

NATURAL RESOURCES SYSTEMS PROGRAMME
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Zero tillage technology in wheat as tool of resource conservation, higher yield and better livelihood.

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Report Authors

Singh, S.S., Khan, A.R., Prasad, L.K., Sikka, A.K. and Gaunt, J.L.

Organisation

Rothamsted Research and ICAR Research Complex for Eastern Region

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NRSP Production System

High Potential

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Summary

Zero tillage (ZT) machines were used widely in western and northern part of India for sowing of crops without ploughing. However, in eastern India ZT is new introduction and is being largely popularized in Indo Gangetic Basin. In Bihar and eastern Uttar Pradesh, November 15 to 10 December is recommended sowing time of wheat. Delay in sowing reduces yield inspite of all input application. The yield reduction is upto 55%. The problem is more aggravated when rice is harvested delayed till December last and field has excess soil moisture. ZT of wheat is a good option under these conditions.

The spread of Zero Tillage wheat was done in 21 villages in RPC-5 during winter season 2001-02 for sowing of wheat crop. Five ZT machine supported from DFID project were provided to the farmers of 21 villages. Total 181 farmers adopted this technology in first year in 50.24 ha area. Three self-help groups in 15 villages without any institutional support have adopted the technology. Biophysical performance, economic gains and effect of zero tillage on weed, and response of stakeholders were observed.

Reduction in tillage cost from Rs 2000/ha to Rs 650/ha i.e. saving of Rs 1350/ha was observed by the farmers. In the first response about ZT, total 96 % farmers reported about saving of money in crop establishment. Lack of local manufacture facility was found most serious technical constraint in spread of ZT of wheat followed by non-availability of quality drill and late harvesting of rice.

Zero tillage direct seeded rice was taken up in Maharajganj(U.P) in three fields through self-help group and progressive farmers without any support from research institution. A total of 3.0 ha area by a SHG (Laxmi) and 10.5 ha by different farmers were taken up under zero tillage wheat. Responses of 21 farmers of three SHGs in 04 villages were undertaken at the tillering stage of the crop. Majority reported resource and capital saving. The SHG are very much willing to use ZT machine for income generation with help of a tractor owner in next season. The farmers- to- farmers communication is more under this system.

It was learnt that capacity building of service providers, SHG members, progressive farmers and interest groups on maintaining machines and component technology will help in scaling up of the technology. Availability of service centers for repair and spare parts in villages further strengthen the technology scaling up.

1.0 Introduction

Zero tillage (ZT) machines were modified by GBPUAT, Pantnagar for sowing of crops without ploughing. In north – west India initially this technology in wheat was for resource conservation, input saving and higher yield. In eastern India ZT is new introduction and is being largely popularized in Indo Gangetic Basin including eastern India. Here additional benefits of sowing the crop in excess moisture, optimization in sowing time and higher yield have been realized. After wheat thresher, this technology has shown the higher potential of mechanization in agriculture and there by opening of new scope of income generation at village level.

1.1 Rationale

In Bihar, November 15 to 10 December is recommended sowing time of wheat. Delay in sowing reduces yield inspite of all input application. The yield reduction has been reported upto 55% (Singh et. al. 2002). Conventionally the farmers plough the fields by 4-5 times after rice harvest where rice-wheat is major cropping system. Under excess soil moisture they wait to optimum condition of field for ploughing. Due to this situation, the wheat sowing delays and consequently the yield become lower. The problem is more aggravated when rice is harvested delayed till December last and field has excess soil moisture. ZT of wheat may be good option under such condition and its large-scale uptake can increase the efficiency of land productivity by increase in yield and also the water by utilization of initial soil moisture.

Therefore, this is an attempt to make an analysis of land use and crop management issues from a community perspective and to find answers to challenges and to test a participatory technology development model. An approach was made in winter season 2001-02 for the assessment of large-scale uptake of ZT of wheat in RP Channel-5 (RPC-5) distributary of Sone Command, Patna (India). Various Self Help Groups have been formed both at RPC-5 and a pilot study was undertaken at Maharajganj during winter season 2003 – 04 to assess the transfer of technology of zero tillage in wheat through SHGs.

