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Research Paper

Economic Impact of Practicing IPM And INM Technology in Paddy (Basmati) Crop in Haryana

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ABSTRACT

The research work was carried out with the objective to estimate the cost and returns in cultivation of paddy (basmati) in IPM-INM and CPM farms in Haryana. Information was extracted from 120 farmers by using well-structured interview schedule through survey method. Firstly four districts was purposively selected then one block was selected randomly from each district and from each block, 20 IPM-INM farmers and 10 CPM farmers were surveyed. The overall findings revealed that the total cost of cultivation for IPM-INM technology in paddy (₹ 110574ha^{-1}) was somewhat greater than CPM paddy (₹ 106456 ha^{-1}), the per quintal cost of production of IPM-INM paddy (₹ 2197) which was lower as compared to its CPM (₹ 2300), mainly due to higher productivity of IPM-INM (50.33 q/ha) paddy than the CPM (46.29 q/ha). The gross returns from IPM-INM and CPM farm was estimated to ₹ 138854 and ₹ 127927 per hectare respectively. As indicated by B:C ratio over variable cost of 2.73:1 for IPM-INM and 2.45:1 for CPM. Therefore, the cultivation of paddy was found to be more profitable with the adoption of IPM-INM technology, which is sustainable in every aspect.

Highlights

- Adoption of IPM and INM technology by Paddy (Basmati) growers proved more beneficial in terms of economic as well as environment aspects.

Keywords: Integrated pest management, Integrated nutrient management, B:C ratio, Conventional practices management (CPM), productivity, Basmati, Gross returns

Rice (*Oryza sativa* L.) is one of the important cereal crop grown in the world and inhabits the staple food for more than 60 per cent of the global population. Paddy is cultivated over an area of about 167.32 million ha with a production of about 782.00 million tonnes in 2018. (FAO, 2018). The major paddy growing countries are China, India, Indonesia, Thailand, Vietnam, Myanmar, Bangladesh, Philippines, Japan and Brazil. India has the largest area (43.68 million ha) under paddy cultivation in the world followed by China (30.46 million ha) and Indonesia (15.99 million ha), during 2018. In respect to production, India produced 115.63 million tonnes rice and ranked second after China. The major paddy growing states in India are Punjab, Haryana, Uttar Pradesh, West Bengal, Odisha, Andhra Pradesh, Bihar, Madhya Pradesh, Assam and Chhattisgarh. All these states partaking for 78.57 per cent of total production with share of 79.55 per cent area. In Haryana, paddy is cultivated on about 1.33 million ha, with a production of about 4.30 million tonnes during 2018-19. Paddy (Basmati) cultivation alone constituted 47.71 per cent (0.63

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million ha) of total paddy area in Haryana during 2018-19 with a production of 2.14 million tonnes (APEDA, 2018-19). Paddy (Basmati) is cultivated in Haryana largely both for domestic market and export purpose. India exported about 4.4 million tonnes, sharing 13.80 per cent in total agricultural export with 85 per cent of total Basmati Export in 2018-19 (DGCI&S). India trades basmati rice to almost 132 countries across world and major export destinations are North America, Europe and Gulf countries.

Paddy field is generally infested by insect-pests (yellow stem borer, rice leaf folder, brown plant hopper, rice hispa, whorl maggot etc.) that can destroy the whole field with quick succession. The diseases (blast, foot rot and bakanae, sheath blight, false smut, stem rot, brown spot, bacterial leaf light, bacterial leaf streak, etc.) have also reported tremendous loss to crop produce. At present, the biotic stresses are coped to large extent by the use of recommended pesticides. Paddy alone shared 18 percent of total pesticides consumption in India sharing 24 per cent of total cropped area (Devi *et al*. 2017). The pesticides consumption was found highest in Punjab (0.74 kg ha^{-1}) followed by Haryana (0.62 kg ha^{-1}) in 2016-17 (Ministry of Chemicals and Fertilizers, Govt. of India, 2017-18).

Likewise, increased use of synthetic fertilizers to meet nutrient requirement of paddy caused deterioration of soil fertility and degraded the quality of ground water which leads to many health problems in human being and livestock as well as environment. The consumption of chemical fertilizers reached to the extent of 133.12 Kg ha^{-1} in India and it was 225.48 Kg ha^{-1}in Haryana (2018-19) [9]. Moreover, unscrupulous and large scale use of agro-chemicals in paddy cultivation led to many problems like, adverse effect on non-targeted organisms, insecticide resistance in insects, health hazards, environmental pollution, and unsustainable farming systems. Almost all the residual content of pesticides usage is inherently poisonous to human life.

