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Adoption of Soybean Production Technology by the Farmers in Malwa Plateau of Madhya Pradesh

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ABSTRACT

Soybean had played a pivotal role in socio-economic transformation of majority of small and marginal farming community of central India and continued to contribute significantly to the oil economy of India. The average productivity of soybean presently is staggering around one ton per ha, which is a matter of concern. A study, therefore, was conducted in three major soybean growing districts namely, Indore, Dewas and Dhar of Madhya Pradesh of Malwa Plateau with a prime objective to assess adoption of package of agronomical practices by the farmers. The data were collected from 280 soybean growers belonging to different villages in the study area using semi-structured interview schedule containing 25 agronomic practices belonging to six categories. The responses of soybean growers were recorded and measured by adoption index score. The data were analyzed using statistical tools like percentage, mean, standard deviation, and correlation. Majority of the respondents belonged to middle age group, with education up to middle school, having medium income level with semi-medium land holdings (2-4 ha) and medium socio-economic status. The village level rural agricultural extension officer (RAEO) was found to be most important link of technology outreach as reflected in the extension contact of the farmers. However, their participation in extension activities organized in the area was found to be very less. It was observed that majority of the farmers have medium adoption level of the soybean production technology. Further, an analysis of practice-wise adoption revealed that full adoption was found with respect to land preparation, use of improved varieties, sowing time, weeding as well as storage of seed. However, majority of the farmers did not adopt the practices like, germination test, seed treatment and use of bio-inoculation, maintaining seed rate, plant population, spacing, plant nutrition, disease management and time of threshing. Further, the plant protection practices like, use of chemicals weed control and insect management were partially adopted by most of the farmers although they do not follow the recommended spray concentration.

Key words: Adoption index, correlation, extension participation index, soybean

Soybean [*Glycine max* (L.) Merrill], a crop of socio-economic prosperity for millions of small and marginal farmers of central India, has continued to occupy

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premier position in the oilseed scenario of the country. Malwa plateau of Madhya Pradesh has been the epicenter of soybean development, both in terms of its horizontal spread as well as growth and development of soy-based industries (Tiwari *et al*., 1999). Soybean in the state of Madhya Pradesh is mainly grown as rainfed crop during rainy season *(kharif)* by the farmers who presently are fascinated to grow only short duration varieties in order to minimize yield losses due to long dry spells/terminal drought and climatic adversities experienced since last decade. ICAR-Indian Institute of Soybean Research (ICAR-IISR), which was established at Indore in 1987, is continuously engaged in development, dissemination and technical backstopping of location-specific technologies directly and through the nation-wide centres of All India Coordinated Research Project on Soybean (AICRPS). The soybean research and development (R&D) system in India has developed more than 112 improved varieties so far as well as agronomic practices suiting to various agro-climatic regions and clientele groups. The state agriculture department of Madhya Pradesh, which is main extension agency, has major responsibility to provide extension services and to disseminate technological knowledge to the farming community at village level. Though, the crop exhibited a phenomenal growth in area, production and productivity initially up to 1990s, the average productivity of soybean in the country is hovering around one ton per ha till last few years (Sharma *et al*., 2018). Frontline demonstrations which were conducted in the area, have successfully demonstrated the production potential (up to 2.5 t/ha) of soybean varieties grown with improved technologies (Billore *et al.,* 2005). Thus, there exists yield gap indicating scope of increasing the productivity by enhancing level of technology adoption by the farmers. A recent study conducted by Sharma *et al.* (2018) has also pointed out a significant yield gap in soybean and explored considerable scope to enhance soybean yield and thereby, farmer's income through adoption of research emanated recommended package of practices. The earlier study (Dupare *et al.,* 2011) also revealed that most of the soybean growers had low to medium range of adoption level indicative of partial/non-adoption or over adoption in case of some of the major agronomic practices. With this backdrop, it was considered appropriate to analyze status of farmers' adoption of recommended agronomic practices *vis-a-vis* their socio-economic background, information flow *etc*., which could lead to suggest remedial measures for increasing the soybean productivity.

