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Knowledge assessment of farmers in rice-wheat cropping system towards conservation agriculture: A resource saving technology

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Abstract
Conservation agriculture (CA) is a resource-saving agricultural production technology, that aims to achieve production intensification and high yields while enhancing the natural resource base through compliance with three interrelated principles, viz minimum soil disturbance/ Zero Tillage (ZT), permanent soil cover and crop rotation. It is an environmentally friendly, more efficient and sustainable technology, which restore soil fertility, improve moisture conservation, ensure increased crop productivity and reduces total cost of cultivation. Despite of being such a profitable technology, low adoption and knowledge rate is seen among farmers. Thus, to assess the knowledge level of adopters and non-adopters towards CA in rice-wheat cropping system, present study was conducted in Jabalpur district of Madhya Pradesh. In the investigation, it was revealed that, 52.50 per cent of adopters and only 10.00 per cent of non-adopters, had high knowledge of CA. Also, adopters witnessed increase in the yield of wheat and Rice by 2-3q/ha.

Keywords: Conservation agriculture, principle of ca, resource saving technology, knowledge of ca

Introduction
In India, agriculture has been practiced from the time immemorable, But, due to rapidly increasing population, attaining food security and alleviating poverty, while sustaining agricultural systems under the current scenario of depleting natural resources, negative impacts of climatic variability, spiraling cost of inputs and volatile food prices has been witnessed as the major challenges before most of the Asian countries (Bhan and Behera, 2014) [1]. Therefore, a paradigm shift in farming practices through eliminating unsustainable parts of conventional agriculture (ploughing/tilling the soil, removing all organic material, monoculture) is crucial for future productivity gains while sustaining the natural resources. Thus, Conservation Agriculture (CA), a concept evolved as a response to concerns of sustainability of agriculture globally, is one of the best alternative.

According to FAO, Conservation Agriculture (CA) is an approach to managing agro-ecosystems for improved and sustained productivity, increased profits and food security while preserving and enhancing the resource base and the environment. It is characterized by three linked principles, namely: (i) Continuous no- or minimal mechanical soil disturbance (i.e., no-tillage and direct sowing or broadcasting of crop seeds, and direct placing of planting material in the soil; minimum soil disturbance from cultivation); (ii) Permanent organic soil cover, especially by crop residues, crops and cover crops; and (iii) crop rotations / associations (FAO, 2011) [3]. Also, burning of crop residues is totally prohibited and along with these three principle used a new equipment known as “Happy Seeder” is also an integral part of CA system, that helps in managing weeds through retention of crop residues as mulches, besides providing efficient seeding and fertilizer placement. It is an environmentally friendly, more efficient and sustainable technology, which restore soil fertility, improve moisture conservation, ensure increased crop productivity and reduces total cost of cultivation. CA principles are universally applicable to all agricultural landscapes and land uses with locally adapted practices.

Globally, CA covers about ~ 8% of the arable land and is being practiced on about 154.8 Mha (FAO, 2014); The major CA practicing countries are USA (26.5 M ha), Brazil (25.5 M ha), Argentina (25.5 M ha), Canada (13.5 M ha) and Australia (17.0 M ha). In India, CA adoption is still in the initial phases. Over the past few years, adoption of zero tillage and CA has

Expanded to cover about 1.5 million hectares (Jat *et al.*, 2012) [4]. In Madhya Pradesh, large number of successful trials have been conducted on CA by BISA (Borlaug Institute of South Asia, Manegoan, Jabalpur) and DWR (Directorate of Weed Research, Jabalpur), in collaboration with other institutes (DWR report, 2017) [2] and still efforts are being made to cover more area under it.