Basmati rice demands a higher price in domestic and export markets for its scented characteristics, due to which farmers use repeated sprays of pesticides for managing the pests and harvesting higher yields. India accounts for over 70 per cent of the world's basmati rice production and is a leading exporter of the basmati rice in the global market.

Integrated pest management (IPM) and integrated nutrient management (INM) are the recommended practices to reduce the usage of agro-chemicals in basmati rice cultivation and support the trade in international markets. The increasing demand of basmati rice in both domestic and international market requires a sustainable production of the crop with less use of agro-chemicals, thus IPM and INM practices will help in attaining sustained yield thereby benefiting the Indian farmers. There is an emerging consensus that modern petro-chemical based farming is unsustainable and there is a need to promote IPM and INM technology. So, keeping this in view, this study is conducted to address the urgent need with the objective "To analyse cost and returns in Paddy (Basmati) in IPM-INM Farms vis-a-vis Conventional Practices Management".

MATERIALS AND METHODS

Sampling technique: Multistage random sampling technique was employed for selection of ultimate sampling unit i.e. sampled farmers. Four blocks from paddy (basmati) growing districts namely Karnal, Sonepat, Jind and Kaithal were selected randomly. The selection of villages from identified blocks was ended based on availability of information related to IPM and INM practices being adopted in cultivation of paddy (basmati). From each selected village, 20 farmers adopting IPM-INM practices and 10 farmers adopting Conventional Practices methods in cultivation of paddy were selected randomly. Thus, a total sample of 120 farmers from four districts were interacted to collect relevant information by survey method during 2019-20.

Analytical techniques: The cost of cultivation of paddy (basmati) was estimated with the help of standard cost concepts with the tabular analysis.

Cost of production: Cost of production is defined as expenses incurred in production of one unit of output or produce. The formula used for calculation of cost of production is as under.

Cost of production =

$$\frac{\text{Total expenses incurred (variable + fixed)}}{\text{Number of units produced or yield}}$$

Cost of cultivation: It includes all expenses incurred in raising the crop per unit of area.

In operational costs: the cost of hiring human labour, machine power etc. have been estimated at prevailing market rate in the study area.

The B-C ratio: It is ratio of total returns with total expenses incurred. It is an indicator of economic evaluation of farm technologies.

Components of cost of cultivation under IPM-INM

In case of IPM-INM, cost of some of the additional operations like organic manure, cultural practices, mechanical practices and biological practices for control of pests were added. The operations like tillage operations, field sanitation, soil solarisation, seed, human labour, irrigation were some common practices in both IPM-INM and CPM.

(a) Cultural Practices*:* Cultural controls refers to the practices that make the environment less attractive to pests and less favourable for their survival, dispersal, growth and reproduction and that promote the natural pest control. These methods includes field sanitation, removal and proper disposal of crop stubbles, soil solarisation, seed priming with Streptocycline, sun drying of seeds, salt water treatment of seeds, disease and insect resistant seed, selection of healthy seeds, etc.

(b) Biological control: Cost involved in use of biological agents in controlling the pest and diseases. Biological control measures include: (a) Seed priming with *Pseudomonas fluroescens,* (b) Four releases of *Trichogramma chilonis* @ 1.5 lakh/ha at weekly intervals or as determined by the moth captures, (c) Spraying of neem seed kernel extract (NSKE) 5 per cent after at 75, 85, 110 and 120 days of sowing (NSKE acts as anti-feedant and repellent).

(c) Physical/mechanical Control: The cost incurred in mechanical removal of insect like hand picking of insects and infected plant; hand picking of lepidopteran larvae to reduce pest density, weed control for the reduction of pest multiplication sites, installation of bird perches, use of pheromone trap, use of light trap (reduce leaf hopper and leaf folder population by attracting moth towards light). There is no direct harmful effect on farmer friendly insect species with the use of these methods.

(d) Nutrient management: It includes cost incurred on compounds which are used to increase the soil fertility. These compounds include (a) organic manure, green leaf manure (Dhaincha), press mud, vermi-compost, poultry manure, etc. (b) Inorganic compound i.e. fertilizers (the synthetic nutrients which are more concentrated and can provide large amount of nutrient in just small dose of application. e.g. Urea, DAP, MOP, Zinc sulphate ($ZnSO_4$), Ferrous sulphate ($FeSO_4$), mixture of micro -nutrients etc., (c) Biological components (Bio-fertilizers) these compounds are the living organisms which provide nutrient to the plant during their course of living as well as after death as decomposed e.g. *Azospirilium*, *Mycorhiza*, Algal bio-fertilizers, *Azolla*, Blue Green Algae, etc.

