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Article *in* SSRN Electronic Journal · June 2012

DOI: 10.2139/ssrn.2088710

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Decision Process Innovations, Constraints and Strategies for Adoption of Conservation Agriculture

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Introduction

Untenable use of factors of production is causing severe land degradation and food insecurity problems especially in developing world. Land degradation threatens the ecosystem health and food security worldwide and will remain high priority on international agenda (Eswaran *et al.,* 2001). As a result, environmental problem is of growing concern across the world. In the view of globalization, Indian agriculture needs to change. Change is painful but it is necessity. Conservation Technologies (CA) has become an interesting intervention since it is economically profitable, environmentally safe, and practically efficient. Once the no-till system picks-up momentum in other than rice-wheat systems, a tillage revolution will truly emerge on the national horizon. Dissemination of scientific information could change over from tillage to no-till agriculture. No-till agriculture is still co-evolving with agents for change. This is a tremendous achievement to the scientists, extension workers etc., for affecting this change and overcoming the mindset problems associated with a paradigm shift to no-till agriculture to achieve the sustainability.

Concept of Conservation Agriculture

First World Congress defined "Conservation agriculture promotes the infiltration of rainwater where it falls and its retention in soil, as well as a more efficient use of soil water and nutrients leading to higher, more sustainable productivity". It aims to conserve, improve and make more efficient use of natural resources through integrated management of available soil, water and biological resources combined with external inputs. It contributes to environmental conservation as well as enhances and sustains agricultural production. It can also be referred as resource-efficient / resource effective agriculture. CA is a win-win system based on the integrated management of soil, water and agricultural resources. CA is a revolutionary footstep towards preventing land degradation and rehabilitation of fragile land. No-till agriculture together with other associated management practices such as direct seeding into loose crop residues to provide soil cover and to conserve soil moisture, with judicious choice of crop rotations and agro-forestry tree species constitute conservation agriculture. With the understanding of CA, it is very important to differentiate the conservation tillage and conservation agriculture. Conservation tillage is the reduced tillage, with residues left on the surface but it is not same as conservation agriculture where no tillage is done. For instance, seeding with punch planter is a no-till system. Zero-till drill

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does not disturb the soil except to place seed in the soil and hence it is very close to no-till system practiced in CA.

Benefits of Conservation Agriculture

- Good plant growth
- Saving in tillage operation
- Saving of irrigation water
- Saving of time and labor
- Good seed germination and less incidences of weeds
- Less seed required
- Less attack of insect pest
- Proper placement of seeds and fertilizer in lines

Adoption of CA innovations (new idea) is not simple but a complex process involving a sequence of thoughts and actions. The present chapter is an effort to document the factors and constraints that hinder the adoption of conservation agriculture in a comprehensive manner. It has a great significance in putting foundation for a realistic planning in developing suitable strategy to achieve the goals of conservation agriculture.

Understanding Innovation Decision Process

According to Rogers, *"Adoption process is the mental process through which an individual passes from hearing about an innovation to final adoption"* whereas *"diffusion is the spread of a new idea from its source of invention or creation to its ultimate users or adopters".* These definitions indicate that diffusion is a process related to adoption of an innovation in an entire social system such as a village or block, while adoption is a sequence of thoughts and actions which an individual goes through, before he finally adopts a new idea. In Roger's Diffusion of Innovations (2003), he discusses diffusion process as "Innovation-Decision Process". He explains the process through which an individual (or other decision-making unit) passes from gaining initial knowledge of an innovation, to forming an attitude toward the innovation, to make a decision to adopt or reject, to implementation of a new idea, and to confirmation of this decision. Major stages in innovation-decision process as suggested by Roger's (2003) are as:

1. Knowledge stage: Knowledge occurs when an individual is exposed to an innovation's existence and gains an understanding of how it functions. Through two different ways an individual may gain knowledge about an innovation. One such way is need of innovation, where the individual actively seeks out the innovation based on a certain desire or need for it. For instance, a person who is looking for using zero tillage technology at his farm may expose themselves to ideas that are in accordance with their interests, needs, and existing attitudes known as selective exposure. The tendency to attend the communication messages that are consistent with the individual's existing attitudes and beliefs creates a need for the innovation. In relation to RCT, this stage occurs when farmers are first exposed to the information about a certain innovation or product.

2. Persuasion stage: Persuasion stage occurs when an individual forms a favorable or an unfavorable attitude towards the innovation. In the persuasion stage, a person's thinking or feelings are affected. From this stage, an individual can develop an attitude towards a certain innovation and become more psychologically involved with innovation. The individual regards the messages received from the innovation as credible and decides how to interpret the information. This stage forms the basis of a favorable or unfavorable attitude towards an innovation and whether the persuasion will lead the individual to adopt or reject the innovation.