CA has been proven to be a wonderful technology, which saves time and cost required for tillage operations and land preparation by about 2500Rs/ha, as the number of tillage operations done under CT (4-6 operation) is much more than under CA (only 1 operation for sowing). Along with this, it saves fuel of about 60-80lit/ha, 3 to 5 hrs/ha of labour hours, CO_2 emission by 70-75%and reduces irrigation water by about 25-50%. Researcher has also witnessed total increase in yield by 9-36% (Pradhan *et al.*, 2018) [5]. Thus, on one hand, CA technology reduces total cost of production by saving energy, diesel, man-power, inputs and time, on the other hand also increases the production favouring sustainable agriculture. Seeing the importance of CA technology, present study was conducted to assess the knowledge level of adopters and non-adopters towards CA in rice-wheat cropping system.

Methodology

The present study was conducted in Jabalpur district of Madhya Pradesh, which comprises of 7 blocks, out of which, four blocks namely Panagar, Patan, Shahpura and Sihora were selected purposively, as these are the only blocks, where CA technology is adopted by the farmers. 17 villages, adopting CA were selected and from each selected village, a total of 80 adopters and 80 non-adopters of CA were short-listed as respondents. To assess the knowledge level of adopters and non-adopters towards CA, index with a set of 30 statement was developed and the responses of the farmers were recorded through personal interview on 3 continuum viz. complete, partial or no knowledge. The collected data were tabulated and presented in the form of tables and graphs and analysis was done by percentage, mean, standard deviation, coefficient of variation, paired t-test, correlation and regression analysis to draw meaningful conclusion.

Result and Discussion

Knowledge level of adopters and non-adopters towards CA, was computed by totaling mean scores of their responses for individual statements, categorized into 3 sub-heads viz. knowledge on concept of CA, benefits of CA and knowledge about reduction in total cost of cultivation.

Table 1: Distribution of adopters and non-adopters of CA according to their mean score of knowledge level towards concept of CA

S.No.	Statements	Adopters		Non-Adopters	
		MS	R	MS	R
[A]	Knowledge of concept of CA				
1.	CA technology involves 3 principles:- a. minimum soil disturbance b. permanent soil organic cover c. crop rotation	3.00	I (a)	1.57	IV
2.	Burning of crop residues is totally prohibited in CA.	3.00	I (b)	1.70	I(a)
3.	Ploughing of land for land preparation is totally restricted.	3.00	I (c)	1.70	I(b)
4.	Happy-seeder is the implement used for seed sowing, along with fertilizer application and incorporating the crop residues in field.	3.00	I (d)	1.60	III
5.	Sowing of wheat can be done immediately after harvesting of rice with ideal moisture.	2.27	V	1.20	VI
6.	Through happy-seeder, both seeds and fertilizers are is sown at most fertile zone of soil.	2.78	IV	1.35	V (a)
7.	Standing (anchored) stubbles of rice upto 1.5ft is not a problem.	1.80	VI	1.11	VII
8.	Residue of the previous crop is used as mulch for the prevailing crop.	3	I (e)	1.35	V(b)
9.	We can take 3 crops in a year, incorporating a leguminous crop in zaid, which increases profitability.	2.90	II	1.67	II
10.	Integrated weed management is necessary in CA.	2.88	III	1.70	I(c)
11.	Over All Mean	2.76		1.49	

[A] Knowledge level of adopters and non-adopters towards concept of CA

From persual of the data of Table 1 depicted the mean knowledge score of knowledge level of adopters and non-adopters towards concept of CA. The knowledge mean score of adopters ranged from 1.80 to 3, while that of non-adopters ranged from 1.11 to 1.70, and their overall mean scores were 2.76 and 1.49 respectively. Among adopters, cent percent knowledge for all the 3 principles of CA, totally restriction of ploughing and burning of crop residues, seed sowing through a implement known as happy seeder and crop residue of previous crop is used as mulch, was seen. These 5 statements ranked I (a), I(b), I(c), I (d), I(e) respectively with a total mean score of 3. Knowledge for the fact that, we can take 3 crops in a year, incorporating a leguminous crop in zaid, which increases profitability got a mean score of 2.90 and ranked second. A total mean score of 2.88 with rank third was given to the concept that, integrated weed management is necessary in CA. Through happy-seeder, both seeds and fertilizers are is sown at most fertile zone of soil received fourth rank with 2.78 mean score. The statements whose knowledge mean score was less than the overall mean score were sowing of wheat can be done immediately after harvesting of rice with ideal moisture and standing (anchored) stubbles of rice upto 1.5ft is not a problem, with mean score of 2.27 and 1.80 respectively. They were assigned rank fifth and sixth.

