Agricultural Economics Research Review
Vol. 19 (Conference No.) 2006 pp 155-164

Constraints in Adoption of Bio-input Usage in Cotton Cultivation

K.R. Sundaravardarajan[1], K.R. Jahanmohan[2] and L.P. Swaminathan[3]

Abstract

Constraints in adoption of biological inputs usage in cotton cultivation of Tamil Nadu have been identified. Among the reasons for non-adoption of bio-inputs, long-term practice has been considered as the important factor by the non-adopters (mean score, 67.18) and lack of adequate extension as the second important factor (mean score, 62.15). The probability of adoption of bio-inputs has been estimated by the multinominal logit model which has been found significant at one per cent level, based on the log-likelihood ratio test. The model has correctly predicted 78 per cent of the adopters and non-adopters. The analysis has indicated that the farmers' perceptional characteristics are positively and significantly related to the adoption of bio-inputs, whereas storage and handling is negatively related to the adoption. Among the suggestions for enhanced bio-inputs usage, extension of subsidy has been considered as the prime suggestion by the farmers (mean score, 66.21). Cotton crop has inelastic calendar of operations, and the pest management operations are highly time bound and any delay in the availability of biological inputs would seriously hamper its adoption. Hence, the timely availability has been regarded as the second important suggestion by the farmers (mean score, 63.75).

Introduction

The traditional practices of nutrient and pest management have become obsolete because of the immediate result and knock-down effect of chemicals. But, to practise agriculture in accordance with nature warrants reduced use of chemicals and increased use of natural or biological inputs.

[1]Professor and Head, Department of Agricultural Economics, Faculty of Agriculture, Annamalai University, Annamalai Nagar 608 002, [2]Assistant Professor (Agrl. Econ.) and [3]Former Professor and Head, Department of Agricultural Economics, CARDS, Tamil Nadu Agricultural University, Coimbatore 641 003, Tamil Nadu.

Authors are thankful to the referee for his suggestions.

Owing to its inherent deficiencies, biological sources cannot be regarded fully reliable and can act as effective supplements to the chemical sources in crop management. Hence, conjunctive use of chemicals with bio-inputs like bio-fertilizers, bio-pesticides and organic sources of nutrients have been contemplated.

Farmers would like to return to pesticide-free farming but they need to regain their knowledge of alternative pest control methods. They are unwilling to take risk unless their income is guaranteed against possible lower yields during the transition period. Under the plant protection scenario, the procurement of bio-control agents will have indirect competition with pesticides and could succeed if prices were competitive. In the context of globalization and economic reforms, the private sector will play a crucial role in the production and marketing of bio-control agents. A sound economics should therefore be worked out for justifying the judicious use of bio-inputs in agriculture (Crissman and Cole, 1994; Fernandez Cornejo and Jans, 1995).

Under this scenario, a study was conducted to quantify the extent and usage of bio-inputs and to suggest an appropriate mix of chemicals and biological inputs, which would augment the yield without any environmental or social hazard. It is often asserted that the negative efforts of these chemicals in agriculture have resulted in increased awareness in the use of bio-inputs in agriculture during the recent years, which has reduced the ecological degradation. In this study it has been planned to empirically examine this hypothesis by studying the trend in the use of bio-inputs and economics of usage of bio-inputs by the farming community. The specific objectives of the study were: (i) to quantify the existing use of bio-inputs in agriculture and form a technology adoption index, (ii) to identify the constraints in adoption of bio-input usage in principal crops, (iii) to work out the economics of bio-input usage, and (iv) to suggest measures for enhanced use of bio-inputs.

Methodology

For the study, the state of Tamil Nadu was divided into seven agro-climatic regions, viz. north-eastern, north-western, western, Cauvery delta, southern, high rainfall and hill-area zones. Amongst these seven zones, southern zone was purposively selected owing to its predominant cotton cultivation. The farmers were classified into two categories of adopters, and non-adopters. A sample of 60 farmers (30 adopters and 30 non-adopters) per zone was interviewed with the help of well-structured, pre-tested interview schedule. Multistage stratified sampling procedure was employed for drawing samples. In this zone, one district and one taluk with highest area under rice were purposively selected. In each selected taluk, six villages were selected randomly and a sample of five households in each category were selected randomly in the selected villages. The data on socio-economic indicators, area of operational holding, area under the principal crop, extent of usage of biologicals in farming, constraints in adoption and other related information were collected. The percentage analysis was resorted to find out the dosage of different bio-fertilizer cultures, and per cent reduction in chemical fertilizers due to usage of bio-fertilizers.

