

Conservation Agriculture

Getting Agriculture to Work for People and the Environment

newsletter

Mechanization Needs of Conservation Agriculture in Rainfed Regions of India



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Rainfed agriculture is practiced on 60% of India's net sown area and contributes to roughly 45% of agricultural production. Yet it has to play second fiddle to irrigated regions that have been larger beneficiaries of government support in the past. Major crops grow in the rainfed system contributing to substantial national crop production. These are coarse cereals (90%), pulses (87%), and oilseeds (74%). With plateauing yields in irrigated areas and growing needs of food security, rainfed areas are now being increasingly looked upon to contribute to crop production.



Conservation Agriculture (CA) can be a viable and relevant means to address needs of rainfed agriculture as is evident from the fact that the adoption rate in rainfed regions globally is substantially higher than in irrigated regions. To implement CA systems the role of mechanisation is important, thus meriting a focused approach.

In rainfed regions, timely farm operations are crucial in view of the short rainy season period in these areas. This short period puts pressure on farmers to accomplish field operations in the shortest possible time to take advantage of the opportunity window offered. Needs of mechanization for CA mainly relate to challenges of development, standardization and adoption of farm machinery for seeding

with minimum soil disturbance, and developing crop harvesting and management systems with residue maintained on the soil surface. Finally, adapting such equipment to needs of small landholder farmers, typical in rainfed regions, and making it available in a convenient and affordable manner would hold the key. Majority of rainfed farmers have low purchasing power, making investment in agricultural machinery and implements for operations such as planting, weeding and harvesting a difficult task. This will be a major impediment to be addressed to fulfil mechanization needs for CA adoption in rainfed areas in India. However this situation will present itself as an opportunity to develop a low cost private sector service model for "custom hiring".

Past Efforts in India

Most mechanization efforts in India with respect to CA have been conducted in the irrigated Indo-Gangetic Plains where rice-wheat cropping has been the dominant system. The primary effort while pursuing CA in this region has been on developing and promoting the zero-till cum fertilizer drill for sowing wheat crop within the cropping system. Roughly 2 m. ha. area stands covered under zero-tillage on this basis. This practice has helped reduce cost of cultivation due to savings from avoiding recurrent tillage operations without compromising on yields.

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ZERO TILL SEED-CUM-FERTILIZER DRILL: This drill helps seed the crop directly into non-tilled fields just after the harvest of the previous crop with least disturbance to soil. This practice helps in minimizing disturbance of soil by planting seeds in a line or a hole without disturbing the surrounding soil area. This helps soil to retain more moisture and nutrients, and also its physical, chemical and biological properties. By not tilling the soil, the farmer is able to generate savings on account of time normally devoted to land preparation, and costs on account of savings from tractor, fuel and labour hire. The major advantages as revealed through various field experience include:

- Savings in cost of seed bed preparation of approximately by Rs. 2,500 to 3,000 per ha.
- Savings in fuel from 37.3 to 70 litres of diesel/ha. dependent on soil condition
- Saving in time through seed bed preparation and sowing
- Advancement in sowing time over conventional system by 2 weeks depending upon soil conditions
- Saving in water up to about 30%
- Reducing the incidence of weeds (*Phalaris minor*) by about 40-50% in rice-wheat system



Tractor Operated Zero-Till Drill

The tractor drawn zero-till drills were introduced in mid '80s by Tandon, Shukla and Verma at PAU, Ludhiana, for sowing wheat under rice-wheat system. It can be used just after paddy harvesting for sowing wheat as the soil has enough moisture for germination of seed. Through this, it saves on pre-sowing irrigation before land preparation for sowing wheat after paddy. In the '90s, the Department of Agriculture & Cooperation provided funds for purchase of 100 zero-till drills that paved the way for larger adoption of this technology in India. Later, Rice-Wheat consortium for IGP made efforts that resulted in large scale adoption of this technology in IGP.

ANIMAL DRAWN ZERO-TILL DRILL: The Narendra Deva University of Agriculture & Technology

(NDUAT), Faizabad, U.P. has developed a 2-row animal drawn zero till drill that holds promise in the rainfed regions where animal power is available. It is used for direct seeding of wheat and placement of fertilizer without preparatory tillage under high soil moisture conditions. By use of zero-till drill, the seeding is done timely at a reduced cost. It has field capacity of 0.04 ha./hr. and is expected to be used for working on 75 ha per year. The cost of operating 2-row animal drawn zero-till drill is Rs.750/ha as against Rs. 3,000/ha incurred in tillage.



