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Multidimensional impact assessment of zero tillage technology on wheat productivity in Haryana

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Abstract

The farmer's participatory approach proved to be accurate guide for zero tillage technology adoption by farmers within different districts not only in Haryana, India, but also in other major wheat producing states of the country. Continuously, need is being felt to explore the possibilities of saving critical inputs by adopting zero tillage technology but little research exists that explores agricultural conservation outreach. Current study was so aimed to see factors affecting the adoption and impact of zero tillage technology in rice wheat cropping system. Results revealed that adopters were more literate than non-adopters. Majority of the adopters (62.49%) were in age group of 30-50 years; the relative percentage in this category among non-adopters was very low (39.16%). The probability of adoption of zero tillage technology with the increase in farm size increased, so medium to large land holders contributed to 68.33 percent in adopting zero tillage technology. Attitude, knowledge and satisfaction of the respondents were found to be driving force of change to click from traditional practices to zero tillage technology. The mass media like educational films, radio, pamphlets, farm publication, TV and newspapers, in case of institutional sources panchayat personnel's, extension persons and ADO, while among the non-institutional sources family members, relatives and progressive farmers were the most preferred sources of information to the adopters and non-adopters. Furthermore combinations of a significant "yield effect" and "cost-saving effect" makes adoption worthwhile and is the main driver behind the rapid spread and widespread acceptance of ZT in Haryana.

Key words: Zero tillage, wheat.

Introduction

India has recorded all time high wheat harvest of 86.87 million tons from 29.1 million ha area during 2010-2011. Wheat in Haryana (NW India) is grown as a winter crop in an annual sequence with rice, cotton, pearl millet or cluster bean as the main monsoon crops. Higher wheat yields in Haryana are associated with the use of modern varieties, increase in fertilizer use, improved irrigation practice and conservation tillage as reported by Coventry *et al*. [1]. Despite of self-sufficiency in wheat production, there will be more pressure on Indian agriculture to produce more food for the rapidly increasing population of the country. The problem becomes even more acute with the dwindling natural resources. Not only the farmers have to produce more food grain but of better quality due to stiff competition posed by the open global trade policies.

If green revolution was a turning point for progress of Indian agriculture, sustaining it would need radical reforms in management of natural resources, as of now the green revolution has slowed sharply, as has yield growth [2, 3]. The average yield declined after 2000 is not because of fertilizer or irrigation but because of length of time the crop could grow and reproduce. Late planting of wheat is a major problem in rice-wheat cropping system under conventional system mainly because of long duration and high yielding rice varieties, not only it reduces the yield but efficiency of inputs applied to the wheat crop [4]. Hobbs *et al*. [5] pointed out that delayed wheat sowing after mid-November in Indo-Gangetic Plains and late-November in middle Indo-Gangetic Plains result in grain yield losses of one percent per day. To address the above problems the use of zero tillage seed cum fertilizer drill is being advocated for timely planting of wheat after rice harvest as proposed by Malik and Singh [6] and Mehla *et al*. [7]. The profit that zero tillage can extract from advanced sowing is a non-cash input. It serves as an effective signal for a new avenue for research investment in management of rice fallows in places like Bihar and Eastern Uttar Pradesh. This type of measure for early sowing (a non-cash input) through the use of zero tillage technology will invariably serve the public good and will benefit all farmers. The maintenance of relatively higher yield under zero tillage in the favorable (1999-2000 and 2000-2001) and aberrant weather (2001-2004), is quite enough for us to anticipate that this technology has all virtues of sustainability. Change in tillage and crop establishment practices offer considerable potential for sustainable improvement in the productivity of wheat in rice wheat cropping system of South Asia in general and India in particular. On account of more profits and social benefits, accelerated adoption of zero-tillage best fits the thesis of resource

conservation for future sustainability. Zero-tillage, therefore, is the rational risk avoiding strategy with tremendous potential to conserve natural resources.

