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Gender perspective of conservation agriculture

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ABSTARCT

Conservation agriculture (CA) technologies are the future of sustainable agriculture. Many research, and developmental organizations including farmers group are engaged in promoting CA technology for more than a decade. Gender has an important role in adoption and dissemination of CA technologies that include use of zero tillage, paddy transplanter, crop diversification and other interventions. Present study has been conducted in Madhubani district of Bihar state to analyse gender segregated key benefits, advantages, disadvantages, issues and the key decision processes and criteria for CA technology adoption. Data were collected through focus group discussions involving male and female farmers. Important advantages of CA technologies expressed by the farmers group were reduction of labour, time saving, better yield, cost saving, low tillage cost and reduction in drudgery. The key problems and issues affecting the performance of CA technologies included the weed control, poor germination, and limited skills of machine operators. Labour saving, cost saving, enhanced productivity, time-saving, less irrigation requirement, and higher yield were among the most important factors that led to adoption of zero tillage in rice-wheat system. Preparation of mat nursery and trained operators for paddy transplanter were major criteria for adoption of mechanical paddy transplanter. Farmers were sceptical about the risk associated with CA technologies that included poor seed germination and weed infestation.

Key words: Conservation agriculture, Gender, Madhubani, Paddy transplanter, Technology adoption, Zero tillage

Conservation Agriculture (CA) is a concept for resource-saving agricultural crop production that strives to achieve acceptable profits together with high and sustained production levels while concurrently conserving the environment (FAO 2006). It is based on enhancing natural biological processes above and below the ground. Interventions such as mechanical soil tillage are reduced to an absolute minimum, and the use of external inputs such as agrochemicals and mineral nutrients are applied at an optimum level. CA is defined as crop management that minimise soil disturbance, maintains residue mulch on the soil surface and uses crop rotations for higher productivity.

In India, CA system has been partially practised in the form of zero tillage in winter crops, mainly in wheat in rice-wheat cropping system of Indo-Gangetic Plains. Delayed planting of wheat after late harvesting of long duration conventional transplanted rice is the main bottleneck in harnessing enormous natural resources of eastern IGP for realising higher yield of wheat. Eastern IGP, especially Bihar is experiencing an impressive phase of economic development which has dramatically reduced availability of farm labour due to rapid labour migration from agriculture to non-agriculture sectors like construction, housing and new initiatives taken by government (Singh *et al*. 2010). Previous research found the use of ZT to be a promising technology for sustainable wheat intensification in the eastern IGP where yields are particularly low. Apart from longer-term benefits, immediate cost-savings as compared to conventional tillage are expected to make the technology attractive to farmers (Gathala *et al*. 2013, Keil *et al*. 2015).

Other interventions in CA include raised-bed planting systems, laser equipment aided land levelling, residue management practices, diversification of rice-wheat system etc. It has been reported that the area under zero-till wheathas been increasing rapidly (Sangar *et al*. 2005), and presently 25% – 30% of wheat is zero-tilled in rice-wheat growing areas of the Indo-Gangetic plains of India. In Bihar, ZT technology has been adopted in nearly 3.0 lakh ha area. However, there are potential benefits of conservation agriculture across different agro-ecoregions and farmers groups. The benefits range from nano-level (improving soil properties) to micro-level (saving inputs, reducing cost of

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Table 1 Participation in FGDs by gender

Nodes along with its GPS coordinates (latitude and longitude)	Season	Period	No.of FGDs	No. of persons		
				Male	Female	Total
Korahia, Jainagar N 26.52762;E086.15281	Pre-*Rabi*; *Rabi* and Pre- *Kharif*	October 2015, January 2016, May 2016 and October 2016	9	34	58	92
Khairi, Lakhnaur N 26.19332;E086.29973			9	48	41	89
Mahuahi, Babubarhi N 26.44334;E086.29462			9	43	46	89
Nanore, Andhrathadi N 26.33079;E086.32599			9	29	52	81
Sukhet, Jhanjharpur N 26.26615;E086.29819			9	41	36	77
Total			45	195	233	428

production, increasing farm income), and macro-level by reducing poverty, improving food security, alleviating global warning (Joshi 2011).