METHODOLOGY

The present study was conducted in three major soybean growing districts of Madhya Pradesh, namely Indore, Dewas and Dhar which are popular for soybean revolution in the Malwa plateau region. The sample for the study consisting 280 soybean growers drawn randomly from selected six villages (two villages from each selected district). To collect the data, a pre-tested interview

schedule containing basic information about the farmers, sources of information and their utilization along with list of various recommended practices to know their adoption level was utilized. The information gathered through the semi-structured interview schedule was numbered, coded and scored using standard procedures. The adoption behavior was calculated considering 25 recommended practices starting from land preparation to harvesting and threshing as recommended by soybean R&D system (Table 6). The responses of the respondents were scored as 2 for full adoption of a recommended practice. A score 1 was assigned to partial adoption whereas, non-adoption of a practice was scored zero. The extension participation index and technology adoption index of selected soybean farmers were worked out as below.

The extent of contact of a farmer with different extension agencies and their participation in various extension activities or programmes were considered for constructing Extension Participation Index (EPI).

$$EPI = \frac{\text{Actual total score obtained by respondent}}{\text{Maximum obtainable score}} \times 100$$

The extent of the adoption of the recommended crop production technology was ascertained by Technology Adoption Index (TAI_i) constructed using the scores of 2, 1 and 0 for full, partial adoption and no adoption, respectively, of different package of practices (Table 6) and assigning equal weights to each practice (Dupare, 1995; Sharma *et al*, 2018).

$$TAI_i = (S_{oi}/S_{max}) \times 100$$

Where, TAI_i is the index of adoption of technology by i^{th} farmer, S_{oi} is the total technology adoption score obtained by i^{th} farmer, and S_{max} is the maximum obtainable technology adoption score by the i^{th} farmer.

Respondents were grouped into three categories (high, medium and low) on the basis of mean ± standard deviation of the index. The data obtained were analyzed using standard statistical tools like, mean, standard deviation, percentage and correlation coefficients.

RESULTS AND DISCUSSION

A. Background profile of soybean growers

Majority of the respondents (67.14%) belonged to middle age group (32-58 years) with an average age of about 45 years. Regarding their annual income from all the sources, most of the respondents (40.7%) had average annual income ranging from INR 1.44 to 2.68 lacs (one lacs = INR 100 thousand) followed by 35.7 per cent farmers having annual income of less than INR 1.43 lacs, while the income level of remaining 23.6 per cent of the respondents was more than INR 2.69 lacs. As far as their land holding category is concerned, most of the respondents (37.1%) belonged to semi-medium category, *i.e.* those having land between 2.1 to 4 hectares followed by25 per cent of the small and marginal farmers with holdings of 1 to 2 ha. Another 20.0 per cent farmers with land holding up of 4.1-10 hectares belonged to

medium category whereas remaining a group of farmers (17.8%) constituted large category. Majority of them (62%) had medium to small and marginal land holdings ranged between 1 and 4 ha (Table 1).

It was observed that the farmers had sufficient educational background with only 7.8 per cent of them being illiterate or functionally literate, who can only read and write. Out of 280 respondents, most of them (42.8%) studied up to middle school level followed by 32.1per cent who acquired education up to high school and remaining 17.8 per cent were with education level up to college/graduate level. Majority of the respondents (90%) were found to manage their livelihood separately from their parents as nuclear family and only 10 per cent of them were maintained their livelihood affairs jointly with their parents and siblings (Table 1).

Table 1. Background profile of soybean growers

Characteristic	No of respondents (N=280)	Percent
Age (Mean-45.21, SD-14.18)		
High (above 59 yrs)	38	13.6
Medium (32-58 yrs)	188	67.1
Low (below 31 yrs)	54	19.3
Education		
Illiterate/functionally literate	22	7.86
Up to middle school level	120	42.86
Up to high school level	90	32.14
College/graduate	48	17.14
Farming category		
Marginal and small (<2ha)	70	25.0
Semi-medium (2.1-4.0 ha)	104	37.14
Medium (4.1-10.0 ha)	56	20.00
Large (above 10.1 ha)	50	17.86
Annual incomeMean-2.06, SD-0.63		
High (above INR 2.69 lac)*	66	23.6
Medium (INR 1.44-2.68 lac)	114	40.7
Low (below INR 1.43 lac)	100	35.7
Average family size	***3.87***	
Family type		
Nuclear	252	90.0
Joint	28	10.0