Despite of so many benefits of zero tillage, most of the Indian farmers still rely on the classical, rather inefficient, agricultural practices. One reason that first strikes our mind is lack of awareness about zero tillage. Behaviour in the face of risk aversion is affected by attitude of farmers and the nature of technology. Correcting this may still take some time. For a technology to be adopted and effective really, it is a pre-requisite that it has been evaluated with respect to its economic feasibility and viability which is a major determinant of its adoption. To increase the scale of adoption and impact of innovation, such as zero tillage, action must be based on an understanding of the dynamics of adoption and the critical factors that determine whether farmers accept, do not accept, or partially accept innovations [8]. Currently there is insufficient understanding of factors (household and farm characteristics) affecting adoption behaviour of zero tillage, yet better knowledge of how these characteristics of individual farmers and their farming practices affect adoption would help policy makers and researchers in designing more effective technologies that will be tailored to the needs of the farmers. Therefore, the objective of this study aims to investigate factors influencing zero tillage adoption among farmers.

Materials and Methods

The study was conceded in Kaithal, Karnal and Kurukshetra districts of Haryana state, from each district two blocks and from each block two prominent villages were selected purposively on the foundation of leading regions covering more area under rice wheat cropping system and adequate research being in progress in this region for the last eight years on zero tillage technologies. Ten respondents from adopter category and ten respondents from non-adopter's category of zero tillage technology were randomly selected from each village. Thus 240 respondents from both categories were selected for study. The relevant variables for the study were selected on the basis of extensive review of literature, consultation with scientists and other experts as a preview, the description of contents of variables and procedure followed for the measurement of each of the variables have been presented in Table 1.

Table 1. Variables and their measurement.

	Variables	Measurements
Independent variables		
1	Age	Direct questioning
2	Education	Direct questioning
3	Land	Direct questioning
4	Sources of information	Schedule developed
5	Attitude towards zero tillage	Scale was developed
6	Knowledge about zero tillage	Test was developed
7	Satisfaction level with zero tillage	Schedule developed
8	Perception of the farmers about impact of Zero Tillage in comparison to conventional tillage	Schedule developed
9	Farmers' perception about impact of zero tillage	Schedule developed
Dependent variable		
10	Yield	Direct questioning

A large number of statements were collected from review of literature, discussion with extension experts, agriculture scientists and farmers; care was taken to include approximately equal number of positive and negative statements. Those statements were carefully edited in the light of fourteen criteria suggested by Edwards [9] and statements were revised to avoid ambiguity and duplication. The selected two sets of statements were mailed with appropriate instructions to 60 judges, experts in the field of zero tillage technology for their judgment on each items relevancy on three point continuum, which are very relevant, relevant and not relevant. The judges were also required to make necessary modification and addition or deletion of statements, if they so desire. The judges considered for this purpose were the ICAR scientists, ADO and the person having considerable practical experience about zero tillage technology. The response was received from 50 judges in time. The responses of judges were tabulated and analyzed to work out relevancy percentage, relevancy weightage and mean relevancy score for all the statements. The research instrument in the form of a schedule was pre tested by administering the same to 40 farmers in Panipat district of Haryana which was not included in the study. After getting the responses, necessary modifications in terms of elimination of ambiguous statements, change of format or presentation of the instrument in the schedule, deleting the monotonous responses, etc. were suitably made. Thereby, the quality of presentation of the instruments in the final schedule was improved.

Knowledge has been operationalized as amount of understood information held by the respondents with respect to recommended zero tillage technology (ZTT) in wheat crop. In order to measure the knowledge level of farmers they were asked to reply a set of questions on selected aspects of ZT technology. The correct answer awarded a score of one and zero to incorrect answer. The score thus obtained under various aspect of ZTT cultivation were summed up respondent wise as well as component wise to draw meaningful conclusions.