Women are the backbone of agriculture and play a vital role in agricultural production, management, post-harvest and value addition activities. Extent of female participation in agriculture varies with landowning status of farm households. Out of total female workforce, 79.22% are engaged in agriculture as against only 43.48% male work force (Anonymous 2014). Wherever the new agricultural technology led to multiple cropping, the work load of women has increased. While a number of tasks performed by males have been mechanized, the tasks usually allotted to women continue to be manual and suffer from drudgery. Even where improved techniques have been found suitable for the women, there is not sufficient access to training in such techniques.Encompassing the technological innovations such as weeders, multicrop drills, paddy threshers, winnowers, sprayers, harvesting tools, maize shellers, *dal* making machines etc., has reduced the burden of women. Transplanting of rice is highly labour intensive and majority of the transplanting is done by the female. Use of zero tillage and paddy transplanter has certainly reduced drudgery, especially of women farmers (Singh *et al*. 2014). This paper discusses about the gender segregated key advantages, disadvantages, issues, and the decision processes and criteria for conservation agriculture technology adoption in Madhubani district of North Bihar.

MATERIALS AND METHODS

Madhubani district located in northern parts of Bihar comprises 21 blocks**.** Five villages - Korahia, Sukhet, Nanore, Mauahi and Khairi respectively from Jainagar, Jhanjharpur, Andhrathadi, Babubarhi and Lakhnaur blocks were selected for undertaking the studies. These villages had diverse agro ecological situations. Focus Group Discussions (FGDs) technique was adopted for getting information and perception of the farmers in a particular village. FGDs were done for exploring issues with a community or group for following purposes: (a) Understanding resources of the area, existing crops, technologies and human capital. (b) Evaluate farmer perceptions of the suitability, benefits, costs and risks of the technologies being adopted by the farmers. (c) Get responses from farmer/community groups about the CA technology in the area.

FGDs were carried out by interacting thoroughly with 9 focus groups separately in each node (4 male, 4 female and 1 mix groups). Each focus group consists of 8-15 individuals (men/women or mix). Thus, total 45 FGDs were conducted. Care was taken to have representation from each category (landless, marginal farmers, small farmers, large farmers, small traders, farm women etc.) of household during FGDs in the selected villages. Help of village panchayat, SHGs and other institutions wasalso taken to get village related informations. A qualitative research approach was employed in analyzing the key decision processes and criteria for CA technology adoption among farmers in Madhubani.

RESULTS AND DISCUSSION

The CA technologies (ZTDSR, mechanical rice transplanting and ZT wheat) were assessed in terms of their advantages and disadvantages, criteria for adoption, problems and risk involved in adoption of the technologies as perceived by the farmers group.Across five nodes, a total of 428 participants were involved in the FGDs consisting of 195 males (46 %) and 233 females (54 %) (Table 1). The CA technologies assessed included zero-till wheat, Zero till direct-seeded rice (ZTDSR) and rice transplanter.

Problems and issues

The advantages associated with adoption of ZTDSR as identified by the groups across villages include: labour saving (97.77%), time saving/timely seeding (77.77%), increased yield/better production (75.55%), lesser tillage cost (95.55 %), reduction in drudgery (84.44 %), less irrigation/ water saving (84.44%) (Table 2).

On the other hand, the problems associated with the use of ZTDSR technologies include: more weed problem (77.77 %), poor germination (48.88 %), low yield (68.88%), uneven sowing (46.66%). Among those groups that identified the disadvantages, limited knowledge of herbicide use (100%) and excess weed (80 %) topped in female FGD

Table 2 Advantages of ZTDSR

Factor	Group response (N= 45)			
	Male (N=20)	Female (N=20)	Mix (N=5)	Total
Labour saving	19 (95)	20 (100)	05 (100)	44 (97.77)
Time saving and timely seeding	16(80)	15(75)	04(80)	35 (77.77)
Reduction in drudgery	14 (70)	20(100)	04(80)	38 (84.44)
Lesser tillage cost	19(95)	19(95)	05(100)	43 (95.55)
Water saving	12(60)	13(65)	03(60)	38 (84.44)
Higher yield	15(75)	15(75)	04(80)	34 (75.55)

*Figures in parentheses indicates percentage.