Animal Drawn Zero-Till Drill

POWER TILLER OPERATED ZERO TILL DRILL: This drill was first introduced in Nepal and can be introduced in India for small land holdings of rainfed regions. Frequent break down of the engine and non availability of spare parts were the major constraints for its non-adoption. The machine holds a great promise in small lands especially in rainfed regions where very little time is available with the farmer for land preparation and sowing.



Power Tiller Operated Zero-Till Drill

HAPPY SEEDER TECHNOLOGY: Happy Seeder is a useful device that can seed the ensuing crop in untilled and residue covered fields. It consists of a straw management unit and sowing unit in one composite machine. It was developed by Punjab Agricultural University, Ludhiana, in collaboration with Australian Centre for International Agricultural Research. It needs a 45hp tractor for traction, and cuts, lifts and manages the standing stubble and loose straw, retaining it as surface mulch and sows

wheat in a single operational pass of the field. Happy seeder technology provides an alternative to straw burning. The existing machine is expensive that is a key barrier to adoption for the poor segment of farmers in rainfed regions or even in irrigated North-West India. Efforts are on to develop a new prototype of Happy Seeder specific to needs of the soil and cropping systems of different regions.



Happy Seeder

Source: National Agro Industries

Complementary Practices: Practices such as raised bed planting system, laser equipment aided land leveling etc. have helped in resource conservation and are being tested and promoted along with main CA practices (zero-tillage & residue retention) in irrigated areas. Land preparation through precision land leveling and bed and furrow configuration for sowing crops further enables improved resource management. Raised bed planting system helps grow crops on ridges or beds. The main objective of this system is to enhance productivity and save irrigation water. Other major benefits include improvement in soil structure, reduced water logging and timely machinery operations while creating opportunity for mechanical weed control and improved fertilizer placement.

BED FORMER-CUM SEEDER: This equipment has been developed for sowing wheat. The machine can make three beds in a single run and the width of each bed is adjustable (35 to 45 cm). The machine is also provided with a shaper after seeding to shape and compact the beds. A planting machine has also been made along with bed former for sowing maize, groundnut, and cotton on the beds. The field capacity of the machine is 0.26ha./hr. The crop on being sown on beds saves about 20-30 % water and 20% seed consumption.

Farmers and scientists in India have also used this technology also known as Furrow Irrigated Raised Bed System (FIRBS) (introduced by CIMMYT for trials in IGP) and have found that it results in 50% savings in seeds, 30-40% savings in water, and reduction in lodging and higher yields. The machine is very suitable for introduction in rainfed areas

where pulses are grown that are susceptible to water logging. The furrow between the two beds serves as a water channel and helps in removing excess water. The crop sown on the ridges is able to draw water from furrows. This implement needs to be promoted through large scale demonstrations at farmers fields in rainfed regions.



Broad Bed Former

Source: Edwards Farm Machinery Ltd.

LASER LAND LEVELER: Unevenness in the soil surface adversely affects even distribution of irrigation water in the fields that leads to poor crop stand and over irrigation. Laser land leveling technology involves the process of smoothing the land surface within +/- 2cm of its average micro-elevation using laser guided drag scrapper. Effective land leveling reduces the work involved with crop establishment and crop management. It increases yield, improves uniformity of crop maturity and reduces weeds and the amount of water needed for land preparation. Laser land leveling when applied under various crops and cropping patterns has resulted in water savings up to 15-30%, savings in irrigation cost to the tune of 5-25%, nutrient use efficiency by 10-15% and operational efficiency by 8-10%. Nearly, 2.0 lakh ha. area has been brought under this technology and farmers are using this through custom hire services. Under micro-management scheme of Department of Agriculture & Cooperation, Laser Land Levelers have been sanctioned to different states for conducting frontline demonstration, and induction.

These complementary practices have been very successful in irrigated areas, however, their adaptation to rainfed areas has to be done very vigilantly for its implications in these very poor resource situations. There will be specific mechanization needs for rainfed regions related to land development, tillage, residue management, sowing/planting and harvesting. Agriculture in rainfed regions is still dominated by small holder and subsistence farming characterized by limited capital, technical know-how, infrastructure, and limited support services leading to poor crop production.



