

## Success of Zero-Tillage Technology: A Case of Knowledge Management for Sustainable Agriculture

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### ABSTRACT

*Zero-tillage is a conservation technology that has the potential of saving time, energy and inputs for small farmers. But it did not spread as fast as expected during initial years in Pratapgarh due to perseverance of the farmers towards tilling and ignorance about some technical aspects critical to its apt implementation. An effective strategy in knowledge management formed the pivotal force behind large scale adoption of zero-tillage technology among farmers. Successful adoption, continued use and up scaling of zero-tillage technology in the villages in Pratapgarh district of Uttar Pradesh, is an example of effective knowledge management. Zero-tillage in wheat was introduced in rice-wheat cropping systems of Pratapgarh in 2001 in just 0.33 ha and its adoption has expanded to 13,000 ha in rabi 2009 in the district. For the first three years, the spread was quite slow; the acreage reached only 48.5 ha. It resulted in exponential growth of the area under zero tillage and area reached about 1616 hectares in 2005 and numbers of machines reached to 24. New ZT Drills were procured by farmers to meet the increasing demand. The strategy worked well and farmers have tasted the fruits of technology; so adoption of zero-tillage has reached close to 13,000 ha by the end of 2009. The key to the grand success was the knowledge management done by the tractor owners/operators. They convinced the farmers about the efficacy of zero till drill in saving the time, cost and water as well as for getting better yields due to timely sowing of wheat. Thus, zero-tillage gained popularity among the farmers of the district as an appropriate farm worthy, knowledge intensive, eco-friendly, profitable and socially acceptable technology.*

**Keywords:** Zero-tillage technology; Knowledge management; Sustainability; Conservation;

**T**he crop productivity of the country is very low as majority of the farmers are still practicing traditional farming techniques. Moreover, cost of production has increased many times due to rising prices of fuel and other agricultural inputs. The existing crop production technologies do not offer effective and efficient utilization of natural resources. Extremely low input use efficiency has led to wastage of inputs and depletion of natural resources besides environmental degradation (*Hobbs et al., 1997*).

Water shortage is increasingly becoming a global issue. Environmental impact from all uses of water, particularly irrigated agriculture urgently needs special attention and it is highly important to develop better understanding for water scarcity and its trend in future. It is also necessary to consider possible

strategies based on increasing water productivity (producing more crop per drop) leading to efficient management of the scarce water resources (*Akhtar, 2006*).

These facts press upon an abrupt change in crop production system and the best option available now is to adopt conservation agriculture. "Conservation agriculture 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 2007*). Conservation agriculture offers option for meeting future food demands with minimal disturbance to environment. It can increase input use efficiency and farm income. It also can improve or sustain crop yields and protect or even revitalize soil, biodiversity and the natural resource base.

Zero-tillage is a conservation technology that has the potential of saving time, energy and inputs for small farmers. The technology in wheat was first time introduced in rice-wheat cropping systems of Pratapgarh in 2001 in just one acre and adoption of zero-tillage has reached close to 13,000 hectares by the end of 2009. An effective strategy in knowledge management has formed the pivotal force behind large scale adoption among farmers. Successful adoption, continued use and up scaling of zero-tillage technology in the villages in Pratapgarh district of Uttar Pradesh, is an example of effective knowledge management.

## METHIODOLOGY

Zero tillage technology in wheat programme of the Krishi Vigyan Kendra, Pratapgarh (Uttar Pradesh) was started in 2001 and systematic studies of adoption of the technology were initiated in 2003. The studies included formal and informal surveys to diagnose farmers' problems and circumstances in which they make decisions about adoption of the technology and their perception about various critical technological factors. The surveys were followed by extensive on-farm technology demonstration, organising travelling seminars, field days and kisan gosthies involving farmers and tractor owners/operators. The data generated by surveys tabulated and analysed to find out the impact of technology on various contributing factors.