(e) Chemical Control: Cost incurred for pesticide application. Although pesticides are the last option in IPM pesticide include synthetic fungicides, insecticides, rodenticides, etc.

In case of CPM method of cultivation of paddy (basmati), cost of using of biological method of pest control, organic manure and bio-fertilizers and some cultural and mechanical were not included. Other costs incurred in cost of cultivation were (a) field preparation (It include all the mechanical operations i.e. primary and secondary tillage operations to make land suitable for cultivation of crop), (b) Irrigation charges (the cost incurred in irrigating the field. It can be of monthly electricity bill or fuel cost of generator for running water pump, (c) Human labour (casual labourers charged at the rate actually paid in cash or kind, family male and female labourers were charged at par with the casual labourers in the locality.), (d) Implements and machinery (owned implements and machinery were charged at hiring rates prevailing in the locality.), (e) Interest on working capital (the interest on working capital was calculated @ 9 per cent annually and calculated for the crop season only), (f) Rental value of land (the rental value of land was taken as per rates prevailing in the selected villages during study period), (g) Risk factor and management charges (it is calculated @ 10 per cent of total variable cost), (h) Depreciation on implements and machinery (calculated by the straight line approach).

RESULTS AND DISCUSSION

The obtained results of present research are described under following heading.

1. Additional cost incurred in adoption of IPM and INM practices

The additional cost incurred in adoption of IPM and INM in cultivation of paddy (basmati) was worked out and presented in table 1. Among five components i.e. biological, genetical, cultural, mechanical and chemical of IPM technology in cultivation of paddy (basmati), the expenditure was mainly on plant protection chemicals. Further, under the mechanical practices, the major expenditure incurred was on removal of disease/pest infested part of crop plants, manual removal of weeds. The cost involved in adoption of cultural practices increased because of addition tillage operation (deep summer ploughing, seed treatment). For practicing INM technology at farmer field, additional expenditure was made for usage of FYM, green manure, crop residues, vermi-compost and other organic components like mushroom residue, sea weed, parle bio-care (an organic manure), etc.

The analysis of data collated from field reveals that the cost incurred on IPM-INM farms (₹ 19901) was found higher than CPM farms (₹ 16202). The average cost of chemical pesticides of paddy (basmati) on IPM-INM farm was ₹ 4185 ha^{-1} (21.03% of total cost) as against ₹ 8386 ha^{-1} (51.76% of total cost) on CPM farms. The difference among expenses incurred on IPM-INM farms and CPM farms was reported to the tune of ₹ 3699 ha^{-1}. The increased cost of IPM-INM farms was attained due to usage of organic nutrient sources i.e. crop residues, cow dung, green manure etc. and control of pests and weed manually (Table 1).

2. Analysis of costs and returns in IPM and INM and conventional practices management

The expenditure on IPM and INM component was found to be an important item in the total cost of cultivation on IPM-INM farms. The total cost of paddy (basmati) production on IPM-INM farm was

Table 1: Cost incurred in adoption of IPM and INM practices vis-a-vis CPM in paddy (Basmati) at in Haryana (2019-20) (₹/ha)

Sl. No.	Items	Haryana	
		IPM-INM farms	**CPM farms**
1	**Organic nutrient**		
a)	FYM (qtl)	892 (4.48)	—
b)	Cover crops (dhaincha/moong)	1043 (5.24)	—
c)	Crop residue	851 (4.28)	—
d)	Vermi-compost	157 (0.78)	—
e)	Mushroom residue/ Wastage/Parlebiocare/Decomposer/ Prom/ Denjyme/ Seaweed/Growth regulator	534 (2.68)	—
2	**Total Chemical fertilizer investment**	**4043 (20.32)**	**5712 (35.25)**
3	**Fertilizer application**	**585 (2.94)**	**632 (3.90)**
4	**Plant protection**		
a)	Seed priming	82 (0.41)	65 (0.40)
b)	Summer ploughing	3975 (19.97)	—
c)	Bio-pesticide (*Pseudomonas fluorescens*)/ *Trichoderma sp.)*	920 (4.62)	—
d)	Chemical pesticide	4185 (21.03)	8386 (51.76)
e)	Hoeing /weeding		
	i) Chemical	760 (3.82)	1262 (7.79)
	ii) Manual	1874 (9.42)	145 (0.89)
5	Total	19901 (100)	16202 (100)
6	**Difference between IPM-INM and CPM farms**	**3699**	

Note: *Figure in Parenthesis indicate the percentage to total cost.*

Table 2: Total Cost and returns in adoption of IPM-INM practices vis-a-vis CPM of paddy (basmati) in Haryana (2019-20) (₹/ha)