Laser Land Leveler

In deciding farm mechanization needs for rainfed areas, where farmers are generally poor, their socio-economic condition would always need to be borne in mind. Therefore, the needs and challenges for mechanization of CA in rainfed regions would need to be very specific and could include:

- Special methods or equipments to be able to plant into unploughed soil.
- Direct seeders needing to be designed to seed in the presence of surface mulch in untilled soils.
- Both manual and mechanical systems being made available to small holder farmers for sowing specific crops under CA.
- For zero tillage to succeed, addressing needs of weed control would be important, either mechanically or by use of chemicals

The mechanization scenario in the country is changing, and has started to pick up in rainfed regions as well. Small and poor farmers need to mechanize in order to increase their crop productivity, but lack of farm profits inhibit them to afford such means thus affecting demand for such inputs. The key is to enhance farmers' income and make machinery available to them at affordable prices. A major test will be to create a sustainable and viable machinery production and supply chain to give an impetus to mechanization.

Implements too need to be made relatively cheaper and specific to the soil depth and different cropping systems in these regions. It should facilitate low cost modification to machines designed through inclusion and participation of local artisans for repair and maintenance of CA equipment.

Location specific seeders need to be developed for rainfed areas. A feature of these machines is that the seeds and fertilizers are placed in the moist zone of the soil resulting in a high percentage of seed germination and good crop vigour. Custom hiring of equipment could be encouraged as equipment may be unaffordable to many, other than the low capacity utilisation issue.

Mechanization strategies have to look at provision of testing and evaluation to ensure the performance of reliability of locally manufactured equipments through integration with local university and agriculture engineering departments. The efforts to improve mechanization have to be associated with better land management practices.

Learning and adapting from successful pockets of rainfed regions in other parts of the world will be particularly useful. For example, CA for small scale farmers has been very successful in Brazil and some of the African regions through development of successful technology and its application. These could be adapted for application to Indian field conditions.

Though many schemes and programmes have been developed for rainfed regions (some of them covered in issue 8 of this newsletter), inclusion of these mechanization needs through numerous government policies and strategies that are supportive of CA would be very encouraging. There will be a need for piloting projects with a CA component within the agricultural development plans with an agro-ecological focus for the rainfed regions.

Mechanization is not an end in itself and is at best a key input for adoption of CA practice. Adaptive work needs to be done in this regard looking to machineries available in other regions for specific needs of rainfed areas. This machine could be shared then through custom hire mechanism. Integration with other resource conserving practices will in the long run help revamp the rainfed agriculture needs. Improved institutional functioning, service delivery, infrastructure development and synergy between the farmers, researchers, machinery manufacturers and other specific stakeholders will only help in getting sustainable results.

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4. Minimal Tillage Factsheet
5. Two Posters on CA
6. Past Issues of Newsletters

Conservation Agriculture - Under the Lens

A recently published article "Conservation Agriculture and small holder farming in Africa: The heretics view" by Ken E Giller and associates (Field Crops Research, 2009, 114 : 23-34) has evoked considerable response and discussion in relation to the issues raised and conclusions arrived at by the authors. Based principally, on the experience gained in Sub-Saharan African (SSA) countries over the past decade to promote the concept of Conservation Agriculture (CA), the authors have raised a number of questions on the soundness of the CA approach and the practicality of promoting adoption of CA based practices to achieve goals of enhanced productivity and sustained agriculture on smallholder farms. We need to remind readers that smallholder farms in SSA is the focus of the paper and ensuing discussions, knowledge and experience gained globally has been extensively cited to drive the arguments.

Realising the need to look inwards, PACA takes this opportunity through this article to present issues highlighted in the paper by Giller et al (2009) and deliberated through email discussion, for wider sharing in the context of opportunities available to promote CA practices in the Indian context. The matter has been presented in an "issues presented" and "response received" format.

BACKGROUND

Conservation agriculture is just beginning to be considered as a way forward to address multiple challenges facing agriculture practitioners in the South Asia region and India in particular. Although, farming situations in different parts of India differ widely from each other and from conditions cited in the Sub-Saharan Africa (SSA) context, there is much in common between problems and constraints faced in adoption of CA practices by small holder farmers. Sharing these experiences and lessons learnt from promoting CA in SSA will be a valuable input to developing appropriate strategies in the context of our efforts within the South Asia region. The following provides a summary of issues raised and discussed, and also its implication while promoting CA in this region.