Table 3 Problems associated with adoption of ZTDSR

Factor	Group response (N=45)			
	Male	Female	Mix	Total
Excess weeds	15(75)	16 (80)	04 (80)	35 (77.77)
Poor germination	10(50)	11 (55)	01(20)	22 (48.88)
Limited knowledge of herbicide use	14 (70)	20 (100)	05(100)	39 (86.66)
Not uniform seeding and spacing (Seedling uniformity)	08 (40)	10 (50)	03(60)	21 (46.66)
Low yield	15 (75)	14 (70)	02(40)	31 (68.88)

*Figures in parentheses indicate percentage.

groups followed by low yield (70 %), poor germination (55 %) and not uniform seeding and spacing (50 %). For male groups, an equal distribution of FGD sessions cited the same disadvantages such as excess weed (80%), lower yield (70 %), limited knowledge of herbicide use (70 %), poor seed germination (50%) and not uniform seeding and spacing (40%) (Table 3).

Participants in focus group were asked about advantage and disadvantages of mechanical paddy transplanter. Major advantages includes: line transplanting (100%), reduction in input cost (82.22 %), drudgery reduction (88.88%), more yield (80 %) and labour saving (77.77 %). Male and female groups expressed almost similar advantages of mechanical paddy transplanter (Table 4). The machine has some disadvantage also, that include: preparation of mat nursery (80 %), uneven sowing (no uniform transplanting) if land is not levelled (68.88 %) and gap filling in case of missed placing of rice seedlings (48.88 %). Among male groups, preparation of mat nursery (90%) was top most disadvantage, followed by seedling uniformity (75%) and gap filling (50%). Among female groups also, preparation of mat nursery (70%) was top most disadvantage, followed by seedling uniformity (60%) and gap filling (45%). Mix groups expressed preparation of mat nursery and seedling uniformity (80%) as top most disadvantage (Table 5) for further scaling of area under mechanical transplanted rice

Table 4 Advantages of mechanical paddy transplanter

Factor	Group response			
	Male	Female	Mix	Total
Labour saving	15(75)	16(80)	04(80)	35 (77.77)
More yield	16(80)	16 (80)	04(80)	36 (80)
Reduction in input cost	17(85)	15(75)	05(100)	37 (82.22)
Line transplanting makes intercultural operation easier	20(100)	20(100)	05(10)	45 (100)
Reduction in drudgery	15(75)	20(100)	05 (100)	40 (88.88)

*Figures in parentheses indicates percentage.

Table 5 Disadvantages of mechanical paddy transplanter

Factor	Group response			
	Male	Female	Mix	Total
Preparation of mat type nursery	18(90)	14(70)	04(80)	36 (80)
Gap filling	10(50)	09(45)	03(60)	22 (48.88)
Seedling uniformity	15(75)	12(60)	04(80)	31(68.88)

*Figures in parentheses indicates percentage.

in Madhubani district.

Table 6 depicts advantages of ZT wheat. All groups (100 %) revealed saving of input and tillage cost, timely sowing (93.33 %), saving of labour (91.11%), saving of water (82.22%) and higher yield (73.33%) in ZT sown wheat. On the other hand, the problems associated with the use of ZT wheat technologies include: non-availability of trained tractor drivers for machine operation (80%), appropriate moisture at the time of sowing (77.77%), poor germination in case of inappropriate depth of sowing (62.22 %), more weeds at the time of sowing (55.55%) and choking of seed and fertilizer pipe in case of excess moisture (53.33%) (Table 7).

Various issues were also encountered by the farmers across the villages during the use of the technologies. In general, issues encountered by majority of the villages

Table 6 Advantages associated with adoption of ZT wheat

Factor	Group response			
	Male	Female	Mix	Total
Timely sowing	18 (90)	19 (95)	05 (100)	42 (93.33)
Saving of labour	18 (90)	18 (90)	05(100)	41(91.11)
Saving of input and tillage cost	20 (100)	20 (100)	05(100)	45(100)
Higher yield	15 (75)	14 (70)	04(80)	33 (73.33)
Saving of Water	16 (80)	17 (85)	04(80)	37 (82.22)

*Figures in parentheses indicate percentage.

Table 7 Problems associated with adoption of ZT wheat

Factor	Group response			
	Male	Female	Mix	Total
Choking of seed and fertilizer pipe in case of excess moisture	12(60)	10(50)	02(40)	24 (53.33)
Poor germination in case of inappropriate depth of sowing	13(65)	12(60)	03(60)	28 (62.22)
Appropriate moisture required at the time of sowing	15(75)	16(80)	04(80)	35 (77.77)
More weed at the time of sowing	10(50)	12(60)	03(60)	25 (55.55)
Trained tractor driver	15(75)	16(80)	05(100)	36 (80.00)

*Figures in parentheses indicate percentage.

include limited operators/limited skills of operators and mechanics, more weed at the time of sowing, proper levelling of the fields, appropriate moisture required at the time of sowing, availability of herbicides for weed management, timely availability of machines during the season, training for women farmers etc.