**One lacs = INR 100 thousand*

B. Socio-economic status of soybean growers

Socio-economic status refers to position of an individual with reference to prevailing average standard or cultural position, effective income, material possession and participation in group activities of the community. An effort made to know the socio-economic profile of soybean growers revealed that majority of soybean growers (54.28%) belonged to medium socio-economic category, followed by 28.57 per cent had low socio-economic status and only 17.14 per cent had high socio-economic status (Table 2). Soybean crop had contributed significantly to the socio-economic transformation of small and marginal farmers. The earlier studies on soybean also documented improvement in the socio-economic condition of farmer's post-soybean introduction in the region (Dupare *et al.,* 2009; Badal *et al.,* 2000; Gadge, 2003; Sharma *et al.,* 2016).

Table 2. Socio-economic status levels of respondents

SES score (Mean-20.17, SD-3.81)	No. of respondents (N=280)	Percent
High (above 23)	48	17.14
Medium (17-22)	152	54.28
Low (Below 16)	80	28.57

C. Extension Contact and Extension participation

The extension contact is the degree to which contacts were made by an individual farmer with extension personnel for seeking advice and information related to farming. The frequency of contacts made with different types of extension agencies was used for calculating the extension contact. To study the information seeking behavior of soybean growers, two major activities followed by the farmers, namely contacts with extension agencies and their participation in extension activities conducted in their area, were considered. It can be noted that the Rural Agricultural Extension Officer (RAEO) is the most important link between the farming community and the department of agriculture of Madhya Pradesh (Table 3). About 51.42 per cent of the farmers kept contact with RAEO on regular basis whereas 30.72 per cent of the respondents consulted the RAEO as per the need. However, surprisingly rests of the farmers (17.85%) had no contact with the RAEO. Moreover, only few farmers had their contact with higher officials of department of agriculture and the KVK/ICAR scientists located in their area.

Extension participation denotes herein that the participation of soybean growers in various extension activities conducted in the study area and was worked out on the basis of regularity. A very dismal picture of the farmers' participation in extension activities emerged out. It was observed (Table 3) that majority of the farmers (78.58%) had

Table 3. Extension contact and participation

Extension professionals / Program	Frequently/ Always	Sometime	Never
Extension contact			
1. RAEO/Gram Sewak	144(51.42)*	86 (30.72)	50(17.86)
2. Officers of department of agriculture	6(2.14)	34(12.14)	240(85.72)
3. Scientists of KVK/ICAR Institute	2(0.71)	16 (5.71)	262(93.58)
Extension participation			
4. Farmers' Training Program	36 (12.85)	24 (8.57)	220 (78.58)
5. *Krishi Mela*	68 (24.28)	28 (10.00)	184 (65.72)
6. Group Meetings	20 (7.14)	4 (1.43)	256 (91.43)
7. Field Day/ Demo visit	6 (2.14)	22 (7.86)	252 (90.00)

**Figures in parentheses shows percentage*

never attended any agricultural training programmes, 65.72 per cent did not attend any farm exhibition, 91.43 per cent did not attend any meeting/programme organized by agricultural department, 90 per cent did not attend any field days and almost all of them did not see any crop-specific demonstration programmes organized for them. But, few progressive farmers mostly participated in such programmes (training, *krishi mela*, field days, demonstrations, meetings, *etc*) and got benefited in terms of knowledge or technical know-how related to new technologies and practices, which could be used in their current farming practices.

D. Extension Participation

The sum total of scores received by the respondents for their extension contact as well as extension participation was considered to work out the extension participation index (Table 4). Majority of the respondents (70%) had medium extension participation followed by 19 per cent had high extension participation and only 11 per cent had low extension participation. This situation warrants improvement through modern IT tools as well as through extension outreach so as to make the farmers aware of new agricultural technologies and practices in order to motivate them to adopt those in the field and increase the yield potential.

E. Magnitude of adoption of recommended soybean production technology

The data (Table 5) related to adoption levels of respondents related to recommended soybean production technology revealed that majority of soybean growers (65%) had medium level of adoption of the recommended practices. Only 7.9 per cent of the respondents adopted the technologies at high level, whereas, only 27.1 per cent farmers had low level adoption, which is a major concern for the development.