The term 'Conservation Agriculture' has been increasingly used over the past decade to refer to agricultural practices and technologies that are rooted in three basic principles that call for:

- Minimum or no mechanical soil disturbance
- Maintaining a cover on the soil by growing a crop (including cover crops) or by leaving crop residue on the soil surface, and
- Adopting diversified crop rotations (including intercropping / agro forestry practices)

There is now sufficient accumulated experiential and experimental evidence to conclude that when agricultural practices and technologies based on the above three principles are adopted in an integrated manner; they bring about a number of benefits – both in the short run and the long run. Conservation agriculture systems have been adopted extensively in USA and Australia and the area under CA practices has grown exponentially in Latin American countries of Argentina, Brazil, Bolivia, and Paraguay. The concepts of CA are only now being appreciated and considered a way forward to address multitude of problems that require urgent attention - climate change being an important one.

DISCUSSION POINTS

Conservation agriculture is considered to have potential to address problems of soil degradation resulting from agricultural practices, and as a way

to achieve improved use efficiency of external inputs and enhanced productivity on a sustainable basis. These benefits accrue when the three principles of CA are appropriately translated into agricultural practices and adopted in an integrated manner over a period of time. Thus, CA is seen as a 'holistic' package which will work only when a number of agronomic management practices are applied simultaneously. In practice, farmers have been found not to adopt all principles of CA due to various reasons like limited access to inputs (herbicides, seeds of cover crops), labour constraint, insufficient financial resources etc. What the farmers are able to practice, therefore, may be quite different from the 'ideal' CA practice developed through on-station trials, and as such that it is less certain what benefits will actually be realized by farmers. The constraints of farmers to adopt all principles of CA as a package make it imperative that the benefit of each principle is appropriately evaluated.

It is true that the theme CA calls for simultaneous application of agricultural practices rooted in the principles of minimum soil disturbance, soil surface kept covered by crop residue, and adoption of crop rotation for maximum benefits being the integrative approach that has the potential to address issues of resource degradation, efficient use and sustained productivity. It is also true that these practices constitute a major departure from conventional practices and for this reason their uptake and wider adoption will be contingent upon the convergence of a number of factors including those related to technology institutions and policy issues.

In some ways, the situation is comparable to the pre-green revolution period when a combination of three elements, viz. dwarf high yielding fertilizer responsive cultivars of wheat and rice crops, availability of fertilizers, and irrigation are largely guided by agricultural research and development efforts. For nearly three decades, technology generation (selection of cultivar, defining amount and timing of fertilizer and water application, developing appropriate pest control measures etc) institutional arrangements (setting up experimental stations and education institutions), and policy measures were focused on these elements as a way to achieving self sufficiency

goals. In the present context, when productivity growth rates are stagnating in the face of widespread resource degradation, climate change, and increasing globalization of markets; past strategies are no longer of avail to move agriculture into the next phase. There is an ample knowledge base to suggest that new approaches to agricultural research and development have to be more integrative – those that address issues of both productivity enhancement and resource base quality, while they are also more adaptive to and resilient to climatic change.

Over the past years, the scientific community has increasingly emphasized the need for developing and promoting 'integrated pest management (IPM), 'integrated plant nutrient management (IPNM), or 'farming system' approaches, but in practice, there has been little progress in widespread adoption of these approaches. CA thus constitutes a good entry point which when translated into a set of agricultural practices enables an integrative demand driven research agenda.

Integrative approaches are best translated into agricultural practices by involving and working together with farmers. It is acknowledged that farmers being central to the farming system are the ones who understand and are best able to see the linkages and implications of new farm practices in the context of farming systems as a whole. Thus, principles of CA while accepted as being universal have to be translated into agricultural practices that are specific to local situations, cropping systems, soil and agro climatic conditions, socio-economic conditions including markets etc. Each situation will present unique difficulties in adoption of technologies that will need to be responded to.