Criteria for technology adoption

The participants of the FGD in Madhubani were particularly asked to the criteria for adopting ZT technology in wheat and rice. In all nodes, the labour saving (100%) of the technology was highlighted. Majority of the nodes identified input cost saving (86.66%), enhanced yield (73.33%), tillage time saving (75.55%), less irrigation (82.22%), machine availability (91.11%), availability of skilled operators of the machine (ZT machine, rice transplanter, etc) (31.11%) and technical skills/technical support (33.33 %). Groups of some villages also expressed moisture content of the field (28.88%) and no stagnant water (33.33%) as criteria for technology adoption (Table 8). Equal percentage of male and female farmers expressed labour saving as one of the most important criteria for adoption of the ZT. Gender segregated data showed almost similar perception related to criteria adoption of ZT technology in rice-wheat system (Fig 1). For example, input cost saving was reported by 90 and 85 % male and female, respectively.

Table 8 Criteria for adoption of ZT Technology

Factor	Group response			
	Male	Female	Mix	Total
Saving of labour	20 (100)	20 (100)	05(100)	45 (100)
Input cost saving	18 (90)	17(85)	04(80)	39 (86.66)
Enhanced yield	15(75)	14(70)	04(80)	33 (73.33)
Time saving	16(80)	15(75)	03(60)	34 (75.55)
Saving of water	16(80)	17(85)	04(80)	37 (82.22)
Availability of machine	18(90)	18(90)	05(100)	41(91.11)
Skilled operator availability	05(25)	06(30)	03(60)	14 (31.11)
Technical and other support	06(30)	05(25)	04(80)	15 (33.33)
Moisture content in the field	05(25)	06(30)	02(40)	13 (28.88)
No flooding/ stagnant water	06(30)	06(30)	03(60)	15 (33.33)

*Figures in parentheses indicate percentage.

The participants of the FGD were also asked about the criteria for adopting mechanical paddy transplanter. Most of the men farmers (90%), women farmers (75%) and