Yield constituted the dependent variables of the study. Yield was measured as wheat produced in quintal per hectare in a crop season (October to April), with the help of prepared interview schedule, the information of general and specific nature was collected personally from the respondents during 2008-2009. Data were collected from both adopters and non-adopters of zero tillage technology in Karnal, Kurukshetra and Kaithal districts of Haryana. Each selected household was visited to collect detailed information using a structured questionnaire covering various indicators at the farm and plot levels. The farm-level indicators covered a range of farmer and household characteristics and experience with and perceptions of zero tillage. For the subsequent analysis and reporting, farm households were classified based on their use of ZT in wheat. The farmers who used ZT for wheat were classified as adopters and those who never used ZT for wheat on their farm were classified as non-adopters. We hypothesize that there are a number of differences among these two classes and these may help explain the observed adoption decision.

Before administering the schedule, the objectives of the study were explicitly explained and proper rapport was established with the respondents. The questions in the schedule were presented to them in their own dialect ensuring that they perceived the questions correctly so as to avoid any interpretational variation

of the questions by the respondents. The answers obtained were recorded. Only one respondent was interviewed at a time. During the interview, care was taken to keep alive interest of the respondents. Their experiences about zero tillage were patiently heard.

Analysis of the level of adoption and the socio-economic profiles of adopters and non-adopters was done using descriptive statistics such as frequencies, mean and standard deviation. Pearson's Chi-square was used to test if the socioeconomic characteristics between adopter and non-adopter farmers were significantly different and t test was performed for the yield. The analysis was performed using SPSS statistical software.

Results and Discussion

Profile of the respondents: It is evident from Table 2 that 35.83 per cent of the adopters were in the age group of 40-50 years, 26.66 per cent in 30-40 years, almost an equal percentage (15% and 14.16%) in 20-30 years and 50-60 years, respectively, whereas least 8.33 per cent adopters were in age group of 60-70 years. In non-adopter's category 27.50 per cent of farmers were in 50-60 years age group and almost equal percentages (19.16%, 20% and 20%) of the respondents were in age group of 30-40, 40-50 and 60-70 years, respectively. There were 13.33 per cent of non-adopters in age group of 20-30 years. The maximum adopters were of middle and young age group, whereas, in case of non-adopters maximum percentage lies in old age group. It reflects that the younger to mature age group (20-50 years) farmers were fast adopters and best decision makers in accelerating new innovation technologies and farmers of old age group (50-70 years) depend on conventional systems. Similar findings were reported by Singh and Pandey [10] who mentioned that medium age group had merit for promotion and feasibility in adopting zero tillage system in wheat. Singh and Kumar [11] also reported that 60% of adopters were middle aged.

The findings presented in Table 2 reveals that majority of respondents were literate among the adopters, however, in-depth study adopters category has indicated that majority (75.84%) were educated above middle level whereas in non-adopter category 68.33 per cent of respondents felt in this category. The illiteracy level was found higher in non-adopter category than in adopters. It could be informed from the above findings that marginal probability of adopting ZT technology was significantly higher for above primary level education attainment as compared to the base of uneducated or below primary level education. Findings indicate that younger farmers are mostly educated and have the tendency to take risk for adopting the ZT technology. Farmers who were educated middle to matriculate level had agriculture as their main occupation and were more inclined to adopt zero tillage technology. Similar results were earlier depicted by Yadav [12] who found that 51.3 per cent of adopters have higher level of education. Malik *et al.* [13] also observed that farmers who were educated up to middle or high school level were more inclined to adopt zero tillage technology.

It is clear from Table 2 that ZT is positively associated with the size of operational holding, with non-adopters having intermediate farm sizes, majority of the farmers (68.33%) were medium to large farmers whereas in non-adopter category 54.17 per cent of respondents fell in this category. There was more marginal and small farmers in the non-adopter categories as compared to adopters. It can be concluded that majority of the adopters had more land holding as compared to non-adopters. One fifth of the non-adopters were marginal farmers in comparison to the adopter category (7.50%) indicating incremental change of adoption probability for ZT technology due to higher land holdings, so marginal farmers find it difficult to adopt zero tillage technology in wheat that may be due to lack of machines, very small land holdings and less risk bearing capacity. Singh and Panday [10] and Yadav [12] also observed that more than 60% of adopters had more than 5 acres land.