2.0 Materials and Methods

2.1. RPC – 5 (Bihar – Site 1)

Five ZT machine supported from DFID project were provided to the farmers of 21 villages in RPC-5 during winter season 2001-02 for sowing of wheat crop. The farmers were also given the information about technique of ZT with individual and group contact, small meeting and demonstration. Operational expenditure was born by the farmers. Total 14 farmers of 3 villages (Aspura, Uchauri and Gangachack) in head reach voluntarily adopted this technology in 5.21 ha land for sowing of wheat. In middle reach 32 farmers of four villages (Nisarpura, Mahajpura, Mohamadpur and Gopalpur) covered 9.6 ha and 135 farmers in tail reach (Amwan, Sangarmpur, Fatehpur, Sahar Rampur and Tangaraila) covered 35.43 ha area under ZT of wheat. Thus, a total of 181 farmers adopted this technology in first year in 50.24 ha area. Biophysical performance,

economic gains and resource conservation, effect of zero tillage on weed, irrigation water and crop vigour, benefits and constraints, yield performance, social performance of ZT, and response of stakeholders were observed.



2.2 Maharajganj (U.P. – Site 2)

2.2.1 Status and constraints in the study area

In the study area of Maharajganj (U.P.) there was not a single machine available and people including extension agencies were unaware about the Zero Tillage in wheat. Excess soil moisture in fields after rice harvest, more use of tractor in tillage operation,



Plate. Group Meeting with SHG members and project members

high weed population in wheat crop and lack of knowledge about improved package of practices were found to be the major constraints to efficient resource use and higher yield. The presence of extension agencies was also found negligible.

2.2.2. The Process

In meeting with SHGs and discussing the various aspects of land, water and crop management to assess the interest of group for activities, it was told that the farmers are facing the problems of high input use, weed and low yield in wheat. The scientist from ICAR broadcasted the end way idea of adoption of Zero Tillage technology of wheat to solve some issues. Some group showed positive response and wanted to know more in

detail. Again in presence of CIRRUS (team member of project R7839) person, volunteers of SHGs and team of scientist from ICAR, discussion was made in detail and it was agreed to take up the case of ZT in wheat. As per agreement the ICAR team made power point demonstration in villages on use of Zero Tillage machine, its effect on crop, resource saving and yield. The farmers were interested more and showed their willingness to adopt this technology. The farmers were reluctant to purchase the machine but were having no objection to use on hire basis. Again the SHG who organised this meeting showed keen interest to take up the strategic field demonstration of Zero Tillage machine with the help of some tractor owner for income generation.



PowerPoint Demonstration on Zero tillage showing to farmers



Meeting with farmers on the field

Encouraged by the response, the DFID project has arranged three Zero Tillage machines in the project area. One ZT machine was taken by a SHG namely Laxmi in village Bairya and another by a tractor owing farmer Sri Mahendra Singh. Sri Ram Singh and Sakil Ahmad, village Barhara, took the third machine jointly. The ICAR team has arranged initial training to the group members and farmer for effective use of ZT machine. The 1st day demonstration was done in presence of ICAR team. Later on interest group arranged the sowing without any help. Need based technical support was given by the ICAR team and CIRRUS. The SHG with help of a tractor owner arranged the ZT sowing with priority in member fields. Rs. 600/ha was charged from the SHG member and Rs. 640/ha from non-SHG member for ZT wheat sowing. The charges were shared both by the tractor owner and SHG. The SHG member deposited Rs. 160/ha in SHG account and Rs. 160/ha as their service charge. The tractor owner was given Rs. 280/ha. The other farmers with ZT machine charged Rs. 600/ha for ZT wheat sowing.

2.2.3 Activities under taken

The following activities were under taken

- Coverage of ZT area by two groups.
- Income generation by technology transfer.
- Assessment of farmer-to-farmer communication.
- Farmers and group perception.