Table 4. Extension Index score of the soybean growers

Level of participation Index	No. of respondents (N=280)	Percent	Average index value
High	54	19.29	0.576
Medium	196	70.00	0.283
Low	30	10.71	0.112

Table 5. Distribution of respondents according to their technology adoption index

Adoption level	No. of respondents	Percent	Average Index value
High (>78%)	22	7.85	0.839
Medium (35-77%)	182	65.0	0.644
Low (< 34%)	76	27.15	0.285

F. Practice-wise adoption of recommended agronomic practices

Since, the categories of adoption as mentioned above do not provide actual picture of the practices being fully or partially adopted or not adopted by the farmers. Therefore, an effort was made to study all the 25 recommended agronomic practices-wise adoption (Table 6) for drawing the meaningful conclusions and suggestions for farmers and extension professionals for updating the technical know-how of the farmers.

Sharma *et al.* (2006) reported that there was 36 per cent gap in adoption of improved soybean production technology in Madhya Pradesh leading yield realization up to 48 per cent compared to that with full package. Thus, adoption of full package of practices for soybean resulted in 48 per cent higher yield over farmers practices. Yield loss due to weed infestation was estimated to the extent of 77 per cent (Tiwari and Kurchania, 1990), while the adoption of weed management practices by farmers was only 26 per cent (Dupare *et al*., 2011). Merely, 16 per cent farmers adopted intercropping soybean. Sulphur is important nutrients to be included in nutritional schedule for optimizing soybean productivity, and about three-fourth of the farmers did not use this nutrient. Since, most of the farmers were following mono-crop system (soybean-wheat/gram) over time and even did not adopt intercropping and integrated approach for nutrient management, the soil fertility level had declined significantly and crop also became more prone to diseases and pest infestation (Dupare *et al*., 2010). For long-term sustainability and enhancement in yield levels, varietal/crop diversification is to be promoted. Three cycles of soybean-wheat cropping systems over nine years had revealed that inclusion of maize in each cycle in place of soybean led to higher profitability (*Vyas et al.,* 2013). Also, there was partial adoption of integrated approach for insect-pest management and many farmers did not use even recommended pesticides at appropriate time and doses.

Table 6. Practice-wise adoption of recommended soybean production technology (N=280)

Package of practices	Non-adoption	Adoption
Tillage and land preparation		
1. Deep summer ploughing	44 (15.72)*	236 (84.28)
2. Criss-cross harrowings	30 (10.72)	250 (89.28)
3. Planking	30 (10.72)	250 (89.28)
Variety, germination and treatment		
4. Improved variety	8 (2.85)	272 (97.14)
5. Germination test	122 (43.58)	158 (56.42)
6. Seed treatment	120 (42.86)	160 (57.14)
7. Seed inoculation	122 (43.58)	158 (56.42)
Sowing and plant geometry		
8. Seed rate	244 (87.14)	36 (12.85)
9. Plant population	160 (57.14)	120 (42.86)
10. Row to row spacing (cm)		
35	76 (27.14)	-
35-40	84 (30.00)	-
45		120 (42.85)
11. Plant to Plant spacing		
1-3 cm	218(77.86)	
3-5 cm		62(22.14)
12. Intercropping	248 (88.58)	32 (11.42)
Weed control		
13. Chemical control (herbicides)	12 (4.28)	268 (95.72)
14. Hoeing for weed mgt	32 (11.42)	248 (88.58)
15. Manual weeding	190 (67.86)	90 (32.14)
Plant Nutrition		
16. Application of FYM	106 (37.86)	174 (62.14)
17. Optimum NPKS	118 (42.14)	162 (57.86)
18. Application of sulphur	234 (83.57)	46 (16.42)
Plant protection		
19. Management of green semilooper	116 (41.42)	164 (58.58)
20. Management of Heliothis and tobacco caterpillar	44 (15.72)	236 (84.28)
21. Management of girdle Beetle	100 (35.72)	180 (64.28)
22. Disease management	252 (90.00)	28(10.00)
23. Use of bio-pesticide	252 (90.00)	28 (10.00)
Harvesting and threshing		
24. Harvesting time	-	280(100.00)
25. Threshing	238 (85.00)	42 (15.00)

**Figures in parentheses shows percentage to each practice*

The low level of adoption of improved production technology was mainly due to various socio-economic constraints faced by the farmers, such as non-availability of quality inputs, high cost of inputs, lack of access to capital, lack of knowledge, poor extension support and poor marketing facilities (Sharma, *et al.*, 2006; Dupare, *et al.* 2011; Kumar *et al.*, 2012; Singh *et al.*, 2013). Singh and Singh (2013) reported that lack of knowledge about improved soybean production technology was high particularly regarding seed treatment (62% knowledge gap), weed control (35.6%) and plant protection measures (30%).