Sources of information: Everything is new but nothing is impossible to adopt that is what source of information conveys. If any technologies which had been developed for the betterment of society, will not convey a fruitful message to the society, if not driven in proper direction. For the recommendations of such technologies, demonstration must be given to adopters for clearing their doubts. Afterwards different media are the sources which help to disseminate the technology to the farmers for adoption. Different sources of information do play vital role in transfer of technologies to different societal categories which are source and situational dependent.

Three types of sources of information, i.e. mass media, institutional and non-institutional, exist for farmers. It is evident from Table 3 that among different sources of information from mass media a few exhibited significant impacts on adoption of zero tillage. Among these radio, TV, farm publication and newspapers were used by the farmers to get agriculture related information. Surrounded by institutional sources of information, ADO, extension workers and panchayat personnel were used by the respondents in the region. The non-institutional sources of information were the backbone among all categories to convey the message of benefits of technology in order to adopt it. The family members, relatives, friends, village leader and chopal meetings contributed significantly as sources of information.

Table 2. Respondent profile effect on zero tillage technology validation.

Age	20-30	30-40	40-50	50-60	60-70
Adopters (N=120)	18 (15.00)*	32 (26.66)	43 (35.83)	17 (14.16)	10 (8.33)
Non Adopters (N=120)	16 (13.33)	23 (19.16)	24 (20.00)	33 (27.50)	24 (20.00)
Education	Illiterate	Primary	Middle	Matric	Intermediate
Adopters (N=120)	13(10.83)	16(13.33)	23(19.17)	32(26.67)	18(15.00)
Non Adopters (N=120)	20(16.67)	18(15.00)	28(23.33)	26(21.67)	15(12.50)
Land holding (Hectares)	Marginal (<1.0)	Small (<1.0 to 2.0)		Mediums (<2.0 to 4.0)	Large (>4.0)
Adopters (N=120)	09(07.50)	29(24.17)		39(32.50)	43(35.83)
Non Adopters (N=120)	24(20.00)	31(25.83)		32(26.67)	33(27.50)

* Value in paranthesis represents percentage.

Table 3. Sources of information of respondents.

