Madras Agric. J., 97 (4-6): 180-184, June 2010
https://doi.org/10.29321/MAJ.10.100376

Economics of Pest Control and Adoption of IPDM Practices in Major Pesticide Consuming Crops in Tamil Nadu

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The need for pesticide free agriculture is multidimensional. But alternative pest control technologies available at present are not very successful and popular among the farmers in different production environments and across crops. Hence this study estimates the awareness and adoption of integrated pest and disease management practices in major pesticide consuming crops in Tamil Nadu. Through a multi stage sampling procedure data were collected from 360 randomly chosen farmers growing the major pesticide consuming crops namely cotton, paddy, chillies, groundnut and vegetables (tomato and brinjal) in their major production centers. The results indicate as a share in total cost the plant protection expenditure was around 15 per cent in brinjal and tomato, 12 per cent in cotton, seven per cent in chillies, six per cent in groundnut and four per cent in paddy. There was significant gap between awareness and adoption of IPM practices for different crops. In paddy cultivation farmers' awareness on the different recommended practices ranged from 20 to 100 per cent but adoption was relatively low and it ranged from 0 to 60 per cent for different IPM practices. In cotton, IPM practices with very low adoption rate were collection and destruction of larvae, application of recommended dose of nitrogen, use of pheromone traps and light traps, application of NPV baits, parasitoid card and synchronized sowing. In groundnut there was zero adoption in five IPDM technologies. In chillies adoption ranged from 23 to 97 per cent for different technologies. In vegetables, adoption was 100 per cent in few technologies while there was zero adoption in many technologies.

Key words: Pesticide Consumption, Cost of Pest Control, Awareness, Adoption and Integrated Pest and Disease Management (IPDM)

Use of pesticides in India began in 1948 when DDT was imported for malaria control and BHC for locust control. Consumption of technical grade pesticide increased from 94 g/ha in1965-66 to 349 g/ha in 1974-75 (Chand and Birthal,1997) and there after, pesticide consumption kept on increasing till 1990-91 but at a slower rate and since 1991-92 it has been declining. During 1998-99, it was about 275 grams (Birthal *et al.,* 2000). In the last ten year period from 95-96 to 04-05, the consumption of insecticides and fungicides registered a negative growth of -3.99 and -3.12 per cent per annum respectively. But weedicides registered a positive growth of 0.33 per cent in this period. This may be due to the increasing labour cost for weeding operations for crops. The reason for the reversal of trend in pesticide use could be due to development of resistant crop cultivars and development of more efficient pesticide molecules, which require in small quantities for a given level of pest control. While 40 years ago pesticides were applied in bulk of active ingredient per hectare, modern pesticides, with sophisticated technology, only require grams or milliliters to achieve the same or better result. India is currently the largest manufacturer of Pesticides in Asia, second only to Japan. In 1958, India was producing over 5000 metric tonnes of pesticides and production has increased to approximately 85,000 metric tonnes (Gupta, 2004). Many of the pesticides commonly sold in developing countries are extremely hazardous chemicals that are banned or restricted for use in developed countries (Pingali and Roger, 1998). A study by Chandrasekaran *et. al.*(1997) confirmed that 89 per cent of the vegetables studied were contaminated with residues of insecticide last sprayed and about 14 per cent of these had residues above their respective maximum residue limits level. Pesticide policies and regulations are in their infancy in many developing countries and, as a result, pesticide misuse is prevalent (Tjornhom, *et al.,* 1997). Concerns about health and environmental effects associated with pesticide use were raised in many quarters. Evidence of pesticide threat to human health and of the tradeoff between health and

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economic effects have been documented in recent studies (Pingali, *et al.,* 1994; Antle and Pingali, 1994; Pingali and Roger 1995). To address these concerns, the focus of plant protection research gradually shifted towards development of alternative methods of pest control to reduce pesticide use in agriculture like Integrated Pest Management (IPM). IPM is a pest management strategy, which uses a combination of methods like thresholds, forecasts, chemical, biological, cultural methods etc., to achieve environmentally safe and economically feasible alternative to chemical control of pests. Bio-agents and bio-pesticides are the important components in the IPM strategy. The case for moving towards pesticide free agriculture is thus multidimensional. But alternative pest control strategies available at present are not very successful and popular among the farmers in different production environments and across crops. In this context this study estimates cost of pest control and awareness and adoption of integrated pest and disease management practices in major pesticide consuming crops in Tamil Nadu.

Materials and Methods

A survey was conducted during 2005-06 for data collection, in Tamil Nadu on the major pesticide consuming crops of cotton (irrigated), paddy, chillies (irrigated), groundnut (irrigated), and vegetables (tomato and brinjal).