3. Decision stage: Moving to decision stage, an individual engages in activities that lead to choice of adoption or rejection of innovation. One way, an individual decides whether to adopt or reject an innovation is through a partial trial basis. Most individuals do not adopt an innovation without first trying it on a probationary basis to determine its usefulness in their own situation.

4. Implementation stage: Implementation occurs when an individual puts a new idea into use. At this point, innovation-decision process has been strictly a mental process. There are clear differences between thinking about an innovation and putting it into use. The implementation stage may continue for a longer period of time depending on nature of innovation. Farmers are in this stage when, they are actively asking for the product or innovation.

5. Confirmation stage: The final stage in this process takes place only after an innovation-decision has already been made. In confirmation stage, an individual may seek to reinforce or reverse a decision previously made "if exposed to conflicting messages about the innovation". Confirmation may involve one of four ideas about an innovation: *continued adoption, later adoption, discontinuance, or continued rejection.* This stage is also relative to "recognition of benefits of using the innovation".

Factors in Adoption of CA Innovations

Socio-economic and psychological factors are significant in the decision making process to adopt the CA. Farmers who have a strong conservation ethic, for example, may be willing to accept, reduced profits in return for feeling that they have contributed to welfare of future generations. Environmentally concerned farmers may also be willing to invest in practices that will enhance the environmental quality of their lands and water resources, as well as enhance the economic value of land when it is sold or passed on to next generation. Researchers developed social-psychological models to determine the characteristics of farmers who adopt innovations. These models were used to explain adoption behavior on the basis of social and psychological characteristics of individual adopters. Thus, farmer is called upon to adopt CA, not only to protect his or her own future, but also to protect society's future. Because of this change in social context, old conservation practices can still be considered innovations, since for many producers they represent new practices. A profit-driven advantage of zero-tillage technology as RCTs has allowed the small and medium farmers to gain the confidence in the technology (Malik *et al.,* 2005).

Table 1 Factors Associated in Adoption of CA							
Author (s)	Knowledge	Attitude	Change proneness	Working population in household	Satisfaction	Prevailing constraints	Information source
Malik *et al.* (2005)	+	+	+	+	+	+	-
Sinha & Singh (2005)	+	+	+	-	-	-	-
Singh *et al.* (2007)	+	+	+	-	-	-	+
Singh (2005)	+	+	-	-	-	-	-
Kumar (2005)	-	+	-	-	+	-	-

It contributes to environmental conservation positively and has been successfully implemented in both small-scale and large-scale farming, where it has given economic benefits as well as improved water resources. In Indian context, the major factors / determinants for adoption of CA have been presented in table 1. Most authors have reported the variables / factors like knowledge, attitude, change proneness, satisfaction level, working population in household, information sources and prevailing constraints which determine the adoption or rejection of CA innovations.

Constraints in Adoption of CA Innovations

The simplest dictionary meaning of constraints are: to compel, to force, to restrict, to restrain, compulsion put upon expression of feelings or behavior, repression of natural behavior, quantity or state of being checked, restricted to avoid or perform some action etc., Various researchers elicited the constraints, which hampered the adoption of CA (Table 2) and most of the work has been conducted on zero tillage technology. These prevailing constraints strictly control the adoption behavior at farmers' level. The major constraints are depicted as:

a) *Technical constraints:* Technical constraints relate to the functioning or technical part of hardware (machinery) like non-availability of quality drill, lack of regular monitoring of machines, lack of training / capacity building and spare parts are not available locally and lack of local manufacturers of machines.

b) *Extension constraints:* Lack of extension support from state extension agencies, lack of extension literature, lack of attention by mass media, lack of knowledge of extension agencies, inadequate extension facility at disposal of input agencies and lack of cooperation from fellow farmers makes the extension machinery ineffective.

C) *Financial constraints:* Financial constraints include lack of credit facilities, lack of money to buy new machines and inputs, no subsidy on machines and high cost of drill which hinders in the purchasing or maintenance of particular machinery.