Tillage and land preparation

It is very heartening to note that out of 25 agronomic practices recommended by the soybean R&D system; majority of the respondents (84.28%) adopted the practice of deep summer ploughing once in 3-4 years. Further, even more numbers of the respondents (89.28%) adopted the practice of two criss-cross harrowing for seed bed preparation. Similarly, the same numbers of farmers adopted the practice of planking to make the field ready for sowing after the arrival of monsoon.

Variety, germination and treatment

It was good to learn that majority of the farmers (97.14%) used relatively new improved soybean varieties, which includes, JS 95-60, JS 93-05 and JS 20-34. The farmers preferred these short duration varieties (85-95 days) in order to avoid the risk of yield loss due to early withdrawal of monsoon and long dry spells during cropping season being experienced during last few years. However, only 56.42 per cent of the soybean growers carried out germination test for their available seed before sowing in order to ensure the ideal plant population. Remaining farmers (about 43%) did not adopt the practice. Germination test ensures the quality of seed and helps to optimize seed rate to achieve recommended plant population for harnessing better yield level. Interestingly, it was found that about 57 per cent farmers only followed seed treatment practice with recommended fungicide as well inoculation with *Bradyrhizobium japonicum* and PSB (phosphate solubilizing bacteria) culture before sowing. The farmers (43%) did not adopt these practices. Similarly, seed treatment with fungicide is recommended in order to avoid the yield losses due to diseases, which otherwise are very difficult to manage at later stage and likely to increase the cost of cultivation. Also, seed inoculation with cultures like *Bradyrhizobium japonicum* helps for biological fixation of atmospheric nitrogen, whereas with phosphate solubilizing bacteria which helps in solubilization of fixed soil phosphorus facilitating its availability to crop. Therefore, the soybean R&D system recommended these practices for ensuring the efficient utilization freely available atmospheric nitrogen and soil available soil nutrients and for avoiding the yield losses due to diseases. Non-adoption of these practices is a matter of concern and requires concerted efforts to motivate farmers to take up the practices

to raise and sustain the productivity.

Sowing and plant geometry

Seed rate: It is very disappointing to know that only 12.85 per cent of the farmers adopted the recommended seed rate for sowing of the crop. Instead, majority of the soybean growers (87.14%) used very high seed rate. The R&D system have recommended the seed rate of 60-85 kg per ha based-on seed size and minimum germination of 70 per cent, which is optimum to ensure optimum plant population thereby realized yield. Some of them used very high seed rate as 125-130 kg per ha with narrow plant spacing than recommended. After further enquiry, it was learnt that they used higher seed rate to manage the weed population. However, this practice of crowding the plants not only expose the crop for competition for natural resources, but also results in higher incidence of pest and diseases, lowering the yield and net income.

Plant population: It was observed that only 42.86 per cent of the respondents maintained the recommended plant population (4.5 to 6.0 lacs/ha) depending on the varietal architecture. It is again a matter of a great concern that majority of them (57.14%) did not bother to follow this practice to ensure recommended plant population. As majority of the farmers used their farm saved seed for sowing without carrying out its germination test obviously, there was doubt about its germinability. Moreover, they were using higher seed rate resulting in higher plant population which resulted in to poor yield.