Table 1. Sampling distribution

Crop	District	Block	Village	No. of Farmers
Paddy	Thanjavur	1.Thanjavur	1.Vayaloor	15
			2.Ramapuram	15
		2. Papanasam	1. Saliyamangalam	15
			2. Kovilur	15
Cotton	Erode	1.Dharapuram	1.Chinnaputhur	15
			2.Kundadam	15
		2.Bhavani	1.Ammapettai	15
			2.Boodhapadi	15
Chillies	Virudunagar	1.Kariapatti	1.Aviyur	15
			2. Melathulukanamkulam	15
		2.Thiruchuly	1.Karisal kulam	15
			2.Aaladipatti	15
Groundnut	Thiruvannamalai	1.Thandarampet	1. Radhapuram	15
			2. Thenmudianur	15
		2.Thurinjiapuram	1. Mallavadi	15
			2. Nayudamangalam	15
Tomato	Dharmapuri	1.Nallampalli	1.Santhanurankottai	15
			2. Jarugu	15
		2. Dharmapuri	1.Adagapadi	15
			2.Sakkarapatti	15
Brinjal	Salem	1. Veerapandi	1.Puthuragragaram	15
			2. Seeragapadi	15
		2.Kolathur	1.Kovilpalayam	15
			2. Chinnathanda	15
			Total	360

A multi stage sampling procedure was adopted for selection of respondents for field survey. In the first stage, the districts were selected based on the average area of each of these crops for the triennium ending 2001-02. Accordingly, the districts of Thanjavur (paddy), Erode (cotton), Virudunagar (chillies), Thiruvannamalai (groundnut), Dharmapuri (tomato) and Salem (brinjal) were selected. From each district two blocks with major area under the selected crops were chosen and in third stage two villages were selected at random from each block. Thus data were collected from 60 randomly chosen farmers of each of these six crops in the major production centres, aggregating to a total sample of 360 respondents (Table 1). The data was collected through survey method. The important variables covered for data collection included different types of inputs used, alternative methods of pest management, socio-economic variables etc.

Awareness and adoption indices

An awareness index (AWI) and an adoption index were constructed from the per cent of awareness and adoption of various recommended IPM measures (ith number of measures) as follows.

$$AWI = (\sum_{i=1}^{n} AWi) / n$$

Where

AWI - Awareness Index

AWi - Per cent of awareness of ith IPM measure, i = 1, 2 …., n

$$ADI = (\sum_{i=1}^{n} ADi) / n$$

Where

ADI - Adoption Index

ADi - Per cent of Adoption of ith IPM measure, i = 1, 2 …., n

These indices give an overall picture about the awareness and adoption of IPM measures in the selected crops.

Table 2. Total cost of pest control measures

Crop	Chemical Cost	Application Cost	Total Cost of cultivation	Per cent to total cost
Paddy	443.43	74.36	517.79	3.71
Cotton	2390.28	392.62	2782.9	12.12
Groundnut	710.67	213.07	923.74	5.63
Chillies	685.20	267.68	952.88	6.76
Brinjal	4812.69	621.48	5434.17	14.52
Tomato	3636.87	585.71	4222.58	14.68

Results and Discussion

Cost of pest control in the selected crops

The relative importance of pest control expenditure among the major pesticide consuming crops in Tamil Nadu is presented in Table 2. In absolute terms the expenditure on pesticides was highest in brinjal fallowed by tomato, the two important vegetables. Plant protection expenditure in these vegetables were Rs. 5434 in brinjal and Rs. 4223 in tomato. In Cotton the total plant protection expenditure was Rs. 2783 per ha.

Table 3. Awareness and adoption levels of IPDM practices in paddy

Particulars	Per cent (n=60)	Per cent (n=60)
Resistant Variety	100.00	100.00
Seed Treatment	100.00	11.67
Trimming and Plastering	100.00	100.00
Clipping off	60.00	0.00
Recommended spacing	81.67	55.00
Flooding Field-army worm thrips control	40.00	5.00
Alternate wetting & drying	36.67	0.00
Bund crops	41.66	16.67
Avoiding excess Nitrogen	68.33	30.00
Keeping field free from weeds	100.00	83.33
Leaving rogue space	100.00	85.00
Use of Bio-Pesticide	21.67	0.00
Use of Pheromone trap	31.67	0.00
Use of trap crop	25.00	0.00
Use of Light trap	50.00	0.00
Collection & destruction	60.00	5.00
ETL based application	36.66	8.00
Application Time	96.67	70.00
Non spraying during rain/high wind	80.00	46.67
Soaking Seeds over night & sun drying	20.00	0.00
Mechanical control	91.67	56.67

Table 4. Awareness and adoption levels of IPDM practices in cotton (Irrigated)