On the other hand, among non-adopters, the statements whose knowledge mean score was higher than over all mean score were ploughing and burning of crop residue is totally restricted and integrated weed management is necessary in CA, with ranks I(a), I(b) and I(c) respectively and mean scores 1.70. Statement, we can take 3 crops in a year, incorporating a leguminous crop in zaid, which increases profitability, received second rank with 1.67 mean score. Happy-seeder is the implement used for seed sowing, along with fertilizer application and incorporating the crop residues in field had 1.60 mean score with rank third. Knowledge of all the 3 principles of CA ranked fourth with mean score 1.57. The statements that had lower mean score than over all mean score were, through happy-seeder, both seeds and fertilizers are is sown at most fertile zone of soil.and crop residue of previous crop is used as mulch with mean score of 1.37 and rank V(a) and V(b). Sowing of wheat can be done

immediately after harvesting of rice with ideal moisture and standing (anchored) stubbles of rice upto 1.5ft is not a problem, received mean score of 1.20 and 1.11 with ranks sixth and seventh respectively.

Thus, it is clear that, among both the categories, for the statements receiving mean score lower than the overall mean score, the knowledge level of the farmers is less, and has the scope to be raised.

Table 2: Knowledge level of adopters and non-adopters towards benefits of CA

(B)	Benefits of CA	Mean Score	Rank	Mean Score	Rank
1.	Reduced tillage, helps in reduction in loss of soil organic carbon (SOC) or matter and nutrients.	2.27	VII	1.32	VI
2.	SOC improve soil fertility and holds moisture.	2.13	VIII	1.35	V(a)
3.	Minimum soil disturbance, prevents soil erosion and improves infiltration rate.	2.57	VI (a)	1.35	Vb)
4.	Mulching helps in moisture conservation.	2.68	IV (a)	1.28	VIII
5.	Dependence on rainfall for sowing decreases, as seed sowing can be done at residual moisture.	2.88	II	1.15	IX (a)
6.	CA also guarantees nutrient availability after decomposition of the residue.	2.65	V (a)	1.15	IX (b)
7.	Leguminous crops included in crop rotation helps in N_2 fixation, which improves soil fertility.	2.57	VI (b)	1.47	III
8.	Emergence of crop under CA is 1 or 2 days earlier than Conventional tillage.	2.78	III	1.30	VII (a)
9.	The crop vigour is better than conventional tillage.	2.68	IV (b)	1.46	IV
10.	Timely operations are possible.	2.90	I	1.52	II
11.	CA is successful in both heavy and relative light soils.	1.80	IX	1.30	VI I(b)
12.	CA acts as an alternative for climate change mitigation.	2.65	V(b)	1.61	I
	Over all mean score	2.54		1.35	

[B] Knowledge level of adopters and non-adopters towards benefits of CA

Knowledge level of adopters and non-adopters towards benefits of CA, showed the knowledge mean score of adopters ranged from 1.80 to 2.90, while that of non-adopters ranged from 1.15 to 1.61, and their overall mean scores were 2.54 and 1.35 respectively. Among adopters, the statements whose knowledge mean score was higher than over all mean score were, in CA timely operations are possible with mean score 2.90 and rank first. Dependence on rainfall for sowing decreases, as seed sowing can be done at residual moisture. got a mean score of 2.88 and ranked second. A total mean score of 2.78 with rank third was given to the statement that, emergence of crop under CA is 1 or 2 days earlier than conventional tillage. Statements, minimum soil disturbance, prevents soil erosion and improves infiltration rate and mulching helps in moisture conservation, received rank IV (a) and IV (b) with 2.68 mean score. Statements CA acts as an alternative for climate change mitigation and CA also guarantees nutrient availability after decomposition of the residue scored a total knowledge mean score 2.65 with rank V (a) and V (b) respectively. Knowledge mean score for statements, minimum soil disturbance, prevents soil erosion and improves infiltration rate and leguminous crops included in crop rotation helps in N_2 fixation, which improves soil fertility was 2.57 with ranks VI(a) and VI (b) respectively.