This approach is in sharp contrast to largely experimental station disciplinary research based package of recommendations promoted at the farm level. Developing and promoting CA practices calls for farmer led efforts with strong support from multi-disciplinary team of scientists including farm machinery, weed and pest control, soil and crop management specialists, and social scientists. Farmers are willing to try out new options and can also understand and appreciate the relevance and possible benefits from adoption of practices based on CA principles. It is also true that widespread adoption will happen only if farmers see immediate benefits, and fortunately CA practices have the potential to bring such short and long term benefits. It is true that developing wider adoption of CA based practices will not be a cakewalk, but the accompanying question would be, what are the alternatives? Thus, the task before the scientific community is to make CA happen – this is the challenge.

Is mulching the most sensible, efficient or profitable use of crop residue?

The question that has been raised and deliberated is extremely relevant to conditions in India. While the benefits of leaving crop residue on soil surface

in many situations stands well documented, limited availability and short supply make it extremely difficult for farmers, particularly small and marginal, to spare crop residue from their current uses for livestock feed, household fuel, or other opportunities that offer cash returns. As such, farmers are unlikely to adopt CA practices if the immediate benefits do not exceed or even match current returns they can get.

Leaving crop residue as mulch has multiple benefits. Most importantly, in a monsoon type climate, it reduces direct impact of rainfall on soil reducing erosion, promotes better capture of rainwater through in-situ conservation and runoff reduction, reduces maximum temperature of soil surface, and water losses through evaporation. These benefits can translate in terms of crop yields in areas with limited / uncertain rain patterns in the short term. In the medium term, maintaining residue and their decomposition sets in the process of soil improvement through improved soil structure, enhanced biological activity, etc that contributes to improving use efficiency of external inputs and sustainable increases in productivity. It is true that the nature and extent of benefits that accrue will much depend on soil and agro-climatic conditions and the amount of residue that is recycled. It will therefore be important to evaluate both short and long term benefits in different situations. It will also be important to find ways and means to encourage and provide incentive to farmers to adopt CA based practices.

The question of amount of residue required to be left on the soil also needs to be understood in totality. What is critical is to start moving in a direction that is based on sound principles even if less than optimum amounts can be spared to begin. We are aware that resource degradation problems have become a major limiting factor in achieving enhanced and sustained productivity increases. CA practices have the potential to reverse processes contributing to soil degradation. With other alternatives not in sight, CA does offer itself as a sound option.

Is there a yield penalty from employing CA practices in the short term and yield gain in the long run?

Much of the evidence, limited though, under Indian conditions tend to indicate that when other agronomic and management practices are followed appropriately, crop yields tend to be similar under no-till and tilled conditions. No-till planted crops frequently have a yield advantage in situations where the turn-around time (e.g. wheat sowing after harvesting rice in rice-wheat cropping system) is a constraint for seeding a crop at the optimal time. This advantage could be substantial in rainfed situations where timely planting is critical to obtain a good crop stand and planning optimal utilization of soil moisture. Something that is common with many countries in SSA and stated as a primary reason by farmers to pursue traditional tillage practice is to improve

infiltration, minimize runoff, and to reduce evaporation. In the clay-poor, structurally weak soils of arid and semi arid regions, zero tillage in the absence of crop residue on the surface could indeed encourage runoff, and result in reduced infiltration capacity and eventually reflect on crop yields. Thus, while the basic principles of CA are sound, translating them into effective practices would call for careful consideration of varied factors to ensure farmers' acceptance and wider adoption.

Do CA practices result in saving of labour?

In the context of SSA, Giller *et al* (2009), argue that unless herbicides are used to control weeds, increased amount of labour required for weeding with CA may outweigh the labour saving gained by not ploughing the soil. For this reason, restricted access to inputs such as herbicides due to cost and supply-chain limitations may be a major deterrent to implementation of CA practices. It is true that one of the key objectives of tillage is to reduce incidence of weeds and that control of weeds under untilled conditions can be a major challenge for successful adoption of CA practices. Unlike in SSA, in India, with major public and private sector presence in the agricultural sector, availability of fertilizer is not a serious problem. What will be needed is to address weed management problems in the context of CA practices. Our limited experience with adoption of zero-tillage for seeding wheat in rice-wheat cropping systems has shown that weed control did not pose a serious problem and even tended to reduce over the years with adoption of CA. Further, when appropriate crop rotations are adopted, incidence of pests is sharply reduced, lowering the cost on this account. There is no doubt, however, that successful implementation of CA practices will call for strong involvement and support of weed control and other specialists.

Does CA result in increased soil organic matter content and soil fertility?