Source	Adopters				Non Adopters			
	Never	Sometime	Often	Most Often	Never	Sometime	Often	Most Often
Mass media								
Radio	13(10.33)*	24(20.00)	32(26.66)	51(42.50)	10(8.33)	27(22.5)	28(23.33)	55(45.83)
TV	12(10.00)	18(15.00)	52(43.33)	38(31.66)	9(7.50)	12(10)	67(55.83)	32(26.66)
Educational Film	11(9.16)	29(24.11)	28(23.33)	52(43.33)	8(6.66)	34(28.33)	30(25.00)	48(40.00)
Farm Publication	26(21.66)	19(15.33)	32(26.67)	43(45.83)	22(18.33)	18(15.00)	32(26.66)	48(40.00)
Pamphlet	20(16.66)	27(22.55)	28(23.33)	45(37.50)	9(7.50)	33(27.50)	33(27.50)	45(37.50)
Exhibition	26(21.66)	25(20.83)	46(38.33)	23(19.16)	20(16.66)	38(31.66)	40(30.33)	22(18.33)
News paper	24(20.00)	22(18.33)	36(30.00)	38(31.66)	23(19.16)	24(20.00)	35(19.16)	38(31.66)
KisanMela	18(15.00)	36(30.00)	35(29.16)	31(25.83)	12(10.00)	42(35.00)	35(29.16)	31(25.83)
Field Days	23(19.17)	37(30.83)	32(26.66)	28(23.33)	27(22.50)	33(27.50)	32(26.67)	28(23.33)
Institutional								
ADO	22(18.33)	29(24.16)	28(23.33)	41(34.16)	22(18.33)	25(20.83)	28(23.33)	45(37.50)
Ag Scientist	11(9.16)	32(26.66)	43(35.83)	34(28.33)	8(6.66)	28(23.33)	54(45.00)	30(25.00)
Extension worker	16(13.33)	27(22.50)	35(29.16)	42(35)	10(8.33)	20(16.66)	45(37.50)	45(37.50)
Panchayat Personnel	27(22.50)	22(18.33)	25(20.33)	46(38.33)	22(18.33)	12(10.00)	20(16.66)	66(55.00)
NGO	22(18.33)	21(17.50)	39(32.50)	38(31.66)	22(18.33)	20(16.66)	40(33.33)	38(31.66)
Private agency	11(9.16)	35(29.66)	40(33.33)	34(28.33)	12(10.00)	35(29.16)	34(28.33)	39(32.50)
Non Institutional								
Family Member	13(10.33)	25(20.83)	39(32.50)	43(35.83)	23(19.16)	20(16.66)	35(29.66)	42(35.00)
Relative	13(10.33)	18(15.00)	54(45.00)	35(29.16)	8(6.66)	12(10.00)	42(35.00)	58(48.33)
Friends	10(8.33)	49(40.83)	32(26.66)	29(24.16)	20(16.66)	25(20.83)	14(11.66)	61(50.83)
Village Leader	10(8.33)	51(42.50)	33(27.50)	26(21.66)	20(16.66)	45(37.50)	33(27.50)	22(18.33)
Progressive Farmer	47(39.16)	18(15.00)	25(20.83)	30(25)	40(33.33)	17(14.16)	32(26.66)	31(25.83)
Chopal Meeting	55(45.83)	18(15.00)	18(15.00	29(24.16)	40(33.33)	17(14.16)	27(22.50)	36(30.00)

* Value in paranthesis represents percentage.

Table 4. Attitude of the respondents about zero tillage technology.

Statements	Mean Score	
	Adopters	Non-adopters
ZT technology gives consistent and good yield at par with conventional.	2.48	2.13
Broad leaf weeds problem is not more in ZT technology.	2.30	2.01
Adoption of ZT reduces cost of cultivation.	2.38	2.23
All type of farmers can not adopt ZT technology.	2.18	2.08
ZT technology does not advance sowing time.	2.05	1.04
ZT technology helps to get higher income.	2.41	1.91
Insect problem is more in ZT technology.	2.58	1.39
Requirement of water is not less in ZT technology.	2.74	1.74
Adoption of ZT helps to improve soil health.	2.63	1.91
ZT does not help in reducing environment pollution.	2.01	1.81
Phalaris minor is less in ZT fields.	1.51	1.31
ZT technology does not require less labour.	1.75	1.60

Attitude: The responses on the questions related to attitude are summarized in Table 4. The attitude of respondents was ascertained based upon their response towards a set of 12 questions. Adopter's positive attitude was a significant indicator of virtues of this technology as it gave more production, reduction in irrigation and cultivation cost, sense of promotion, technical feasibility, maintaining soil health, involvement of less labor and reduction in *Phalaris minor* population.

It is evident from the results that the advantages of zero till technology in terms of production, cost saving and profitability were recognized by all the respondents. Majority of the respondents from both categories emphasized that this technology should be implemented at large scale to bring sustainability in agriculture. Adopters were more convinced about consistent and good yield in zero tillage. The study was in line with the finding of Singh *et al.* [14]. Malik *et al.* [13] also reported that attitude of farmers had been driving force of change from traditional method to zero tillage technology. Kumar *et al.* [15] found that majority of the respondents strongly agreed that zero adoption was mainly due to early sowing, lesser operational cost, less weed infestation and higher yields.