Spacing: It is very disheartening to know that farmers, even after successful cultivation of soybean crop during last 4-5 decades, were not following the recommended practice of row to row/plant to plant spacing. In this regard, only 42.85 per cent farmers followed the recommended row spacing of 45 cm. Remaining farmers (30%) followed either sowing the crop at 35-40 cm or even less than 35 cm (27.14%). Farmers generally believed that dense planting of soybean suppresses the weed population. Similarly, majority of the farmers (77.86%) were not able to maintain plant to plant spacing of 3-5 cm. Only 22.14 per cent were maintained this practice. The non-adoption of spacing could be one of the reasons for not being able to achieve the potential yield of newly introduced high yielding varieties. This sometimes leads to the problem of non-podding in soybean, which was experienced in the region during last decade.

Intercropping: Though, intercropping of soybean with suitable companion crop is monetarily profitable and remunerative, it was adopted by only 11.42 per cent of the farmers. Majority of the farmers had not adopted the intercropping with maize/sorghum/pigeon pea mainly for the reason that they did not have suitable intercrop seed drill and possible delay insowing of subsequent *rabi* crops (potato, onion and garlic).

Weed management

For weed management, a serious concern for major *kharif* season crop like, soybean, the R&D system has recommended variety of approaches namely, manual, cultural and chemical methods for containing weeds during initial critical 45 days after sowing. This included manual weeding, intercultural operations like, hoeing (*dora/kulpa*) and three groups of recommended herbicides, both for minimizing the infestation of monocot/dicot weeds. However, it was observed that the farmers now-a-days had, by and large, dispensed with the use of pre-plant incorporation (PPI) herbicides, except a few started using diclosulum (PE-pre-emergence). In the study area, majority of the farmers (95.72%) used post-emergence herbicide (PoE) like, Imazethapyr, which they sprayed at 15-20 days after sowing. In addition to use of PoE herbicide, the farmers (88.58%) were found resorting to the intercultural operation of *dora/kulpa* as per its suitability during dry spell. The practice of manual weeding was practiced by a few farmers (32.14%), especially, those had small land holdings.

Plant nutrition

Being a leguminous crop, soybean is also contributing to enrich the soil by way of biologically fixing the atmospheric nitrogen added with residue recycling, which is available for soybean and subsequent crop in rotation. Field trials on soybean-wheat cropping systems brought out the contribution of 35-40 kg nitrogen per ha of soybean crop to next wheat crop in rotation (Saxena and Tilak, 1975). Therefore, the soybean R&D system has recommended resorting to nutrient management in soybean utilizing integrated approach. This involves use of biofertilizers, application of Farm Yard Manure @ 10 t per ha or Poultry Manure @ 5 t per ha or through Vermi-Compost @ 2.5 ton per ha before sowing. Subsequently prior to sowing, incorporation of 20:60:20:20 kg NPKS per ha is considered sufficient enough to get adequate soybean yield. This agronomic recommendation of fertilization can further be tailored on the basis of soil test values or can be modified on the basis of targeted yield concept. But, it is equally necessary to incorporate all the basic nutrition in balanced quantity. The effort made to know the status of nutrient application and its adoption by the farmers brought out that majority of them (62.14%) applied organic manure through FYM, but, on rotational basis as the recommended quantity of FYM was either not available at their doorstep or too expensive. The unavailability of the FYM is major constraint now-a-days due to mechanization of most of the farm operations which forced the farmers to get rid of their draught animals. Remaining group of farmers (37.86%) had not applied the FYM as was not affordable due to heavy cost. Most of them viewed that the nutrition applied to the *rabi* crop, particularly potato/onion/garlic suffices the requirement of subsequent soybean crop grown during *kharif*. Further, only 57.86 per cent farmers had adopted the recommended dose of fertilizers partially either through DAP (lacks K and S) or complex fertilizer (12:32:16) (lacks S).

Balanced incorporation of both the elements is necessary for the oilseeds for optimizing yield and quality of produce. Moreover, the soils of Malwa region are deficient in zinc and required to be included in fertilizer schedule. The study revealed that almost three-forth (76.42 %) respondents did not apply the carriers for these two essential elements. Non-inclusion of potassium, sulphur and zinc in fertilizer schedule curtails the yield level and quality of grains in terms of seed lusture and reduced oil content. Potassium is associated with quality of produce (Dev, 1995) and also known to provide protection against moisture stress, insect-pests/disease and lodging .