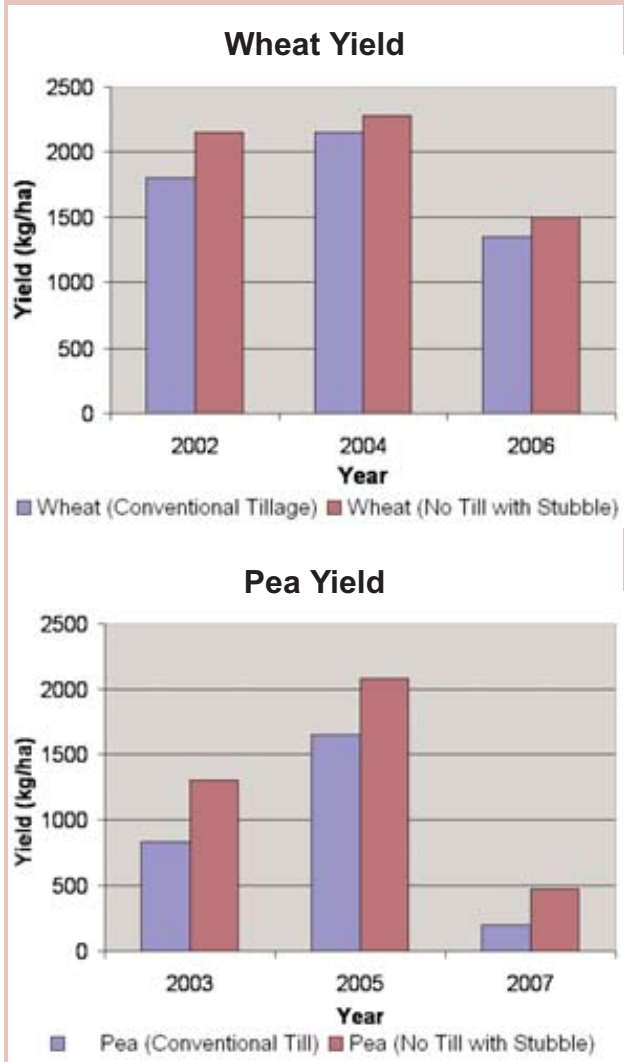
Based on extensive review done, the authors have concluded that there is little evidence that reduced tillage *per se* will lead to increased organic matter content of soils and that benefits of enhanced soil organic matter and soil fertility with adoption of CA practices are more a function of increased inputs of organic matter as mulch. Yes, it is important to understand the extent and mode of interaction of different CA elements as to their perceived and experienced short and longer term benefits. It is also true that the extent and mode of benefit (or for that matter adverse effect) will depend on the nature of soil and climatic features. From a practical standpoint, it is clear that in most situations in India, with soil organic matter content and soil physical properties having reached almost the lowest limit, primary benefit of CA practices in terms of organic matter gain will be mainly due to increased retention of biomass produced rather than reduced tillage. The question of organic matter incorporation v/s need of

INFOPIX

This section will present research data in pictorial form from past studies for benefit of readers

Grain yield of crops under traditional tillage and no-till with stubble retention

Field experiments carried out from 2001 to 2007 in Dingxi, a typical semi-arid area on the Loess Plateau in China showed that no till with stubble retention system performed consistently well in terms of productivity than the traditional tillage system. On an average, grain yield under no-till with stubble system was 18% higher than from conventional tillage system for wheat (2.0 versus 1.7 t/ha) and 20% higher for pea (1.4 versus 1.1 t/ha).



Source: Huang GB, Li LL, Zhang RZ, Unkovich M, Li G, Chan K, Bellotti W (2008), "Conservation tillage research on the Loess Plateau of China", paper presented at the 14th Australian society of agronomy conference, September 21-25, 2008, Adelaide, South Australia

maintaining residue on surface has to be viewed from the point of view of “mode of benefit”. The primary benefit of surface maintenance of residue under monsoon type climatic conditions in the short term can be ascribed to reduced direct impact of rain on soil surface, improved infiltration and reduced evaporation of conserved water. Improved rainwater conservation and use, critical to crop success in rainfed areas will add to biomass production. Reversal of soil degradation processes is seen as the major benefit in adopting CA practice, although build up of organic matter under tropical arid and semi-arid climate will need to be evaluated very carefully.

Is it necessary to apply more fertilizer when practicing CA?