3.0 Results and Discussion

3.1 RPC – 5 (Bihar – Site 1)

3.1.1. Biophysical performance of technology

There was Rs. 600/ha expenditure under land preparation including sowing in ZT against Rs. 2000/ha in conventional method. These are the existing local rates for tillage. Thus, Rs. 1400/ha was saved. There was advancing of the sowing time by 10-12 days under ZT which was in some cases upto 20 days especially when there was excess soil moisture. Total 90-95% seed germination with uniform emergence was in 5-8 days under ZT against 80-85 % uneven emergence in 8-11 days under conventional method. More vigorous seedling and uniform crop density both under timely and late sown condition were found under ZT. In conventional method less vigorous seedling, sparse patches under late sown condition were common. Being the canal irrigated area and fragmented holding as well as poor on-farm development; the field-to-field irrigation in wheat is common. Due to this under conventional method at first



Zero till sown wheat

Irrigation more water is held up by soil and plant became yellow with poor growth. Under ZT condition 25% less water was required for 1st irrigation and early recession of water in field made favourable soil environment and thus, the plants were found greener as compared to conventional method. Normally 50% farmers apply balanced dose of NPK in wheat under conventional method but under ZT all farmers could use this. Beside other annual weeds the *phalaris minor*, a serious weed of wheat, incidence was around 50% less in ZT but the perennial weed incidence was higher. Saving of Rs. 880/ha in manual weeding was recorded. On an average 12-15 q/ha increase in yield under ZT was found against conventional method.

3.1.2 Farmers perception

On the basis of direct contact, farmers perception regarding benefit and constraint in ZT was collected through structured schedules. The results are discussed in the following sections.

3.1.2.1 Direct benefits

- Reduction in tillage cost from Rs 2000/ha to Rs 650/ha i.e. saving of Rs 1350/ha.
- Early seed germination by 2-3 days due to favourable air temperature owing to availability of sunlight at seed zone.
- 7-10 days early sowing in moist field when conventional tillage is not possible. This will increase yield.
- Less incidence of problem weed *Phalaris minor*.
- Crop remains green after 1st irrigation due to early recession of water in field. Under conventional tillage crop plant became pale yellow due to prolonged water stagnation.
- Proper placement of seeds and fertilizer in line.



3.1.2.2 Constraints

- Regular monitoring of running machine is required otherwise clogging may check fertilizer dropping and sometime seeds also.
- Initial training of machine operation is lacking.
- Spare parts are not available locally.
- Tractor owners are waiting for market demand this year. Next year they will assess and then purchase of machine will takes place.

3.1.3. Social performance of ZT

One hundred farmers participating in ZT irrespective of economical status were interviewed on various aspects of technology during summer 2002 after harvest of zero tillage wheat. The results are summarized below

- ❖ Around 76 % farmers were found favourable to most favourable and 24 % were less favourable for ZT wheat. There was no negative opinion. Most favorable 35 % were due to utilization of fallow land in winter season, 10-18 days early sowing with less cost and high yield. Less favourable were due to poor germination owing to less moisture or improper seed placement.
- ❖ Around 71% farmers were found having knowledge about the technology and 29% were having less knowledge about that technology.

- ❖ Lack of local manufacture facility was found most serious technical constraint in spread of ZT of wheat followed by non-availability of quality drill and late harvesting of rice.
- ❖ Lack of adequate manpower from state extension agencies were found most serious extension constraint followed by lack of extension literature and inadequate extension facility at the disposal of input agencies.
- ❖ Lack of credit facilities were found most serious financial constraints followed by no subsidy on machine and lack of money to buy other inputs.
- ❖ In most of the cases the farmers were found highly satisfied, except with the role of State Department in transfer of zero-tillage technology where 80 % farmers were found highly dissatisfied.
- ❖ In ZT wheat there was no loss, while under conventional tillage there was loss in wheat cultivation in few cases.

3.1.4. Response of stakeholders on Zero Tillage in wheat

In the sample survey, 45 farmers were asked to respond about Zero Tillage. They were 9, 12 and 24 in head, middle and tail reaches of RPC-5. Out of 45 farmers 11 were sharecropper, 18 small and 16 were progressive farmers.