The statements having knowledge mean score less than the overall mean score were reduced tillage, helps in reduction in loss of soil organic carbon (SOC) or matter and nutrients, SOC improve soil fertility and holds moisture and CA is successful in both heavy and relative light soils, with mean scores and ranks 2.27 (7^{th}), 2.13 (8^{th}) and 1.80 (9^{th}) respectively.

On the other hand, among non-adopters, the statements whose knowledge mean score was higher than over all mean score were CA acts an alternative for climate change with mean score 1.61 and rank first. Knowledge level for the statement that timely operations are possible ranked second with mean score 1.52. Leguminous crops included in crop rotation helps in N2 fixation, which improves soil fertility ranked third with mean score of 1.47. The crop vigour is better than conventional tillage ranked 4^{th} with mean score of 1.46. Statements SOC improvs soil fertility and holds moisture and minimum soil disturbance prevents soil erosion and improves infiltration rate ranked V (a) and V(b) with mean score of 1.35. Further, the statements having knowledge mean score less than the overall mean score were reduced tillage, helps in reduction in loss of soil organic carbon (SOC) or matter and nutrients ranked sixth with mean score of 1.32. Emergence of crop under CA is one or 2 days earlier than conventional tillage and CA is successful in both heavy and relative light soils VII (a) and VII (b) with mean score 1.30. Mulching helps in moisture conservation ranked eight with means score 1.28. Statements Dependence on rainfall for sowing decreases, as seed sowing can be done at residual moisture and CA also guarantees nutrient availability after decomposition of the residue ranked IX (a) and IX (b) respectively with mean score of 1.15.

Table 3: Knowledge level of adopters and non-adopters towards benefits of CA

S.No.	Savings in total cost of cultivation	Mean Score	Rank	Mean Score	Rank
1.	Saves cost of man-powers.	3.00	I (a)	1.67	I (a)
2.	CA can save diesel upto 20-25 l/acre.	2.88	II (a)	1.47	IV
3.	The saving of at least Rs. 2000-7000/ha is possible by using CA.	2.88	II (b)	1.55	II(a)
4.	It saves inputs (viz. seeds, fertilizers, insecticides, etc.) but in the consecutive year, not in the first year of adopting this technology.	2.88	II (c)	1.55	II(b)
5.	The water does not remain stagnant in CA after first irrigation.	2.08	IV	1.11	V
6.	Less incidence of insects and pests, earthworms termites and rats specially yellow stem borer does not increase in rice after wheat using CA technology. Thus, saves cost of insecticides and pesticides.	2.65	III	1.52	III
7.	The yield in CA field is more or equal as in conventional tillage.	3.00	I (b)	1.67	I (b)
8.	Total cost of cultivation is less in CA as compared to conventional tillage.	2.88	II (d)	1.67	I (c)
	Over all mean score	2.78		1.52	

[C] Knowledge level of adopters and non-adopters towards savings in total cost of cultivation