Garrets's ranking technique was used to analyze the major sources of information about bio-inputs, reasons for not using bio-fertilizer culture by the non-adopters, reasons for preferring bio-control methods to chemical control methods, problems encountered in adopting various bio-control methods of pest management and suggestions for improvement of the bio-input usage. The order of the merit assigned by the farmers was converted into ranks using Eq. (1):

$$\text{Per cent position} = \frac{100\,(R_{ij} - 0.5)}{N_j} \qquad \ldots(1)$$

where,

R_{ij} = Rank given for the ith factor by the jth farmer, and

N_j = Number of factors ranked by the jth farmer.

By referring to Garret's table, the per cent position estimated were converted into scores and then for each factor, the scores of various respondents were added and the mean value was calculated. The factor with the highest mean value was considered to be the most important reason.

Within the logit framework, it was postulated that the probability of adoption of bio-inputs depends upon the attributes like age, education, experience in farming, family size, family labour ratio and product price and farmer's perception about the toxicity of chemicals in agriculture.

The index variable Z_i indicates whether the farmer adopts bio-inputs or not, and the function of these attributes was expressed as per Eq. (2):

…(2)

where, Z_i takes the value 1 if the farmer adopts bio-inputs, 0, otherwise

The personal characteristic variables, viz. age (AGE) (in years), education (EDN) (schooling years), farming experience (EXP) (in years) were provided as explanatory variables in Eq. (2). Apart from these variables, farmers' perceptional characteristics like 'access to bio-inputs' (AB), 'sources on information on bio-inputs' (SI) and 'awareness on health hazards' (HH) were included in the model.

Results and Discussion

Years of Usage of Bio-fertilizers for Cotton

The usage of bio-fertilizers over a period of time is important for its sustained adoption for it favours to build up inoculums in the field and the data collected on these aspect have been presented in Table 1.

The southern zone experienced a near uniform pattern in all the three categories of years of usage of bio-fertilizers. Under the other category of bio-fertilizers, viz.. VAM (vasicular arbusicular micohorriza) was used by 10 per cent of the adopters and the use years were less significant (<5 years).

Dosage of Different Bio-fertilizer Cultures in Cotton Cultivation

The usage of appropriate dose of bio-fertilizer is considered indispensable for maintaining the efficiency of the strains and hence, the data on the dosage used by the adopters and deviation from the recommended dosage were worked out and the results have been recorded in Table 2.

The usage of azospirillum among the adopters of cotton crop in the southern zone exhibited more or less equal degree in all the three categories,

Table 1. Years of usage of bio-fertilizers for cotton

(in percentage)

Bio-inputs	Southern zone		
	< 5	5 - 10	> 10
Azospirillum	16.67	36.66	46.67
Phospho-bacteria	36.67	33.33	30.00
Others	10.00	-	-

Table 2. Dosage of different bio-fertilizer cultures

(in percentage)

Bio-inputs	Southern Zone		
	Low level	Recommended level	Higher level
Azospirillum	36.67	33.33	30.00
Phospho-bacteria	70.00	30.00	-
Others	10.00	-	-

viz. low, correct and high dosages. But, this phenomenon failed to exist in the case of phosphobacteria and a larger section of adopters (70%) was found to apply at levels lower than the recommended level. The adoption and usage of these bio-fertilizers, especially azospirillum favoured the crop growth in a sustained manner, i.e. uniform and long lasting green with adequate succulence in the leaves attracts pests of cotton crop in a lesser magnitude as compared to the crops with chemical fertilizer usage. Hence, the adopters considered the above sources of biological nutrient management as a potential tool for cost reduction in cotton cultivation.

Reduction in Chemical Fertilizers due to Usage of Bio-fertilizers

The data on the reduction of chemical sources of fertilizers, especially nitrogen and phosphorus due to the usage of biological sources were collected and were grouped under three classes, viz. <10 per cent, 10 to 20 per cent and >20 per cent of their normal fertilizer schedule. The details of the percentage analysis are given in Table 3.

In the southern zone, near equitable distribution was noticed in all the three scales of chemical fertilizer reduction among the adopters. Nearly 37 per cent of the adopters opted for cut by more than 20 per cent of their normal chemical manurial schedule for cotton crop, whereas only 33.33 per cent of the adopters expressed their concurrence for reducing the chemical sources of nitrogen fertilizers by less than 10 per cent. There existed adequate awareness about the beneficial effects of biological sources of N fertilization and adopters had perceived that sustained use of bio-fertilizers would reduce the repeated occurrence of pests and reduction of excessive succulence in the cotton leaves could be the reason for this phenomenon. The response for reduction in phosphatic fertilizers was meagre and 86.67 per cent of the farmers did not opt for reduction in chemical phosphatic sources by more than 10 per cent of their normal fertilizer schedule.