## RESULTS AND DISCUSSION

*Knowledge management* : Knowledge is defined by the Oxford English Dictionary as expertise, and skills acquired by a person through experience or education. All knowledge can be classified according to its complexity on a continuum from explicit to tacit (Polanyi, 1967). Explicit knowledge can be articulated into formal language and can be processed by a computer or stored in databases; however, tacit knowledge is personal knowledge embedded in individual experience and involves intangible factors. It contains subjective insights and intuitions. Tacit knowledge plays more important role in application of the explicit knowledge. Knowledge Management is a targeted coordination of 'knowledge' as a factor of production and the management of the organisational environment to support individual knowledge transfer and subsequent creation of collective knowledge. "Knowledge Management is a process of enabling individuals, teams and entire organisations to collectively and systematically

create, share and apply knowledge, to better achieve their objectives" (Ron Young, 2007).

Knowledge management itself is not a technology, though technology is exploited to enable it. It is not directive, but strategic leadership is essentially required for successful knowledge management. Knowledge management requires a culture that promotes faith in collectively sharing and thinking. It may be viewed as leveraging of collective wisdom to increase responsiveness and innovation.

*Managing Knowledge for Success* : The success of zero tillage in Pratapgarh is based on the creation of an environment of confidence among the farmers about the technology, that supported by viable and dynamic innovation systems, demonstrating successful and sustainable agricultural practices year after year. Zero tillage being financially attractive, created demand among farmers. Same time tractor owners were promoted to purchase the drills. State government has provided a subsidy of about 50 percent on the purchase price of a new zero-tillage drill. This investment subsidy had enhanced farmers' access to new implements.

The success of zero tillage in India is based on the creation of viable, dynamic innovation systems, building on a successful and sustainable business model. Zero tillage is financially attractive to farmers and thereby has created farmer demand. Adoption surveys reveal that 60 percent of zero-tillage adopters did not own a zero-tillage drill (Erenstein, Malik, and Singh, 2007). Service providers have the added advantage of having hands-on experience and self-interest in promoting the technology (Erenstein and Laxmi 2008).

A new strategy was developed and zero till drill owners were adopted by Krishi Vigyan Kendra as partners for technology promotion. Accordingly the tractor owners/operators were thoroughly trained about the skill of calibrating the zero till drill, which is crucial technical aspect and the science that works. Extension literatures was developed to show how it can save costs and increase the productivity and given to them. Film shows were also organised to create mass awareness. Print media and electronic media have also supported and they had started special column to provide the information about movement of the machine and area covered on daily basis. Prize money of Rs.5001 and an appreciation certificate was announced to boost the morale of zero-till drill owners/operators, who could achieve maximum coverage of wheat under zero till to

develop a sense of competitiveness among the operators, who participated actively in sharing knowledge with farmers.

Technology was exploited to develop a culture that supports the knowledge management initiative and collective responsibility and leadership was promoted to develop the faith among the farmers. The step followed for the promotion of the technology may be summarized as follows:

1. Sensitizing farming community about the impact of resource conservation technologies (RCT) through mass media.
2. Motivation/mobilization of farmers to adopt RCT through individual contact, trainings and demonstrations.
3. Promoting tractor owners to purchase the drills and subsidy on drills were provided by state government.
4. Capacity building and technical support to drill owner and farmers for adoption of RCT.
5. Coordination with other partners for adoption-oriented research to get the outcomes of the collaborative efforts.
6. Regular media briefing to provide updated information about the performance of the machine and economics of the technology.
7. Recognition and awarding the outstanding performers in Kisan Mela.

Now if we consider the definition of the 'Knowledge management' three critical points implies in the process of establishing the technology.

1. Knowledge is connected. It exists in a collection (collective wisdom) of multiple experiences and perspectives. In the present case Krishi Vigyan Kendra initiated the process of technology application with the four farmers in beginning, these farmers experiences the technology and gained the knowledge. The knowledge they gained were shared with the other farmers and the process continued. The process enriched the technology as application of the information builds up the knowledge.
2. Knowledge management is a catalyst. It is an action –leveraging. Knowledge is always relevant to environmental conditions, and stimulates action in response to these conditions. Information that does not precipitate action of some kind is not knowledge. During the application of the

technology it was learnt that in sandy soil application of the technology is difficult as such soils lacks elasticity.

