate of potential yield. The relationship can be written in following term in case of single pest control strategy.

$$Yi = f(li) \ldots\ldots \quad \ldots(1)$$

In case of multiple technological options, potential yield can be obtained by estimating equation (i) with simultaneously with equation (2) below :

$$li = f(Ti\ Cj) \quad \ldots(2)$$

Where,

li = Pest infestation

Ti = Different technological options

Ci = Cost of pest control

Cost of pest control is taken when the level of pest management effort is also considered while estimating the equations.

For estimating these relationships, one may use either trial level cross sectional data or the time series average of trial data. In case of time series data; we may neutralize the time effect on the level of pest infestation by adding a time trend variable (ti) on the right hand side of equation 2.

When varieties are also changed year after year then variety specific dummies (dv) can also be incorporated in R.H.S. of equation (1) thus we may get the following functional relationship.

$$Yi = f(li\ Dv) \quad \ldots(3)$$

$$li = f(Ti\ Ci\ ti) \quad \ldots(4)$$

From these equations potential yield (Yp) can be obtained. The actual yields (Yt) with application of different pest management options are compared with the potential yield to estimate the yield loss. Equation (5) provides yield loss in percent.

$$YL = (Yp - Yt)/Yp \times 100 \quad \ldots(5)$$

Economic Efficacy: Cost and return analysis

Technical feasibility though necessary but not a sufficient condition for adoption of a technology. Whether or not a technically feasible technology will be adopted by farmers will depend on its expected cost and benefits. From economic point of view no technology will be accepted if it does not yield higher net returns as compared to the competing alternatives. A cost and return analysis is performed to examine the relative profitability of different pest control technologies. Here changes in costs and benefits for each pest management option are calculated over the costs and benefits from no protection. The change in net revenue due to application of technology is calculated as –

$$\Delta Xi = Xi - X2$$

Where Xi is per hectare net revenue from application of i^{th} a technology and X2 is per hectare net return from the unprotected field.

Marginal Benefit Cost Ratio is estimated as –

$$B/C = \Delta Xi - \Delta Ci$$

Where $\Delta Ci = Ci - C2$ is the net cost change due to i^{th} technology, Ci is per hectare cost on application of i^{th} technology, C2 is per hectare cost with no protection.

Net revenue changes and the benefit cost ratios associated with different technological options are then compared to examine the relative profitability.

Measurement of Adoption of IPM

Measurement of adoption of IPM is different from the measurement of any other technology that does not require integration with other technologies. As the later can be measured by the proportion of the crop area applied with the technology. Its intensity of adoption can be measured by quantity applied per unit of the cropped area. But IPM is a combination of several new or existing technologies and practices. Hence the measurement of adoption of IPM requires some different approach. IPM adoption can be measured in an "either-or" framework. Here IPM is treated as binary dependent variable. Social, personal and economic characteristics of adopters and non-adopters on the adoption behaviour. In some studies on IPM a range can be considered like non-adopters, low-adopters, medium-adopters and high-adopters. In some other studies "dominant technique" is used as an indicator of adoption of IPM package. Continuous scales can also be developed to measure the adoption of IPM. In such scales, various production practices are assigned weights based on their utility and compatibility with IPM package.

The "either-or" approach is simple and useful when a single component of IPM is examined. The adoption range estimate is useful in case of single technique. Dominant technique approach is a widely used technique. It makes one assumption that other IPM practices are same across the farms. "Continuous scales" has the advantage of combining different techniques considering their relative importance but intensity of application of different practices is ignored. Further, it is difficult process to evolve the weights for each practice. It requires considerable scientific inputs of multidisciplinary nature.

Aggregate Economic Impact of IPM: Economic surplus approach

In budgeting technique the assumptions of the constant prices and no supply shift are quite restrictive and do not confirm to the real market behaviour, net revenue may not accurately represent the net benefits to the produces and consumers. Economic surplus approach recognizes the changes in the cost of production supply and prices resulting from the technological change and consequently the changes in procedure and consumers welfare.

Estimation of willingness to participate in collective action

In order to realize maximum benefits from the investments made for pest control wide efforts are needed. As the IPM utilizes biological pesticides and the activities of biological pesticides can be adversely affected by the use of chemical pesticides in the vicinity. Likewise, other agronomic and management activities which are important in pest management require collective efforts.

Contingent valuation technique

It is used to elicit farmers' response on their willingness to participate in different pest management activities. Farmers' willingness to participate in any activity vary with the importance of that activity. A composite weighted index of the willingness can be constructed by assigning weights to the different activities, according to their utility in the pest management. The weights can be obtained on a scale from 1 to 4. The weighted index of willingness to participate is given by –

$$lj = (Wi\,Aij) / \Sigma\, Wi$$

Where lj is the index of willingness of participation of j^{th} respondent, Aij is the i^{th} activity in which j^{th} respondent is willing to participate and Wi is the weight of i^{th} activity.