After evaluating determinants and constraints in adoption of CA, it is the prime function of extension workers to diffuse new ideas and practices among farmers. It is their task to expedite the process of getting ideas from their sources of origin to those who can adopt or use them. To be effective in this process, one must know what techniques to use at the different stages of adoption and how to mobilize them effectively. It is easier and more fruitful to work within existing patterns of decision making habits than to try to short circuit or change them. The extension workers must know that the individuals are in which stage of the adoption process. In order to be most effective, an agricultural leader must know how to use all of the communication channels available to him. In order to be most effective as an extension / educational worker one must understand:

- The nature of acceptance process
- The values and aspirations of stakeholders with whom he must work
- The formal and informal relationship within his area
- Availability and most appropriate use of mass communication
- Sequence and inter-relationships of influence in acceptance of new ideas.

Table 2 : Prevailing Constraints in Adoption of CA Innovations

Author (s)	Singh & Kumar (2005), Kumar *et al.* (2005), Singh *et al.* (2005), Singh (2005), Singh *et al.* (2005), Singh & Pandey (2005), Sinha & Singh (2005), Singh *et al.,* (2006).
Constraints	
Technical	• Non-availability of quality drill • Lack of regular monitoring of machines • Lack of training/ capacity building • Spare parts are not available locally • Lack of local manufacturers of machines
Extension	• Lack of extension support from state extension agencies • Lack of extension literature • Lack of attention by mass media • Lack of knowledge of extension agencies • Inadequate extension facility at disposal of input agencies • Lack of cooperation from fellow farmers
Financial	• Lack of credit facilities • Lack of money to buy new machines and inputs • No subsidy on machines • High cost of drill

Strategy for Implementation of CA Innovation

- **Implementing situations and prevailing constraints**

Factors limiting the agricultural production should be rectified before the full benefits from implementation of CA can be realized. This might refer to technical factors, such as soil compaction, insufficient drainage, soil chemical properties, as well as socio-economic factors such as availability of adequate technology, investment capital, land use rights, livestock pressure, customary practices or access to markets. These will have to be addressed in order to establish CA in a sustainable manner.

- **Transforming the Agricultural System**

The transition phase usually takes about two years; however, the full benefits of this system often become visible only after five years. In CA, mechanical tillage is replaced by biological tillage and soil fertility is essentially managed through soil cover management, crop rotations and weed management. Fertilizers, water harvesting technologies and irrigation can complement CA, and minimum tillage might be necessary in some cases particularly during the transition.

- **Changing the Attitude**

Changing the attitude or mentality of the farming community is a difficult task but it paves the way to success for task like implementing the conservation agriculture. Proper knowledge about the concepts of conservation agriculture is also inevitable like soil is a habitat for roots and soil organisms, any damage to this habitat endangers soil fertility and leads to land degradation, soil fauna creates a stable soil structure etc.

• Encouragement, Support and Capacity Building

Promotion of CA should be done simultaneously through policies, education Research, and extension institutions in the field. Adoption by farmers is supported most effectively through farmers' groups, study tours, networks and NGOs. Research and extension institutions and the private sector have a major role in providing farmers with appropriate and affordable technologies.

- **Policies and Incentives**

Policies should focus on access to market, credit and input supplies, and rural infrastructures. Policies should support the development of farmers' groups. Incentives should encourage diversification and CA practices, especially during the transition phase. Inadequate policies and subsidies that support conventional practices might constrain CA adoption. Land use and customary rights must also be taken into account and eventually adapted to favor CA adoption by farmers and rural communities.

- **Support from International organizations**

Food and Agricultural Organization (FAO) is promoting the adoption of the CA concept at policy level as well as stimulating farmer-based movements and collaboration between the research sector and farmer groups. Due to its positive effects on food security, biodiversity, land and water resources, carbon

sequestration and sustainable development, CA is a major opportunity to implement the International conventions on combating desertification, on biodiversity and on climate change.

Conclusions

Conservation agriculture innovations offer a new paradigm for agricultural research and development. While examining the total innovation-decision process, one can see how the farmers observe innovations (knowledge), relate to images and message within technological innovations (persuasion), formulate a want for item (decision), actively pursue the desire for item (implementation), and ultimately decide whether future uses of technologies / are desirable (confirmation). The adoption of CA innovations can be facilitated by locally identified and specially trained group leaders or by promoters. For the success, farmers will need to be in forefront for helping in identification, development and deployment of CA innovations. Developing and promoting RCT systems is highly demanding in terms of knowledge base. This will call for greatly enhanced capacity of scientists to address the prevailing problems / constraints from a systems perspective and be able to work in close partnerships with farmers and other stakeholders. There is also need to strengthen the knowledge and information-sharing mechanisms. Improvement in coordination amongst various stakeholders like research, extension service, farmers, service providers, agricultural machinery, and manufacturers for transfer of technologies will play a pivotal role in accelerating the Conservation Agriculture.

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