In the first response about ZT, total 96 % farmers reported about saving of money in crop establishment, 91% said that there was timely sowing of wheat, 100% farmers reported that early germination and 96% reported that there was uniformity in germination. Total 77% farmers were of opinion that there was proper placement of seed and fertilizer.

Asking the farmers opinion about the measures to spread large scale of ZT in wheat, 96% farmers told that weed control is necessary. Total 62.2% farmers said that availability of tractor and ZT machine on hire basis in the area might spread the large-scale uptake. Total 87% farmers told that training on ZT technology might increase the uptake. All farmers were of opinion about extension of ZT technology in the area. 27% farmers said that trained driver might increase large-scale uptake because in many cases due to faulty operation of machine proper distribution of seed and fertilizer is not done and the other farmers feel reluctant to adopt this technology.

Weed management has been found serious constraints to large-scale adoption of ZT according to 95.55% farmers. In opinion of 71% farmers, lack of tractor and ZT machine in the area and lack of knowledge about importance of ZT are other constraints in large-scale adoption. Total 95.5% farmers told that there was no change in soil behaviour and rest 4.5% reported some change.

Total 37 farmers (82.2%) reported that there was better growth of wheat under ZT than that under conventional, while rest 8 farmers (17.7%) told that the similar growth

both under ZT and conventional tillage was found. There was no response that wheat growth under ZT was lower than conventional tillage. Total 62.2% farmers reported better yield in ZT than conventional tillage, while 37.8% farmers reported similar yield under both the situation. There was no report of low yield in ZT.

Hundred percent farmers reported that there was more saving due to adoption of ZT in wheat than that under conventional tillage. Due to this similar or lower saving in ZT over conventional was not reported.

3.1.5. Learning from feedback received on ZT demonstration

- ❖ Technology is favourable for the area, liked by the majority of the farmers, attracted the attention of other stakeholders and policy makers.
- ❖ Extension literature, creating supply and maintenance facility of machines and demonstration in untouched area is important steps in large uptake.
- ❖ Credit facility and more involvement of State dept., SAU, KVK and manufacturer are required.
- ❖ SHGs may be involved to popularize this technology besides their income generation.

3.1.6. Demonstration activities for communication strategy – what is an acceptable cost?

- ❖ Giving facility of machine only for sowing can be acceptable cost for result demonstration at farmers' field.
- ❖ Method demonstration at research station/ farmer's field may be done for policy makers and stakeholders. For this, machine with small inputs is required.
- ❖ Farmers exposure visit and field day should be organized with support of travel and miscellaneous costs.

3.1.7. Linkages with livelihood improvement

Linkage of Zero Tillage technology with livelihood improvement was worked out. In pilot study trial, after receiving the request, one ZT machine was provided to SHG of unemployed youth facilitated by volunteers of CIRRUS (member of project R7839) village Danara for income generation. The group contracted with a tractor owner to provide hire facility of machine to the farmers willing to adopt ZT. The group and tractor owner took the rent on share basis. The group member again distributed the profit after maintenance of the machine. It was observed that this technology might be a source of income generation for resource poor group in the villages. The saving in land preparation due to ZT may be utilized for support of other critical inputs in the farm like quality seed and agro chemicals in order to increase the income and improve livelihood.

3.2 Maharajganj (U.P. – Site 2)

3.2.1. Technology transfer and income generation by SHG

A total of 3.0 ha area under ZT wheat was covered by SHG and 10.5 ha area by the individual farmers. Thus, total 13.5 ha area was covered by three machines. With communication of ZT technology a sum of Rs. 960 was earned by SHG of where Rs. 480 were gone to SHG account and Rs. 480 to members service charge. The tractor owner also earned Rs. 7,580.