Reasons for Non-usage of Bio-fertilizer Cultures by Non-Adopters

The reasons that hindered the adoption of bio-fertilizers by the non-adopters were ranked and the results have been presented in Table 4.

Table 3. Percentage reduction in chemical fertilizers due to bio-fertilizer usage

(in percentage)

Chemical fertilizers	Southern zone		
	<10	10-20	>20
Nitrogenous fertilizers	33.33	30.00	36.67
Phosphatic fertilizers	86.67	13.33	-

Table 4. Reasons for non-adoption of bio-fertilizer cultures by non-adopters

Sl No.	Particulars	Southern zone	
		Mean score	Rank
1.	Non-awareness	34.52	IX
2.	Lack of adequate extension practices	62.15	II
3.	Lesser impact than chemical fertilizers	60.63	III
4.	Long-term practice	67.18	I
5.	Non-availability in all the major outlets	53.74	V
6.	Lack of sufficient training	54.70	IV
7.	Storage and less shelf-life	38.62	VIII
8.	Cumbersome application methods	50.82	VI
9.	Lack of technical labour	50.82	VI

In the southern zone, long-term practice was considered as the important factor for non-usage bio-fertilizers for nutrient management in the cotton crop, as perceived by the non-adopters (mean score, 67.18). Cotton being a commercial crop, farmers expected a higher concentration of the extension functionaries but the actual situation was not in accordance with their demands and hence, the lack of adequate extension was considered as the second important factor for not using the bio-fertilizers (mean score, 62.15). The lesser impact of bio-fertilizers than of the chemical fertilizers was the next reason for their non-adoption (mean score, 60.63). The problem of unawareness was given the least importance (ninth reason) as the farmers were cultivating a highly rewarding commercial crop, viz. cotton.

Reasons for Preferring Bio-control Methods to Chemical Control Methods

The reasons for preferring the biological control methods to the conventional chemical control methods were ranked as per the adopters' preference and the results are presented in Table 5.

Cotton crop grown in vast tracts in the Southern Zone, by virtue of its nature, needs more pesticides and labours for application. Farmers in this zone have opted for bio-control agents as they could save the labour and accordingly, they ranked it as the prime reason (mean score, 71.54) for selecting it over chemical pesticides. Similarly, the heavy dosage of pesticide application which posed a big threat to the environment, could be very well reduced by this method and hence, it was ranked as the second reason (mean score, 62.48). Resurgence and resistance to pest was a common problem in cotton economy, since the application of bio-control methods can have positive impact and reduce its effort in the long-run, the adopters ranked it as the third reason (mean score, 57.83) for preferring it. Health hazard

Table 5. Reasons for preferring bio-control methods

Sl No.	Reasons	Southern zone	
		Mean score	Rank
1.	Cost effectiveness	42.46	VI
2.	Labour-saving technology	71.54	I
3.	Better control in the long-run	37.21	VII
4.	Increase in beneficial insect population	50.27	V
5.	Reduced pollution	62.48	II
6.	Reduces pesticide resurgence and resistance	57.83	III
7.	Less health hazards	54.94	IV

could be lowered by opting bio-control agents and the farmers therefore, considered it also as an important reason.

Problems Encountered in Adopting Various Bio-control Methods

The constraints in adopting the bio-control methods of pest management were ranked and farmers' preferences were calculated; the results have been presented in Table 6.

In the study area, the less perceptible impact of bio-control agents over chemical control measures was encountered as the prime reason with a mean score of 61.54. Cotton crop, known for pest incidence and frequent applications by the non-adopters, could have forced the adopters to conceive it as the most important one. Lack of adequate training and usage of bio-control agents in cotton crop require specific demands and hence it was ranked as the second reason (mean score, 60.07). Non-availability of these inputs in time was considered as the third problem with a mean score of 53.22.

Implications of Logit Model on Bio-inputs Adoption

The extent of adoption of biological inputs is influenced by both economic and social factors. Normally, probability models are employed to understand

Table 6. Problems encountered in adopting various bio-control methods

Sl No.	Reasons	Southern zone	
		Mean score	Rank
1.	Non-availability in time	53.22	III
2.	Lack of adequate training	60.07	II
3.	Complicated technology	49.27	IV
4.	No perceptible immediate control	61.54	I
5.	Problems in storage and handling	43.22	V

socio-economic factors determining the extent of adoption of bio-inputs. In this study, multi-nominal logit model was employed to assess the probability of overall extent of adoption of bio-inputs by the farmers. Besides, the farmers' subjective assessment of bio-inputs characteristic features were included as AB (availability of bio-inputs), PI (perceptible impact of bio-inputs) and HH (storage and handling problems of bio-inputs) in Eq. (2).