Sl. No.	Particulars	Haryana (Value/ha)	
		IPM-INM	CPM
(A) Variable Expenses			
1	Field Preparation and sowing	13077 (11.83)	13768 (12.93)
2	Seed cost	1837 (1.66)	1694 (1.59)
3	Fertilizer Investment	8305 (7.51)	6344 (5.96)
4	Irrigation	6254 (5.66)	6886 (6.36)
5	Plant protection	7379 (6.67)	9899 (9.30)
6	Harvesting & Threshing	11525 (10.42)	11085 (10.41)
7	Miscellaneous + Interest	2495 (2.26)	2608 (2.45)
	Sub-total	50872 (46.01)	52284 (49.11)
(B) Fixed Cost			
8	Management & Risk factor	10486 (9.48)	10193 (9.57)
9	Rental Value of land	47605 (43.05)	42544 (39.96)
10	Transportation	1611 (1.46)	1435 (1.35)
	Sub-total	59702	54171
(C) Total cost (Cost A+B)		**110574 (100)**	**106456 (100)**
(D) Gross Returns			
11	Main product	134133	123281
12	By-product	4741	4646
	Total	138854	127927
(E) Cost of Production (per quintal)			
13	With by-product	2122	2216
14	Without by-product	2197	2300

Note: *figure in Parenthesis indicate the percentage to total cost.*

more than that of CPM farm. However, the average yield of paddy (basmati) was achieved significantly higher on IPM-INM farms as compared to CPM farms.

The total cost of cultivation was worked out to be ₹ 110574 ha^{-1} and ₹ 106456 ha^{-1} on the IPM-INM and CPM farms, respectively. The cost incurred on plant protection chemicals was higher (₹ 9899 ha^{-1}) in CPM farms as compared to IPM-INM farms (₹ 7379 ha^{-1}) (Table 2). The study conducted by Kumar *et al.* (2008) concluded that although the cost of production per hectare was more in case of IPM but maximum yield was harvested under IPM module only. Per hectare net profit was maximum i.e. ₹ 9724 ha^{-1} in adoption of IPM module. Similar findings were reported by Raj Kumar *et al*. (2001), Tamizheniyan *et al*. (2004), Singh *et al.* (2007), Sumit *et al.* (2014), Sowjanya*et al.* (2017).

The average cost of production in term of per quintal of basmati rice on IPM-INM farms came out with figure ₹ 2197 as against ₹ 2300 on CPM farms (Table 2). The cost of chemical fertilizers and cost of plant protection chemicals on CPM farms were the major constituents of expenses incurred in raising paddy (basmati). The share of variable cost reached to the extent of 45.82 and 47.89 per cent of the total cost of cultivation of paddy (basmati) on IPM-INM and CPM farms, respectively. Similar finding were found by Ganesh K, (2000), Biridar BR, (2010), Ashok *et al.* (2010).

The yield of paddy (basmati) was found higher on IPM-INM farms (50.33 quintals) in relation to CPM farm (46.29 quintals ha^{-1}) indicating increase of 24 per cent. The gross returns and net returns obtained from the cultivation of paddy (basmati) on IPM-INM farms, was also higher i.e. ₹ 138854 ha^{-1} and ₹ 28280 ha^{-1} in comparison to CPM farms (₹ 127927 ha^{-1} and ₹ 21471 ha^{-1}). The Benefit cost ratio comparison presented in Fig. 1, shows that IPM-INM practices give more benefit as compare to CPM i.e. 2.73:1 in case of IPM-INM and 2.45:1 in case of CPM when measured with variable cost