Particulars	Per cent (n=60)	Per cent (n=60)
Resistant Variety	100.00	78.33
Timely sowing	100.00	85.00
Seed Treatment	100.00	100.00
Synchronized sowing	26.67	16.67
Recommended spacing	50.00	35.00
Water management	95.00	76.67
Earthing up	100.00	100.00
Weeds free fields	100.00	86.67
Recommended nitrogen	23.33	3.33
Sowing same variety	41.66	0.00
Collection & destruction	38.33	0.00
Use of light traps	55.00	8.33
Use of Pheromone trap	41.67	3.33
Use of trap crop	66.67	0.00
Use of border crop	96.67	73.33
ETL based insecticide application	40.00	35.00
Time of spraying	81.67	73.33
NPV	16.67	6.67
Bio pesticides /Parasitoid card	45.00	10.00
Avoiding ratoon crop	100.00	98.33

In ground nut and chillies the expenditure is almost same and it is lowest in paddy at Rs. 518 per ha. As a share in total cost the plant protection expenditure was around 15 per cent in brinjal and tomato, 12 per cent in cotton, seven per cent in chillies, six per cent in groundnut and four per cent in paddy. The use of pesticides results in both higher

Table 5. Awareness and adoption levels of IPDM practices in groundnut (Irrigated)

Particulars	Per cent (n=60)	Per cent (n=60)
Summer ploughing	100.00	97.67
Seed Treatment (Rhizobium, P.flourescens, T.viridae)	91.67	48.33
Time of sowing (July to avoid leaf spot)	25.00	5.00
Keeping the field weed free	95.00	95.00
Collection and destruction of egg masses and insects	96.67	58.33
Growing lab lab as intercrop	100.00	90.00
Growing castor as border or intercrop	96.67	51.67
One row of cowpea for every 5 rows of ground nut	83.33	36.67
Intercrop ground nut + cumbu in 4:1 ratio)	20.00	13.33
Use of light trap	26.67	0.00
Use of NPV	0.00	0.00
Use of bio pesticides	98.33	1.67
Use of Pheromone traps	30.00	0.00
Use of light trap	26.67	0.00
ETL based insecticide application	23.33	0.00
Use of baits for Spodoptera control	0.00	0.00
Time of spray	100.00	100.00

Table 6. Awareness and adoption levels of IPDM practices in chillies (Irrigated)

Particulars	Per cent (n=60)	Per cent (n=60)
Resistant Variety	66.67	45.00
Timely sowing	100.00	95.00
Seed Treatment	60.00	13.33
Recommended spacing	95.00	73.33
Water management	100.00	78.33
Earthing up	100.00	96.67
Fields free from Weeds	96.67	78.33
Plant Growth Regulators	63.33	16.67
Recommended Fertilizer dosage	91.67	61.67
Collection & destruction	75.00	60.00
Use of Psuedomonas fluorescenes	0.00	0.00
Use of Bacillus thuringensis	35.00	0.00
Use of maize/ sorghum as inter crop	26.67	8.33
Use of pheromone trap	0.00	0.00
Use of poison bait	0.00	0.00
NPV	31.67	0.00
Bio PC/Parasitoid card	60.00	0.00
ETL based insecticide application	40.00	23.33
Time of spraying	85.00	55.00

cost of production and externalities. While it ensures private benefit to the extent of production risk due to pests, still the social costs of externalities are largely left out. The significant share of plant protection expenditure in total cost emphasis the need for alternative strategies for pest control.

Table 7. Awareness and adoption levels of IPDM practices in brinjal

Particulars	Per cent (n=60)	Per cent (n=60)
Resistant Variety	100.00	75.00
Timely planting	100.00	68.33
Seed Treatment	66.67	38.33
Adopting Recommended Space	75.00	71.67
Water Management	76.67	73.33
Earthing Up	98.33	75.00
Weed Free Field	75.00	70.00
Recommended Application of Fertilizers	73.33	45.00
Removal of infected shoots	68.33	43.33
Collection and Destruction of Egg masses	65.00	43.33
Application of Psuedomonas flouroscens	0.00	0.00
Neem Oil	55.00	28.33
Neem Seed Extract	0.00	0.00
Teepol	16.67	0.00
ETL Based application	25.00	13.33
Time of Spraying of the insecticide	100.00	73.33

Awareness and adoption levels of IPM practices

Integrated Pest Management (IPM) is a pest management approach that can help reduce use of pesticides in agriculture, lower production costs and improve long-term sustainability of the agricultural system. The research system in the country developed number of IPM techniques for transferring to the farmers' field. These technologies were adopted at varying degrees at field level. In paddy 21 recommended IPM practices were included in the study (Table 3). While farmers' awareness on the different recommended practices ranged from 20 to 100 per cent, adoption ranged only from 0 to 100 for different IPM practices. All the farmers were aware of the practices like growing resistant variety, seed treatment, trimming and plastering of bunds, keeping the field free from weeds and leaving rogue space. Of these, more than 80 per cent of farmers adopted practices like growing resistant variety, trimming and plastering of bunds, keeping the field free from weeds and leaving rogue space. Practices which were not adopted in the field include clipping off, alternate wetting and drying, use of bio pesticides and use of trap crop and light trap.