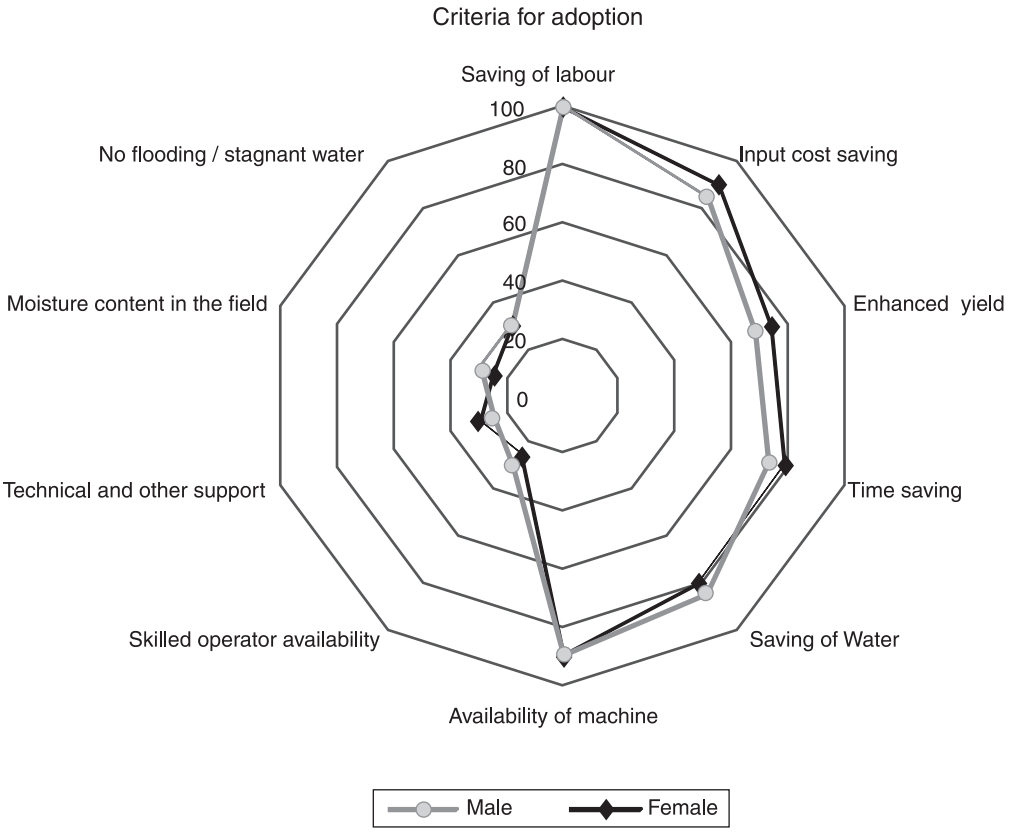

Fig 1 Criteria for adoption of ZT technology in Madhubani.

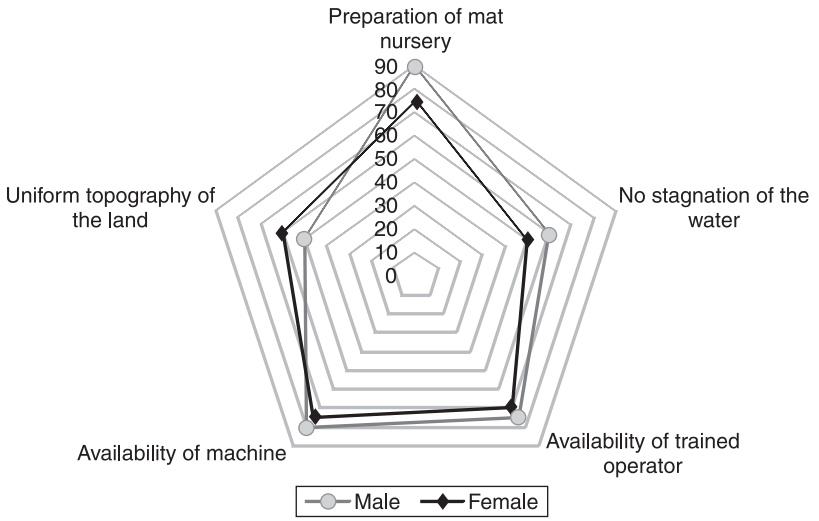

Fig 2 Criteria for adoption of mechanical paddy transplanter in Madhubani.

mix groups (100%) considered preparation of mat nursery as a crucial consideration (Fig 2). It was also important that there should not be stagnant water in the field during use of transplanter according to male (60%) and female farmers (50%). Also, availability of trained operators as expressed by 75% male and 70% female groups as well as availability of machine is also deciding criteria according to 80% male and 75% female for adoption of mechanised paddy transplanting technologies. Uniform topography of land was particularly important for both male (50%) and female farmers (60%) (Table 9).

Risk associated with CA technology adoption

Madhubani district is prone to flood as well as drought. Agricultural vulnerability is dependent upon climatic, biological, social and other infrastructural factors. Out of five studied villages in the district, agricultural vulnerability in four villages (Korahia, Sukhet, Nanore and Mauahi) was medium. Agricultural vulnerability index in these four villages varies from 0.36 to 0.48 that reveals that one should adopt technologies, crops and strategies which can minimize risk from adverse climatic, social and biological factors (Kumar *et al*, 2016). A number of potential risks associated with adopting CA technology were identified in the district (Table 10). Majority of the male farmers (70%) believed there was no change in yield while the remaining 30% reported increase in yields. Among female farmers, 47% believed yield enhancement with the technology introduced. On the effect on food security, majority of male farmers (75%) was optimistic while the remaining 25% expressed there was no change. Among women farmers, 53% were optimistic while the remaining 47% did not agree. In terms of income, majority of the male farmers (80%) experienced increase in income while the remaining 20% experienced decrease in income. Similarly, more female farmers (67%) experienced increase in income compared to those who experienced decreased in income (33%). In terms of timely availability of the machine, majority of male farmers (77%) had positive experience with machine availability compared to those who experienced delays (23%). Majority of female farmers (85%) reported timely machine availability while remaining 15% experienced delays. Other risks identified include weed problem among men (37 %) and most especially women (40%) farmers. Lastly, in terms of early planting opportunity, majority (78%) of male farmers were willing to use zero-tillage/direct-seeded rice in June while 22% were not willing. For women farmer almost equal proportion of willing farmers (76%) were observed while the remaining 24% were not willing to use ZT rice in June. The reasons for adopting early planting include increase of yield, saving of water, timely sowing of *rabi* crops. The farmers who were not willing to adopt early planting identified the risks of high temperature, lack of moisture during the month and the presence of summer crops (especially moong bean) in the field.