Factors which may affect the willingness

A number of socio-economic, psychological and institutional factors, influence the willingness to participate in collective pest management.

Data requirement

One may use two types of data for such studies (i) Data from experiments and (ii) Data from survey.

Experimental data : Experimental data can be used to examine the technical and economic efficacy of different pest management options. Here data on multi-locational trials are found useful to test the efficacy of different pest management options. The average of inputs and outputs for different pest management options are recorded for a number of years. Usually such data are not consistent over time in terms of particular input or combination of inputs. So first data are carefully screened and treatments are suitably groped into different categories like natural control, chemical control, biological control and IPM (Integration of biological and chemical control).

Empirical findings of controlled experimentation have a limitation of their non-replication under field conditions. As a result, a number of technologically advantageous interventions remain un-adopted. Therefore, field surveys are conducted to examine the technical and economic feasibility of IPM under farmers' conditions.

Survey data : Surveys provide the picture of situation as it exists in the field. Surveys are the powerful tools to obtain the answer of queries of following nature-

- Awareness level of farmers about IPM technology.
- The available pest management technology with the farmers.
- Extent of usefulness of available pest management technology with the farmers in substituting chemical Pesticides.
- Assessment of economic impact of IPM technology.
- Identification of factors that influence the adoption of IPM Technology.
- Extent of willingness of farmers to adopt IPM technologies.
- Identification of factors that may promote the use of these technologies.

The surveys should be conducted following should methodology. It requires a systematic planning and sound execution followed by appropriate analysis and interpretation of data for scientifically reliable and valid conclusion. For a large scale survey multi-stage sampling schemes are recommended. The sample should include farmers from different sections of adopters of IPM and the farmers who are the users of chemical pesticides.

Validation of IPM Technology

Validation of IPM technology is a scientific culmination of the philosophy of IPM Knitted with available Technology in its ultimate test under ground realities of the field. Since IPM is a multidisciplinary, multiorganizational and multilocational participatory concept, involvement of all he stackholders including the farmers is to be ensured.

Prior to validate IPM technology it is necessary to collect the detailed information on crops, varieties, crop production and protection practices followed by the

Table 1: Comparative economic of validated IPM technology

S. No.	Crop	Location	Gross Return (Rs./ha)		Cost benefit ratio	
			IPM	FP**	IPM	FP
1.	Chickpea	Jaipur	28,800 (13.8)*	19,840 (12.4)	1:2.28	1:1.94
2.	Pigeon pea	Gulbarga (Farthabad)	16,005 (9700)	13,282 (8050)	–	–
3.	Wheat	Baghpat	37,237 (60.06)	33,914 (54.70)	1:1.79	1:1.63
4.	Rice	Faizabad	27,500 (50.0)	24,220 (44.00)	1:1.80	1:1.56
5.	Groundnut	Jaipur	24,871 (18.09)	13,250 (9.46)	1:2.07	1:0.51
6.	Mustard	Gurgaon	37,818 (21.01)	31,356 (17.72)	1:2.97	1:2.56
7.	Cabbage	Banglore	81,750	–	1:2.89	1:2.60
8.	Tomato	Banglore	3,01,571 (74.38)	1,84,382 (45.56)	1:4.82	1:0.61

Source: Validated IPM technology for selected crops
* Values in parameters are yield q/ha
** FP = Farmers practices

Table 2: Performance of IPM approaches in cotton in the country

Zone	Area) (ha	% of reduction of pesticide use	Seed cotton yield kg/ha		Net return Rs./ha		CB ratio	
			IPM	FP**	IPM	FP	IPM	FP
North zone	145	58.58	1678	1319	24135	15004	3.73	2.41
Central zone	315	69.09	1423	1192	19828	15627	3.24	2.77
South zone	192	51.44	1314	1051	18351	12557	3.94	2.47
Total/Average	652	59.70	1472	1187	20771	14396	3.64	2.55

** FP = Farmers practices
Source: validated IPM technology for selected crops

farmers, analysis of the cropping system, pest problems and historical data to identity the key pest problems. Based on available information and farmer's practice IPM modules are synthesised which are expected to be ecofriendly as well as farmers friendly. Community participation is necessary for the success of IPM.

National Centre for Integrated Pest Management (NCIPM) has been endowed with mandated responsibilities of validation and promotion of IPM Technology in important crops which are the Principal crops interms of economy and pesticide consumption viz; cotton, rice and vegetables that consume 80 percent of the total pesticides used in the country.

The centre has validated IPM technology and worked out the cost benefit ratio for some important crops viz; rice, wheat, pulses, oilseeds and vegetables (Table-1 and 2).

It is very clear from the above tables that IPM not only ensures better economic return to the farmers but also helps in maintaining environment by minimizing pollution resulting from the use of chemical pesticides. Hence, whole hearted concentrated efforts are needed at all levels to popularize the IPM at ultimate farmers' level.

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