The model (Table 7) has been significant at one per cent level based on the log-likelihood ratio test. The model correctly predicted 78 per cent of the adopters and non-adopters. The analysis indicated that the following farmers' perceptional characteristics were positively and significantly related to the adoption: availability of bio-inputs and perceptible impact whereas, storage and handling was negatively related to the adoption. Education and size of the farm were significant in explaining the adoption decisions in the southern zone.

Suggestions for Improvement in the Usage of Biological Inputs

The adopters were asked to rank the different suggestions for improvement in the usage of biological inputs and it was subjected to Garret's ranking technique. The results of the analysis are given in Table 8.

Table 7. Non-linear estimates of bio-inputs adoption in southern zone (cotton)

Sl No	Variables	Estimates
1.	Constant	9.36 (1.08)
2.	Age (years)	0.75 (1.17)
3.	Education (schooling years)	0.82* (1.62)
4.	Farming experience (years)	4.36 (2.10)
5.	Farm size (ha)	0.65** (3.03)
6.	Bio-fertilizer (in Rs)	1.32 (1.05)
7.	Availability (binary)	0.49* (0.76)
8.	Perceptible impact (binary)	0.84*** (2.12)
9.	Storage and handling (binary)	-13.32* (36.25)
	Log-likelihood ratio	14.02 (10.25)
	Count R^2	0.78

Note: Figures within the parentheses are asymptotic 't' ratios with respect to log likelihood ratio denoting χ^2 value

***$P < 0.01$ (two-tailed test)

**$P < 0.05$ (two-tailed test)

*$P < 0.1$ (two-tailed test)

Table 8. Suggestions for improvement in the usage of bio-inputs in the study area

Sl No.	Suggestions	Southern zone	
		Mean score	Rank
1.	High virulent and native specific cultures	55.48	III
2.	Extension of subsidy	66.21	I
3.	Enhanced shelf-life	53.22	IV
4.	Adequate training	48.23	VI
5.	Timely availability	63.75	II
6.	Widespread extension	50.40	V
7.	Private sector production	44.51	VIII

In the cotton tracts of southern zone, extension of subsidy was considered as the prime suggestion by the farmers (mean score, 66.21). Cotton being a high input-demanding crop, could have motivated them for selecting this suggestion as a prime one. Cotton crop has inelastic calendar of operations, and the pest management operations are highly time-bound and any delay in the availability of biological inputs would seriously hamper its adoption. Hence, the timely availability has been regarded as the second important suggestion by the farmers (mean score, 63.75). High virulent and native specific cultures would obviate the chemical inputs usage to a sizeable extent and it was given the third suggestion for enhanced usage of biological inputs in the cotton cultivation (mean score, 55.48). Since, the private sector production could not reach the farmers to the desired extent, the importance of the sector was not perceived by the farmers and it was kept as the last suggestion (mean score, 44.51).

Reference

Cornwell, J., (1995) *Risk Assessment and Health Effects of Pesticides Used in Tobacco Farming in Malaysia, Health Policy and Planning* (United Kingdom), 10 December, pp.431-437.

Crissman, C. and D. Cole, (1994) Economics of pesticide use and farm worker health in education potato production, *American Journal of Agricultural Economics,* **16**(August): 593-597.

Damodar N. Gujarati, (1992) *Basic Econometrics*, New York: Mc Graw Hill Book Company.

Dhaliwal, G.S. and Balwinder Singh (Eds), (1993) *Pesticides: Their Ecological Impact in Developing Countries*, New Delhi: Common Wealth Publishers.

Fernandez Cornejo, J. and S. Jans, (1995) The economic impact of IPM adoption for orange producers in California and Florida, *Acba Horticulture,* **(429):** 325-334

Forget, G. Goodman and A. de Villiers, (1993) Impact of pesticide use on health in developing countries, *Proceedings of a Symposium* held in Ottawa, Canada, 17-20, Sept.1990. Ottawa: International Development and Research Centre.

Gandhi, Vasant P. and N.T. Patel (1997) Pesticides and the environment: A comparative study of farmers' awareness and behaviour in Andhra Pradesh, Punjab and Gujarat, *Indian Journal of Agricultural Economics*, **52(3):** 519-529.

Pastakia, Astad R., (1996) Groos toots innovations for sustainable development: A case of agricultural pest management, *Ph.D. Dissertation*, Indian Institute of Management, Ahmedabad (unpublished).