3. Knowledge is applicable in unencountered environments. Information becomes knowledge when it is used to address novel situations for which no direct precedent exists. Information that is merely 'plugged in' to a previously encountered model is not knowledge and lacks innovation. Initially the drills was made to be used only for sowing the wheat but latter the same drills were also used for sowing the mustard as farmers themselves learned that blocking the alternate opening, mixing the mustard seed with DAP (Diammonium Phosphate – Fertilizer) and reducing the opening will do the job. They took the action and tried it in small area and after getting the success, they started using the same drill for mustard sowing also.

The three critical points, afore mentioned do not draw a clear line of distinction between information management and knowledge management. Both are important for success of any programme. Information management, a field of explicit knowledge that works in a controlled environment where one will get predefined outcome to anticipated stimuli, however in case of Knowledge management there will be always innovative outcome to new opportunities and challenges. Information and Knowledge management in a dynamic work environment is illustrated as Fig. 1.

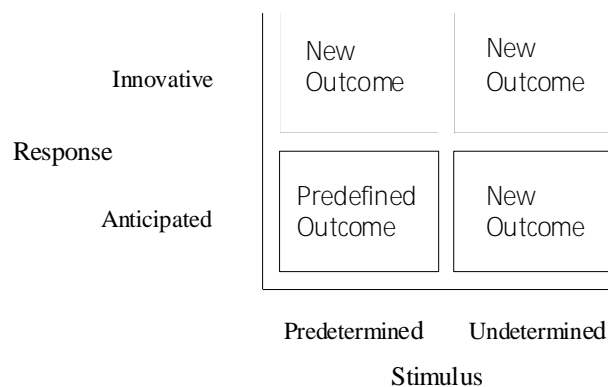


Fig. 1 Information and Knowledge management in a dynamic work environment

The focus of knowledge-based solutions is application of innovative new responses in a dynamic work environment. Knowledge must be internalized as it co-exists with intelligence and experience. It emanates at the points where decisions are made. The

**Table 1 Adoption of Zero Tillage Technology**

Years	Area	villages (ha.)	farmers covered	No. of covered
ZTD**				
2001	0.33	1	4	2
2002	15.35	12	82	2
2003	48.48	48	517	5
2004*	1406.73	175	772	14
2005	1616.81	198	1097	24
2006	3192.81	278	2980	35
2007	5577.62	445	3885	65
2008	9764.68	692	5256	88
2009	12928.00	876	11656	140

\*Data upto year 2003 are actual and onward data are based on approximation and farmers inputs