Knowledge level: It is revealed in Table 5 that adopters had more knowledge of beneficial effects of zero tillage than the non-adopters. Adopters had knowledge of zero tillage machine that it places seed at right depth, less time required to irrigate and operate zero till fields, equal seed rate as in conventional, success in different soil types, less lodging of crops, less rats infestation, more stubbles retaining, crop does not turn yellow after first irrigation, zero tillage can be used in 18 inch stubbles, proper placement of DAP fertilizer and much more synergistic advantages. Not only adopters but non-adopters also realized the benefits of this technology. Rate of adoption was comparatively good enough in all categories of farmers, so termed as resource neutral technology. Singh *et al.* [14] reported that farmers had fairly high knowledge about zero tillage in adopter category but poor in non-adopter's category. Similar findings had also been reported by Singh and Kumar [11]. Our findings are also in corroboration with those of Malik *et al.* [13] who reported knowledge regarding zero tillage technology as sign of positive effect on its adoption. Malik *et al.* [13] and Singh *et al.* [14] also reported that mass media, non-institutional and institutional organizations serve as full or occasional sources of information for both type of respondents.

Table 5. Knowledge level of the respondents about zero tillage technology.

Serial No.	Statements	Mean	
		Adopters	Non-adopters
1	Seed is placed at right depth in zero tillage technology.	0.73	0.45
2	Requires comparatively less time in irrigation.	0.88	0.77
3	Seed rate equal to conventional method in zero tillage technology.	0.72	0.64
4	Planking is not required in zero tillage technology.	0.84	0.63
5	The height of a tyne should be 50 cm in zero tillage machines.	0.78	0.58
6	Zero-tillage technology is successful in different type of soils.	0.74	0.63
7	Lodging is less in zero tillage technology.	0.69	0.59
8	The population of rats does not increase if we use zero tillage technology.	0.74	0.60
9	The population of termite does not increase in zero tillage technology.	0.78	0.54
10	Line to line distance is more in zero tillage technology then conventional method.	0.74	0.60
11	More Fertilizer is required in zero tillage technology.	0.53	0.51
12	Crop turns yellow after first irrigation.	0.44	0.63
13	Burning of residue is must in zero tillage technology.	0.53	0.32
14	Comparatively high soil moisture is good for germination in zero tillage technology.	0.54	0.50
15	Zero tillage machines can be used in 18 inch stubbles.	0.69	0.63

Level of satisfaction after adopting zero tillage: To understand satisfaction level of farmers after adoption of zero tillage technology, response was obtained on a 5 point continuum as revealed in Table 6. The data reflected that the farmers were satisfied by adopting zero tillage technology. The farmers will accept the technology if they find it economically feasible and profitable. The respondents were satisfied with achievement through zero tillage, technical feasibility, labour reduction, advantage to women, reduction in cost, scope of advancement of technology in village, timeliness of sowing and guidance from other villagers. The respondents were not satisfied with the role played by NGOs in introducing zero tillage in the region. Satisfaction level was also low on introducing zero tillage in non-rice wheat rotation and yield level.

Impact of zero tillage: The response of adopters and non-adopters on the questions related to impact are summarized in Table 7. It is evident that zero tillage resulted in higher germination percentage, time reduction per irrigation, bold seed, less lodging, terminal heat tolerance, more grains per head, time saving in operations, lower input costs, advancing date of sowing, less weed germination, soil degradation and easiness in post mechanical operations. Majority of the adopters agreed higher profitability under zero tillage. Majority of the respondents agreed that all the farmers should shift from conventional to zero tillage as there are more advantages than disadvantages; similar findings are well reported by Singh *et al*. [16].

Table 6. Level of satisfaction after adoption of zero tillage.