Machine possessor	Covered area under ZT (ha)			Total income (Rs.)		
	SHG member field	Non SHG member field	Total	From SHG member field	From Non SHG field	Total
Laxmi SHG Baria	0.5	2.5	3.0	160	800	960
Mahendra Singh, Barahara	2.5	5.9	8.4	1500	3776	5276
Ram Singh & Shakil Ahmad, Barahara	-	2.1	2.1	-	1344	1344
Total	3.0	10.5	13.5	1660	5920	7580

The high response was found about transfer of technology through farmer-to-farmer communication. At each village site on an around 100-150 farmers have visited and seen the crop as well as discussed with the beneficiaries regarding method of establishment and resource saving. As per assessment of villagers, total 400 – 500 farmers have visited the ZT wheat fields. The media persons have visited the area and total 07 times news coverage appeared about this event in local newspaper.



Training on ZT use and machine demonstration

The SHG are very much willing to use ZT machine for income generation with help of a tractor owner in next season. They are feeling their inability to purchase the machine because of poor resource condition but as their capacity is built up so, their response is positive for using technology for income generation. The other farmers are willing to purchase the machine. In the locality the people are willing to adopt this technology at large scale next year. The farmers reaction, observed at 38 fields is as under.

Particular	Detail	Number of farmers
At the time of wheat sowing	Risk	20
	No-risk	18
After germination of crop	Good	30
	Medium	04
	Poor	04
After first irrigation of crop	Good	27
	Medium	09
	Poor	02

Total 38 farmers from 08 SHGs in 04 villages were interviewed regarding their perception on ZT technology of wheat. The summary of results is as under:

Item	Detail	No. of farmers
Capacity built up/ sowing	By ICAR training	13
	Sensitized by seeing demonstration	24
	Listening to Radio	01
Weed emergence	More	05
	Less	18
	Negligible	15
Saving	Sowing time	09 days
	Land preparation and sowing	Rs.1154/ha
	Irrigation by tube well	Rs. 260/ha
Expenditure of saving	Agriculture	09
	Family work	06
	Agriculture +house	23

3.2.2. Response of farmers at tillering stage of crop:

Responses of 21 farmers of three SHGs in 04 villages were noted at the tillering stage of the crop. Majority reported resource and capital saving.

N= 21

S.N.	Type of response	Response Per cent
1.	Saving of time	38.1
2.	Labour saving	33.3
3.	Saving of irrigation water	71.4
4.	Good germination	35.3
5.	Saving of capital	
6.	Less weeds	42.8
7	Saving in tillage operation	
8	Less seed rate	14.2
9	Less insect pest	4.8
10	Good plant growth	

3.2.3. *Qualitative economics of communication methodologies compared*

Parameters	Traditional	NATP-RWC	Project (IRCER -Cirrus)
Input support	Inputs at all sites	Input at permanent site only	Only knowledge
Staff	Full time	Part time	L
Technology	Full support	Partial	No incentives
Participation level	Individual		SHGs/Interest groups
Capacity accumulation	Post-demonstration	Pre/post-demonstration	During demonstration
Level of communication	Staff to farmers	/contact farmers to farmers	S s/interest groups to farmers

4.0 Conclusion

4.1. Experiences and lessons learnt

The transfer of technology of ZT through SHG and other farmers was taken up as a result of the strategic field demonstration. The income generation was also realized. The SHG with poor resources may earn income through transfer of technology if their capacity is built up and some financial support/credit is made available for the purchase of critical input or material. The other farmers have also potential. The farmers- to-farmers communication was observed in this system.

4.2 *Salient achievements*

Without any institutional support the spread of Zero Tillage wheat was done in 21 villages at Patna and adjoining villages. Three self-help groups in 15 villages without any institutional support have adopted the technology. Service providers are also emerged during the process. The technology scaling up has been found a means of earning for resource poor farm families.

A model of technology transfer and income generation by SHG and other farmer could be demonstrated at a small scale. The ZT technology of wheat was taken as one of the example. During kharif season 2004, the technology transfer was assessed in rice through SHG and for income generation in Maharajganj.

Zero tillage direct seeded rice was taken up in three fields through self-help group and progressive farmers without any support from research institution. SHG members involved in Zero Tillage activities for wheat sowing providing service on a communal basis. A total of 3.0 ha area by a SHG (Laxmi) and 10.5 ha by different farmers were taken up under zero tillage wheat.