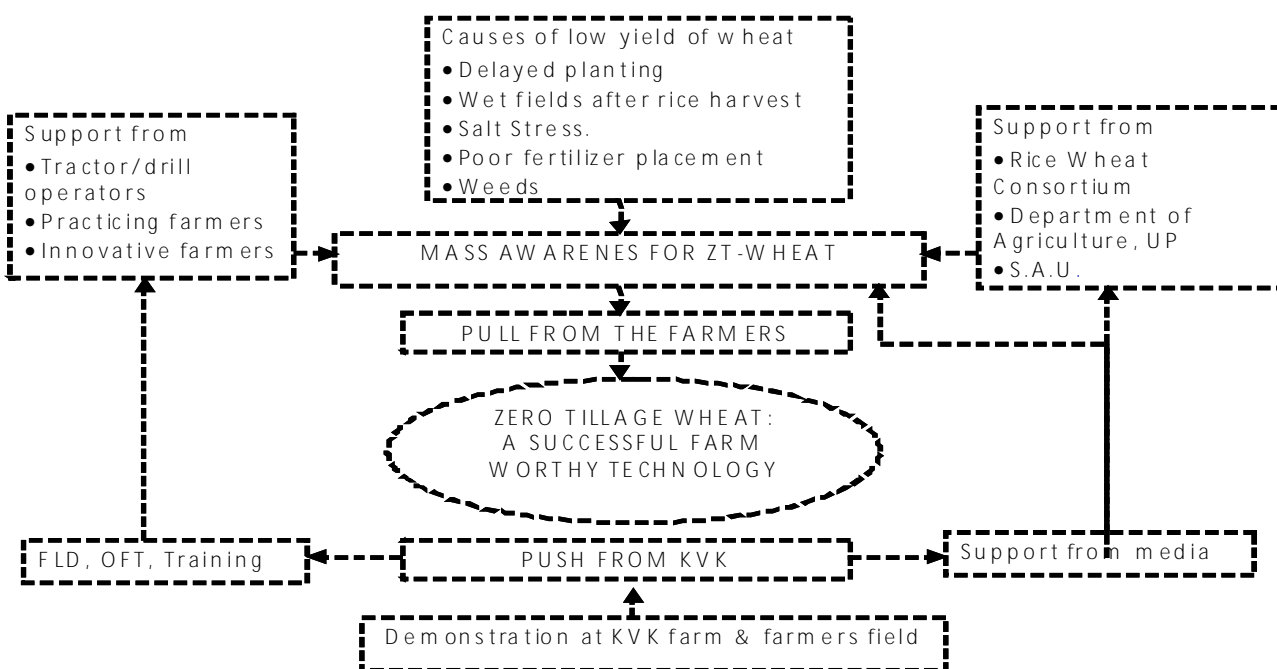
\*\* Zero Till Drills

management of the knowledge is basically the management of the human minds. The key of success of the zero till programme lies with the support rendered by tractor owners/operators in managing the technology. They helped in convincing the farmers about the efficacy of zero till drill in saving the time, cost and water as well as for getting better yields due to timely sowing of wheat. This they could do because the explicit knowledge provided to them was internalized and they developed the tacit knowledge by their own experience of working with the technology. The same time they were getting a benefit out of it as the farmers were

clientele base for the future as they have purchased the drill. Thus the zero-tillage gained popularity among the farmers of the district being an appropriate farm technology that is knowledge intensive, eco-friendly, profitable and socially acceptable. Area coverage has reached close to 13,000 hectares by the end of 2009 (Table 1).

*Impact of Technology at Ecosystem Level* : Zero tillage technology conserve, improve and make more efficient use of natural resources through integrated management of soil, water, crops and other biological resources in combination with selected external inputs. It represents a resource saving and efficient agriculture that contributes to environmental conservation and at the same time enhances production on sustainable basis. A survey was conducted in four villages; viz. Mangarh, Barai, Meerapur and Garibpur involving 240 respondents to know the farmers prospective about the impact of zero tillage technology. The results obtained are presented in Table 2.

Majority of the farmers indicated zero till technology as environment friendly as it saves fuel (84.17%), time of sowing (80.00%) and irrigation water (78.33%) and reduces weed (*Phalaris minor*) load (63.33%). Similar observations were also recorded by Singh *et al.*, 1997 and they reported saving in time of sowing (83.44%) and saving in fuel (80.93%) during sowing were the major factors towards orientation and adoption of this technology. Weeds are the strong competitors of crop



**Fig. 2. Mechanism of Promotion of Resource Conservation Technology in Pratapgarh**



**Table 2. Reasons to adopt zero – tillage technology**

Reasons	%
Fuel saving	84.17
Saving in time of sowing	80.00
Saving in irrigation water	78.33
Less infestation of weeds ( <i>Phalaris minor</i> )	63.33
Less infestation of weeds (Other weeds)	32.08

and it reduces crop yield up to 57 per cent. Lower incidence of *Phalaris minor* (59.77%) and other weeds (33.33%) under zero tillage regime also gave impetus to this technology among farmers (Singh *et al.*, 1997). There is a prime factor in Rice – Wheat cropping system to catch the right time of sowing of wheat. In rice – wheat cropping system, delayed sowing of wheat has been found to be one of the reasons behind poor yield of this crop (Hobbs, 1994).