Table 8. Awareness and adoption levels of IPDM practices in tomato

Particulars	Per cent (n=60)	Per cent (n=60)
Resistant Variety	100.00	100.00
Timely sowing	100.00	88.33
Seed treatment	100.00	88.33
Adopting recommended spacing	63.33	35.00
Proper water management	60.00	56.67
Earthing up	100.00	100.00
Keeping the field free from weeds	100.00	85.00
Recommended dose of fertilizers	100.00	46.67
Collection and destruction of egg masses,larvae	100.00	76.67
Spraying Bacillus thuringiensis	0.00	0.00
Application of Pseudomonas fluorescens	0.00	0.00
Use of pheromone traps	0.00	0.00
Use of light traps	16.67	0.00
Growing marigold	0.00	0.00
Use of parasitoid card	0.00	0.00
Use of yellow sticky trap	46.67	0.00
Use of NPV	0.00	0.00
Use of neem oil	100.00	0.00
Use of Neem seed kernel extract	20.00	0.00
Use of teepol	100.00	0.00
Use of baits for Spodoptera	0.00	0.00
ETL based application	28.33	15.00
Time of spray	100.00	100.00

In cotton the per cent of awareness of IPM measures ranged from 17 to 100 for different measures and adoption ranged from 0 to 100 (Table 4). The most widely adopted IPM measures were seed treatment and earthing up with cent per cent adoption. Other important IPM measures with large scale adoption included avoidance of rattoon crop, weed free fields, timely sowing, growing resistant variety, water management, right time of spray and growing border crops. IPM practices with no adoption were sowing same variety and collection and destruction of larvae. Other measures with very low adoption include application of recommended dose of nitrogen, use of pheromone traps and light traps, application of NPV baits and parasitoid card and synchronized sowing.

The important IPM measures in which farmers' had cent per cent awareness in groundnut cultivation were summer ploughing, growing lab-lab as inter crop and adoption in these practices were 98, 90 and 98 per cent respectively (Table 5). The IPM practices with no adoption or very low adoption were use of pheromone traps and light traps, ETL based application, use of baits and bio pesticides, adjusting the time of sowing to avoid leaf spot and inter cropping. More efforts are needed to popularize these techniques in pest management.

Table 9. Awareness and adoption Indices

Crops	AWI	ADI
Paddy	63.89	32.50
Cotton	65.92	44.50
Groundnut	61.85	38.67
Chillies	59.30	37.10
Brinjal	62.19	44.89
Tomato	53.70	34.42

In chillies farmers were fully aware of methods like water management, earthing up and timely sowing. The levels of adoption in these techniques were 78 per cent, 97 per cent and 95 per cent respectively (Table 6). The other important measures adopted in large scale were keeping the fields free of weeds, following recommended spacing and fertilizer dose, and correct time of spraying. Practices with very low adoption rate were use of pheromone traps, poison and NPV baits; inter cropping, and ETL based pesticide application.

In brinjal, the awareness level for practices like growing resistant varieties, timely planting and time of spray of insecticides was cent per cent (Table 7). The practices which had very low awareness levels were application of Pseudomonas flouroscens, neem seed extract, teepol and economic threshold based application and adoption was also poor in these practices. Practices with very high adoption were earthing up, growing resistant varieties, water management, and adoption of recommended spacing.

In tomato there were 21 IPM practices recommended for pest management practices and out of this, only eight practices had an adoption rate of more than 50 per cent (Table 8). There was absolutely no adoption in at least half of the recommended practices. This indicates the failure in transfer of technology and/or constraints in adoption of IPM measures.

Awareness and adoption indices of IPM measures

The indices for awareness and adoption are given in table. 9. The awareness indices varied from 54 to 64 indicating a gap in awareness of IPM technologies. The adoption indices varied from 34 to 45, which shows only less than half of the technology generated, was adopted in the field.

IPM practices are the most important component in scientific pest management. For several years, increased attention has been focused on integrated pest management (IPM) programs to reduce pesticide use in agriculture because of food safety issues, groundwater contamination, and increased environmental awareness. As the results indicate, the adoption rate of IPM practices is not encouraging. In many cases, the inputs required for IPM practices were not readily available to farmers. Another important factor for non adoption was the multiplicity of recommendations which farmers find it difficult to adopt in an increasingly labor scarce environment. More agronomical and entomological research is required to single out the most efficient practices in terms of pest management and to pursue those practices rigorously.

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Received: December 12, 2009; Accepted: June 20, 2010