Table 3 depicted the mean knowledge score of knowledge level of adopters and non-adopters towards savings in total cost of cultivation. The knowledge mean score of adopters ranged from 2.08 to 3, while that of non-adopters ranged from 1.11 to 1.67, and their overall mean scores were 2.76 and 1.49 respectively. Among adopters, the statements whose knowledge mean score was higher than over all mean score were CA saves cost of man power and the yield in CA field is more or equal as in conventional tillage received mean score of 3.00 with ranks I(a) and I(b) respectively. Statements, CA can save diesel upto 20-25 l/acre, the saving of at least Rs. 2000-7000/ha is possible by using CA, it saves inputs (viz. seeds, fertilizers, insecticides, etc.) but in the consecutive year, not in the first year of adopting this technology and total cost of cultivation is less in CA as compared to conventional tillage, got the total mean score of 2.88 with ranks II(a), II(b), II(c), II(d) and II(e). The statements having knowledge mean score less than the overall mean score were less incidence of insects and pests, earthworms, termites and rats specially yellow stem borer does not increase in rice after wheat using CA technology and the water does not remain stagnant in CA after first irrigation, ranked third and fourth with mean score of 2.08 and 2.65 respectively.

On the other hand, among non-adopters, the statements whose knowledge mean score was higher than over all mean score were, CA saves cost of man power and the yield in CA field is more or equal as in conventional tillage had mean score of 1.67 with ranks I(a) and I(b) respectively. Knowledge of the statements viz, the saving of at least Rs. 2000-7000/ha is possible by using CA, it saves inputs (viz. seeds, fertilizers, insecticides, etc.) but in the consecutive year, not in the first year of adopting this technology and total cost of cultivation is less in CA as compared to conventional tillage, got the total mean score of 1.55 with ranks II (a), II(b) and II(c). A total knowledge mean score of 1.52 with rank third was given the statement less incidence of insects and pests, earthworms, termites and rats especially yellow stem borer does not increase in rice after wheat using CA technology. Further, the statements having knowledge mean score less than the overall mean score were CA can save diesel upto 20-25 l/acre and the water does not remain stagnant in CA after first irrigation with ranks fourth and fifth and mean scores of 1.47 and 1.11 respectively.

Table 4: Distribution of adopters and non-adopters of CA according to their overall knowledge level

S. No	Category	No. of respondents		Percentage	
		A	NA	A	NA
1.	Low (39-65)	8	53	10	66.25
2.	Medium (66-91)	30	19	37.5 0	23.75
3.	High (92-117)	42	8	52.50	10
Total		80	100	80	100
Mean		2.64		1.46	
Variance		0.143		0.039	
t-test value		21.15*			

*Significant at 0.05 probability level, $T_{tab=1.99}$

The perusal of the Table 4 reveals that, out of the total adopters of CA, higher percentage (52.50%) were having high knowledge about the practices under CA technology, followed by medium (37.50%) and low (10.00%) knowledge level. On the other hand, among non-adopters higher percentage (66.25%) were having low knowledge about the practices under CA technology, followed by medium (23.75%) and high (10.00%) knowledge level.

Thus, it can be concluded that more than half of the adopters (52.50%) were having high knowledge about, while majority of the non-adopters (66.25%) had low knowledge about the practices under CA technology. Clearly difference between the knowledge levels of both the categories can be seen.

Also, from the Table 4.23, the mean values for the knowledge level of adopters and non-adopters were computed. The data pointed about the variation in two means 2.64 and 1.46 with variance.143 and.039 respectively. A paired t - test was applied to find the significance of the difference of knowledge among both the categories and was found that, calculated t-test (21.15) value was larger than its tabulated value (1.99). Hence, there was significant difference in the knowledge level of adopters and non-adopters of CA.

Conclusion

It can be concluded from the study that, CA can be an alternative in doubling farmers' income and managing the problems of weeds, by reducing the total cost of cultivation and increasing the yield and aiming at optimizing yields and profits, achieving a balance of agriculture, economics and environment. Despite of being such a profitable technology, lack of knowledge is seen among both the categories. Though, in comparison to adopters, knowledge level of adopters was found to be high, but only half of the adopters (52.5%) had high knowledge, while majority of the non-adopters (62.50%) had low knowledge towards CA. Further, we can conclude that, still there is much scope of disseminating knowledge and awareness of this technology among farmers, which can be done by covering larger area under CA, through demonstrations in farmers field and telling them about it benefits.

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