Zero tillage primarily has had positive effects on the environment in the Indo-Gangetic Plains (saving fossil fuel and water and reducing emissions of greenhouse gas), although further research is needed to substantiate and value these environmental impacts more rigorously (Akhtar 2006; Erenstein and Laxmi 2008; Hobbs and Govaerts 2009; Pathak 2009; Sarwar and Goheer 2007). The diesel savings are relatively robust—36 liters of diesel per hectare, an 8 percent saving over conventional wheat tillage (Erenstein *et al.* 2008; Erenstein and Laxmi 2008). Still, in spite of zero tillage's success in the Indo-Gangetic Plains, the full environmental benefits offered by conservation agriculture, including carbon sequestration, have yet to be fully utilized (Gupta and Sayre 2007; Laxmi, *et al.* 2007).

Energy budget for the technology was prepared in a field trail and data obtained is presented in Table 3. Result shows that the zero tillage resulted in more yield with less energy budget, whereas conventional tillage wheat resulted in poor yield in comparison with more energy budget.

**Table 3. Energy budget and yield of wheat as affected by tillage at farmer's field**

Treatment	Tractor hour/ha	Diesel Teq. (l/ha)	Tractor rent (Rs/ha)	Yield* (Kg/ha)
ZTW	1:54	6.38	380	3022
CTW	9:30	33.25	1900	2816

ZTW= Zero Till Wheat  
Conventional tillage wheat

It was observed that adopting zero tillage also reduces weed emergence and quite low *Phalaris minor* population was observed than in conventional tillage wheat Table 4. This may be due to the fact that weed seeds remained in deeper layer under zero tillage system in contrary to conventional system (Verma and Srivastava, 1989)

**Table 4. Irrigation time and weed emergence in farmers field**

Treatment	Irrigation (hr/ha)	Weed density (Nos/m <sup>2</sup> )		Crop color 7 days after irrigation
		<i>Phalaris</i>	Other weeds	
ZTW	10	35	12	Green
CTW	15	87	8	Pale

*Change in the attitude of farmers* : Initially farmers were having a lot of doubts regarding this technology. They have their own myths and were always criticizing and making mockery of zero tillage wheat. They were of the view the zero tillage wheat will not germinate or if it will germinate it will not result in good yield. But slowly their attitude changed after seeing initial performance of the demonstration and now they are welcoming the technology. This has brought another change in their mindset that 'old is gold' is not always true, so before criticizing just give a try.

## CONCLUSION

Knowledge for the most part exists only in application. Explicit knowledge is the part of information gathered by human mind that forms the databases; however, tacit knowledge is personal knowledge gained by individual experience while applying the explicit knowledge. The success of zero tillage in Pratapgarh is based on the creation of an environment where all the information required about the technology was provided to farmers through different ways that has enriched their explicit knowledge. When they adopted the technology themselves, then they experienced the technology and brought changes as per the need of their environment. While adopting the technology, they modified it as per their environmental need and learnt the process; this brought the change in their tacit knowledge base. The explicit knowledge basically forms the part of information management, whereas tacit knowledge implies for knowledge management. Both are important for success of any programme. Information management works in a controlled environment where one will get predefined outcome to anticipated stimuli, however in case of knowledge management there will be always innovative

outcome. Lack of elasticity in sandy soil and use of drills for sowing the mustard are two innovative examples that can be quoted from the adoptive behaviour of the farmers.

The tractor owner played a key role in knowledge management as they were operating in different environment so their knowledge base was much wider than the other farmers. They convinced the farmers about the efficacy of zero till drill in saving the time, cost and water as well as for getting better yields due to timely sowing of wheat. The direct and indirect

benefits experienced by them helped in spreading this promising technology among practicing farmers and others as early and timely sowing of wheat by zero-tillage immediately after harvesting of the preceding rice crop facilitates early establishment of wheat which ultimately leads to its better growth, development and yield. The technology is getting popularity gradually in the district and now the dissemination of technology is self propelling in the district.

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