4.3 Scaling up

Scaling up of the technology can be taken up with the help of SHG, WUA and Progressive Farmers, Government agencies. Capacity building of service providers, SHG members, progressive farmers and interest groups on maintaining machines and component technology will help in scaling up of the technology. Availability of service centers for repair and spare parts in villages further strengthen the technology scaling up.

Reference:

Singh S.R., Gautam U.S., Rahaman A., Kumar U. and Sinha S.K. 2002. A System approach to enhance rice – wheat productivity in Sone Command. Technical bulletin no. 3, ICAR-RCER, Patna pp 44.

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Innovation history

Who was involved and what happened	Date	Why was it significant
<ol style="list-style-type: none"> Strong interest in promotion of zero tillage driven by Indian Govt directly and through NATP 	Prior to project	Project was keen to get in on the action and had experience of implementing the IVLP model for technology promotion supported by NATP projects
<ol style="list-style-type: none"> Project leader of R7839 sought to position project as testing new approaches rather than implementing / validating experiences from other projects. Realisation that researcher intensive approaches would not be scalable 		Did not accept approach being proposed by ICAR RCER, it had seemed OK in project discussions but had assumed that final implementation would be jointly formulated
<ol style="list-style-type: none"> During joint R7839/7830 project inception phase ICAR RCER staff (SS Singh and AR Khan) agree to adopt an approach of demonstration for DSP and O-Till rather than the previously planned researcher led technology trial in farmers fields. This was negotiated with John Gaunt after extensive discussion in the conference hall and meetings in staff offices agreed by Dr SR Singh 	2001	<p>Marked a significant change of emphasis from that anticipated by ICAR staff and enabled project to test strategies for promotion of the technology.</p> <p>The agreement on group formation was respected in the area of ZT</p> <p>Was the start of a productive working relationship</p>
<ol style="list-style-type: none"> It was agreed that technology based groups would not be formed by the project. Rather if groups came forward we would work with them. Agreements were made between CIRRUS (MS Ashok) and ICAR RCER (US Gautham) backed by exchange of letters UK visit by project team enabled a common understanding of the term 'participatory' to be established 		The team were able to have a more critical and informed discussion of their ideas in the context of their understanding

2002	<p>Team continued to seek new ways forward</p> <p>Benefits, constraints and potential was assessed from the end use of the technology for further strategy</p>
	<p>The potential for involvement of SHGs and awareness of alternative strategies for taking the views of farmers and others emerged. The network of contacts is beginning to change – we are talking to more people in new ways</p>
	<p>Projects R7830 & R7839 test non-incentivised model for technology promotion at Maharajganj. Test supports testing of zero tillage by existing groups within the community – contrast in methods is presented as a poster at the Delhi workshop.</p> <p>The network has extended further we have different groups taking on roles as service providers etc.</p>

6. Mid term review focused thinking of team on the need to take the views of those other than the farmers in whose field a technology is demonstrated
7. Response of the Stakeholders regarding Zero Tillage in wheat
8. Awareness of CIRRUS activities grew within ICAR RCER team, particularly SS Singh (in the context of this work).
9. ICAR RCER team accepted that an extensive diagnostic and technology prioritisation phase is not required prior to technology promotion. First the results of the Snowball survey were compared with data from the SHG database (later SS Singh undertakes a survey in Maharajganj)
10. Visit by John Best helped team to formulate their concepts for promotion of uptake
11. IRCER Promote f the value of a non-subsidised (technology promotion based) approach to stimulate PTD. ICAR RCER and CIRRUS are now developing ideas together and jointly analysing experiences

<p>12. IRCER staff member (and project team member) joins CIMMYT on secondment from ICAR</p>	<p>CIMMYT hire former CIRRUS staff (now CPSL) to contribute to PTD activities in Bihar</p> <p>CIMMYT move strongly to adopt an approach that involves PTD of technologies by groups who have interest in testing technology</p>
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