Statements	Mean
Achievement through ZT	4.50
Scope to prove merit for promotion of technology	3.21
Technical feasibility of technology	4.30
Ability to reduce stress of hard labour	4.20
Appreciation by neighbor	3.50
Saving in time	4.60
Advantage of technology to women	4.40
Status and prestige you enjoy from adoption of this technology	3.54
Role of institute /SAU in introduction of zero tillage	3.70
Role of state department in introduction of zero tillage	3.66
Role of NGO in introduction of zero tillage	2.50
Opportunities of using zero tillage in wheat in areas other than rice wheat	3.00
Cost saving you get	4.00
Improvement in yield	3.00
Interest of family women in adoption in zero tillage	3.62
Scope of advancement technology in the whole village	4.63
Timeliness of sowing through zero tillage	4.38
Guidance from other villagers	4.00

Table 7. Perception of the farmers about impact of zero tillage compared to conventional tillage (%).

Component	More	Same	Less
Germination	20.00	80.00	0.00
Aeration problem(yellowing of crop after first irrigation)	00.00	34.17	65.83
Insect infestation	07.50	67.50	25.00
Time required per irrigation	00.00	20.00	80.00
Lodging	00.00	18.33	81.67
Terminal heat tolerance	15.00	68.33	16.67
Bold seed	12.50	70.83	16.67
Time taken by the crop to mature	15.00	68.33	16.67
Number of grains per ear head	17.50	58.33	24.17
Fertilizer requirement	25.83	58.33	15.83
Time saving in operations	20.83	62.50	16.67
Input costs	18.33	65.00	16.67
Advancement in sowing time	17.50	58.33	24.17
Weed germination	15.83	58.33	25.83
Soil degradation	15.83	58.33	25.83
Easiness in weed spray and other post mechanical operations	20.83	62.50	16.67

Wheat yield under different tillage practices: Wheat yield with different sowing methods was evaluated to see the yield variation of different sowing methods (Table 8). During collection of data it was preferred to check effect of sowing methods on yield under both the categories to reduce marginal errors of management practices. The overall conclusion is that adopters were satisfied with yield enhancement under zero tillage and line sowing and non-adopters got maximum yield benefits under line sowing. So there is a greater scope of non-adopters to shift from conventional methods of sowing to zero tillage. Sharma *et al.* [17] found that no tillage wheat yield increased by 10 percent. Gautam *et al.* [18] reported that zero till wheat realized more yield than that of conventional method of sowing. Nagrajan *et al.* [19] also found that zero tillage increased yield by reducing time of wheat sowing and maintain soil health.

Table 8. Wheat yield (q/ha) under different tillage practices.

Tillage option	Adopters	Non adopters	't' value
ZT	48.84	00.00	000
Line sowing	48.41	47.20	4.3272**
Broadcast	46.39	46.4 1	3.260**
Reduced tillage	46.00	46.60	1.074
Rotary tillage	00	46.30	1.855

**significant at (P<0.01).

Conclusions

The combination of a significant yield effect and cost saving makes diffusion across the state worthwhile and is the main driver behind the widespread acceptance of zero tillage in Haryana. Knowledge blockages, resource constraints and zero tillage drill cost and availability all contributed to non-adoption. This suggests that there is potential to further enhance access to this technology and thereby its penetration. Cost and resource saving alone are robust and vitally significant enough to merit wide spread use, more so in view of recent structural price hikes in energy prices. There is need to enhance the accessibility of small holders to zero till drill service providers. The majority of zero till adopters so far is large farmers who have relied on contracted zero till drill services. Such services have higher merit but only when they are timely operated, reliable and widely accessible. Furthermore mass media must have a campaign through state department of agriculture extension to aware different communities with different identities. Educated and medium age group must be targeted by extension to find merit for promotion and feasibility in adopting zero tillage wheat system. Everything is new but nothing is impossible to know and adopt that is what sources of information conveys. Farmer participatory approaches will assure timely monitoring of the performance and at same time will extend adopters by visualizing how, why and when will click for more benefits and better production. Change proneness to adopt new technologies like zero till can be altered through persuasive and educational means. Any technology developed with lot of efforts will go waste in the absence of proper and adequate efforts to popularize among the farmers. For the recommendations of such technologies demonstration must be carried for the farmers so that their doubts can be removed.

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