Plant Protection

Plant protection is the one of the most important aspects of crop management. Of late, soybean crop is being infested by four major insects, *viz*. green semi-looper, *Heliothis armigera*, tobacco caterpillar and girdle beetle. Consequent to their attack experienced during last two decades, the R&D system of soybean has recommended management measures which included cultural and mechanical measures and number of optional insecticides including bio-pesticides, which can be used, if needed. The query on prevailing plant protection with respondents revealed that they used to apply 2-3 sprays of recommended insecticides earlier, but now applying 3-4 sprays during crop season. It also came out that the spraying of insecticide was ritual irrespective of the incidence of pest. Majority of the farmers (58.58%) applied first spray after 3 weeks of sowing for protection from green semi-looper. Even sizable number of the farmers (84.28 %) sometime applied 2 sprays of insecticide during 4-5th week to control insects like, *Heliothis armigera* and tobacco caterpillar. Similarly, more than 64.28 per cent of the respondents adopted management practices to control girdle beetle.

Apart from the insects, viral disease like yellow mosaic virus (YMV) is also found affecting on soybean resulting in considerable yield loss, if not managed in time. But, only 10 per cent of the farmers were attentive to control it. Few of them, believed that the fungicidal seed treatment carried out during sowing would protect the crop from all sort of diseases. Therefore, there is need to educate the farmers about importance of seed treatment and also for control of white fly, a vector for spreading YMV. As far as application of bio-pesticides is concerned, the adoption was found to be merely 10 per cent. The bio-pesticides show their efficacy only if the insect is identified at its initial stage and also needs repetitive sprays on community basis, which has discouraged the farmers for their adoption. Only those farmers engaged in organic soybean production and associated with some corporate only adopted locally prepared bio-pesticides using plant-based sources in soybean crop.

Harvesting, threshing and storage

The best time for harvesting of soybean crop is decided based-on change in pod color (ICAR-IISR, 2015); when 90-95 per cent pods change color form green. In the study area, the practice of right stage of harvesting was adopted by all

the farmers. The harvesting of soybean earlier was mostly carried out manually using human labor using sickle. The harvested soybean is collected and kept in the field itself for 2-3 days for sun drying after which the same is shifted to a threshing floor in the form of heap. But now-a-days, large and commercial farmers started using combine harvesters, which are available on rent and this practice is becoming popular in the area.

The threshing is the most important operation for soybean particularly for keeping the viability of seed and maintaining the quality. Therefore, threshing of soybean is recommended using motorized thresher with 350-450 rpm. It is very disappointing to know that majority of the farmers (85%) had not adopted the threshing technique. Only 15 per cent of them who had large land holdings and associated with seed business had adopted this practice. With regard to storage of soybean for seed is concerned, majority of the farmers were using gunny bags as recommended.

Relationship between adoption and characteristics of soybean growers

In order to ascertain the relationship between characteristics of soybean growers, a correlation analysis was carried out with the adoption index score of individual respondent (Table 7). The analysis revealed that age of soybean grower and soybean production technology index were found to be negatively and significantly correlated. It implied thereby that young farmers were more inclined towards taking risk and that decreases with the increase in age, therefore, young farmers were more likely to adopt technologies. Education of the head of household was found to be positively and significantly correlated with the technology adoption index. It is obvious that with the increase in education, the knowledge on crop production technologies increases and thus, the level of adoption of technologies.

Since adoption levels of majority of the farmers in the present study are found only up to medium level and most of the agronomic practices are either adopted only partially and few of them had not adopted, it is imperative that more number of trainings, awareness programmes may be executed for motivating soybean growers to enhance adoption of recommended production practices. Further, they should be convinced practically by way of

Table 7. Correlation of technology adoption index with farm characteristics

Variable	Correlation	Significance
Age (years)	-0.381*	<.0001
Education level	0.196*	0.001
Land holding (ha)	-0.141**	0.018
Family income (INR Lacs)	-0.112	0.061
No. of family members	0.186*	0.007
Mobile phone	-0.071	0.2395

** and ** denotes significance at 1% and 5% level of significance, respectively.*

organizing large number of on farm demonstrations and more exposure to be given to them by conducting field tours to KVKs/ICAR institutes or wherever extension programmes like, exhibitions, practical demonstrations are organized. The state agriculture department should plan a sound strategy highlighting these issues in their programmes and sincere efforts should be made for their execution.

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