Table 9 Criteria for adoption of mechanical paddy transplanter

Factor	Group response			
	Male	Female	Mix	Total
Preparation of mat nursery	18(90)	15(75)	05(100)	38 (84.44)
No stagnation of the water	12(60)	10(50)	02(40)	39 (86.66)
Availability of trained operator	15(75)	14 (70)	04 (80)	33 (73.33)
Availability of machine	16(80)	15 (75)	03(60)	34 (75.55)
Uniform topography of the land	10 (50)	12(60)	03(60)	25 (55.55)

*Figures in parentheses indicate percentage.

Table 10 Risks associated with CA technology in Madhubani

Risk	Opinion/ comments	Male (%)	Female (%)
Effect on yields	Increase	30	47
	No Change	70	53
Effect on food security	Increase	75	53
	No change	25	47
Effect on income	Increase	80	67
	Decrease	20	33
Timely availability of machine	Yes	77	85
	No	23	15
Early planting	Yes	78	76
	No	22	24
Other risks	No problem	63	60
	Weed problem	27	40

This paper explored the key decision processes and criteria for CA technology adoption in Madhubani district of Bihar. The technology was found promising and among its very important features were reduction of labour, time saving, better yield, cost saving, low tillage cost and reduction in drudgery. All women groups expressed positive response related to drudgery reduction by adoption of CA technologies. The reduction of labour was primarily attributed to less labour requirement for nursery preparation, tillage, and replanting. The key problems and issues affecting the performance CA technologies include the weed control, poor germination, and limited skills of machine operators.

The main concern of the farmers was the timely availability of the machine and it contributed to a major risk in their crop production. While the early planting opportunity could open to a lot of advantages in terms of whole cropping system of the farmer and intensifying production, the timing issues for the harvest season, especially of *rabi* was a major risk. Hence, micro area planning is needed so that maturities of the adjacent plots concede to enable sowing of next crop timely.

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REFERENCES

Anonymous. 2014. Statistical profile on women labour. Labour Bureau, Ministry of Labour and Employment, Goverment of India.

FAO. 2006. http://www.fao.org/ag/ca/en/1a.html

Gathala M K, Kumar V, Sharma P C, Saharawat Y S, Jat H S, Singh M, Kumar A, Jat M L, Humphreys E, Sharma D K, Sharma S, and Ladha J K. 2013. Optimizing intensive cereal based systems addressing current and future drivers of agricultural change in the northwestern Indo-Gangetic Plains of India. *Agriculture, Ecosystems and Environment* **177**: 85–97.

Joshi P K. 2011. Conservation agriculture: An overview. *Indian Journal of Economics* **66**(1): 53–63.

Keil A, D'souza A, and McDonald A J. 2015. Zero-tillage as a pathway for sustainable wheat intensification in the Eastern Indo-Gangetic Plains: Does it work in farmers' fields? *Food Security* **7**(5): 983–1001.

Kumar Ujjwal, Sarkar B, Chaubey R and Bhatt B P. 2016. Agricultural vulnerability assessment: A case of Madhubani district, Bihar. *Research Journal of Agricultural Sciences* **7**(2): 372–4.

Sangar S, Abrol J P and Gupta R K. 2005. *Conservation Agriculture: Conserving Resources Enhancing Productivity*, 19 p.Centre for Advancement of Sustainable Agriculture, National Agricultural Science Complex, New Delhi.

Singh R G, Kumar R and Gupta R K. 2010. Conservation agriculture based resource conservation technologies for rice-maize system for eastern IGP. *Resource Conservation Technologies for Food Security and Rural Livelihood*, pp 98–106.

Singh S S, Singh A K and Sundaram P K. 2014. Agro technological options for upscaling agricultural productivity in eastern Indo Gangetic plains under impending climate change situations: A review. *Journal of Agrisearch* **1**(2): 55–65.