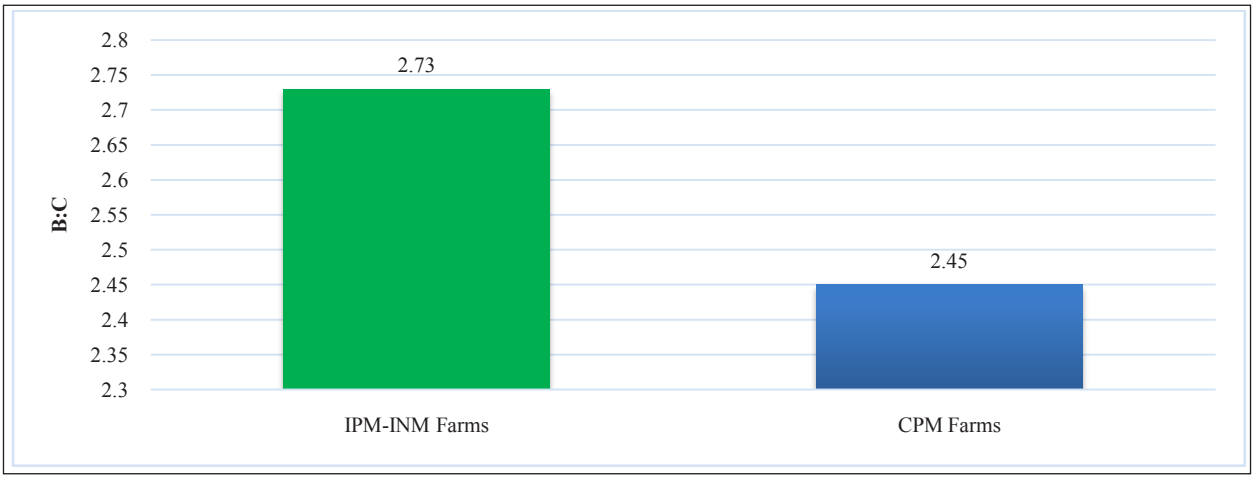

Fig. 1: Overall Benefit Cost comparison

Table 3: Comparative costs and returns in adoption of IPM-INM practices vis-a-vis CPM of paddy (basmati) in Haryana (2019-20)

Particular/ha		Total variable cost	Total Cost	Gross Returns	Return over variable cost	Net Return	Productivity (q/ha)	B:C ratio over variable cost	B:C ratio over total cost
Haryana	IPM-INM	50872	110574	138854	87982	28280	50.33	2.73	1.26
	CPM	52284	106456	127927	75643	21471	46.29	2.45	1.20

(Table 3). Gajanana *et al.* (2004) found that the pest management efficiency of IPM was higher. The crop yield was also higher by 7.2 per cent per hectare in IPM farms. Similar results were reported by Rajaram *et al.* (2001) showed that under IPM block, the yield of cotton seed was at higher side i.e. 1130 kg/ha as compare to Non-IPM block i.e. 645 kg/ha. Another similar findings were reported by Razack *et al.* (2000), Sandeep *et al.* (2002), Singh *et al.* (2004), Veeraiah *et al.* (2005), Rama Rao *et al.* (2008), Tomar *et al*. (2010).

Thus, It has been found by research that even partial adoption of different IPM-INM practices in paddy (basmati) has resulted in higher net return and reduced unit cost of production for IPM-INM following. It was also found that although use of these technologies has potential of avoiding pesticide risk hazards. Paddy growers being risk averse, despite of having good knowledge of pesticide related hazards to the environment, still rely mostly on convention of pesticides. Hence, developing farmers' own capacity by imparting information, knowledge and skill through in-depth and intensive training as well as awareness programs could go a long way in enhancing the adoption level of IPM-INM technologies.

CONCLUSION

The main aim of the present investigation was to study the economics of integrated pest management (IPM) and integrated nutrient management (INM) of paddy in Haryana. The present study was based on the primary data for the year 2019-20. A detailed analysis of data was employed to estimate the cost incurred, yield and returns obtained in the IPM-INM and CPM farms in paddy (basmati). The findings from the present investigation are summarized as under:

Overall finding in Haryana: IPM-INM adopters vis-a-vis CPM adopters:

- The cost of production for one hectare of paddy (basmati) in IPM-INM farmer's category was comparatively lower (₹ 2197) than the CPM farmers category (₹ 2300).
- The irrigation charges was higher in CPM, (i.e. 6.36% in CPM as compared to 5.66% in IPM-INM farms)

- The fertilizer use in IPM-INM was 3.64 per cent and in CPM was 5.22 per cent of the total cost.
- Plant protection component accounted the highest share to the total cost in CPM farmer (9.30%) whereas, it was only (6.67%) in IPM-INM farmers category.
- The per hectare yield and value of the main produce, value of by-product, gross returns and net returns obtained from the cultivation of paddy (basmati) was estimated to be 50.33 quintals, ₹ 134113, ₹ 4741, ₹ 138854, ₹ 28280 respectively in IPM-INM farms, which is more than CPM farms.
- Net return per hectare received was higher in IPM-INM, i.e. ₹ 28280 as compared to CPM farms (₹ 21471).

Suggestions

- The cultivation of paddy was found to be profitable with the adoption of IPM-INM technology due to cost saving in plant protection measures on one hand and an increase in yield on the other. Therefore, use of IPM-INM technology needs to be expanded among all the paddy growers.
- The farmers are risk adverse and have been using chemical pesticides since long to limit the crop loss. Thus, making them to switch over to IPM-INM technology may require considerable efforts and resources.
- Thus, taking an overall view of the situation, there is an imperative need to encourage IPM and INM technologies.

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