The issue is, if a large amount of cereal residue is left on the soil surface that can cause certain amount of mineral nitrogen immobilization, will it then not result in yield loss unless additional fertilizer doses can compensate for reduced N availability? As indicated earlier, India has an excellent network of fertilizer distribution, and availability *per se* may not be a problem. However, it is true that fertilizer management practices will need to be suitably modified and adjusted to suit new practices. Another aspect is the reluctance of farmers to use inputs under uncertain risky rainfall conditions. CA practices with a potential to improve soil water availability would also encourage farmers to use other inputs to optimize yields. In brief, it is clear that translation of CA principles into appropriate location specific practices will also call for adapting other management practices to the new situation. Thus, the need of a strong scientific backing is absolutely essential for promotion and wider adoption of CA practices.

OTHER ISSUES

Other issues raised and discussed related to possibility and choice of legumes that can be introduced as a part of CA strategy, short term v/s long term benefits of adopting CA practices vis a vis erosion control, beneficial or adverse impact of enhanced biological activity in soil on crop production, potential for adoption of CA practices by smallholder farmers in SSA etc. These and the discussions that followed with participation of a large number of scientists worldwide permit us to make observations particularly in relation to potential and opportunity for promoting CA based technologies in the Indian context.

Our past strategies that brought about substantial gains in agricultural productivity are no longer sufficient to achieve the required increase in productivity to meet our demands.

The main aim of our past strategies was to achieve increased productivity and production of selected crops in the shortest possible time. While these efforts have contributed significantly to achieving self sufficiency goals - Indian agriculture facing myriad of problems now calls for a strategy that is

different than what we have pursued. A basic requirement to any new strategy is that it must be able to take on board the concerns of enhancing productivity and resource conservation, and challenges of climate change in an integrated manner.

There is no doubt that CA practices constitute a major departure from conventional practices. It is also true that adoption of CA practices in an integrated manner is more complex, more knowledge intensive, and more demanding from the scientific community. This is the challenge offered by the post-green revolution phase and the scientific community must face it squarely.

Principles of CA constitute a sound basis of a strategy to address multifaceted problems. Successful translation of principles into practical technologies will however call for several innovative interventions. Most importantly, involving farmers as partners in the process of technology adaptation and refinement will be a key requirement. Being at the core of farming system and involving farmers in adapting and refining technologies is the key to build a farming systems perspective in generating and promoting technologies that have a greater likelihood of wider acceptance.

Developing and promoting CA practices will call for a strong location specific bias. CA principles need to be translated in the context of solution to local problems, needs, and social and economic conditions. For this, the scientific community will need to develop a deeper understanding of the local natural resource endowments and socio-economic dynamics and how they interact. This would imply that adaptive research needs to be organized in a variety of agro ecological settings. Fortunately, an infrastructure to enable this exists. This also implies that unlike in the past, technology generation and promotion will no longer follow a linear path where scientists generate technologies, largely, discipline based, and ‘transfer’ to extension workers for wider dissemination.

Many benefits attributed to adoption of CA practices are likely to start emerging in the medium term, say 4-6 years. This is important as farmers always look for good reasons and immediate benefits to be attracted to a new technology. CA practices fortunately can address both the short and long term concerns of farmers.

Adopting CA practices in an integrated way will present difficulties, but this is the challenge of the post-green revolution era. The theme Conservation Agriculture is a way forward to address multiple technological challenges facing farmers and just as certain elements formed a basis of the green revolution success in post ‘60s, elements of CA can provide a sound entry and a starting point to address contemporary issues. This aspect needs to be recognised and addressed by policy makers of countries involved.

Field Efforts Launched for NAIP Mewat Project

A report on ongoing efforts initiated in the World Bank funded NAIP project in the Mewat region of Haryana, India

As reported in our earlier issue (Issue 8) PACA is involved with a World Bank funded National Agriculture Innovation Project (NAIP) in the Mewat region of northern India. The project has a conservation agriculture focus.

The project assumes importance given the fact that it is one of the first organised efforts concerning CA that is being pursued in a rainfed environment in India. The region's typical characteristics are:

- High salinity of ground water is a major limiting factor
- Lack of timely availability of critical inputs such as high yielding variety seeds, weedicides, fertilizers and pesticides
- Predominantly a livestock pursuing region with poor availability of fodder
- Poverty, illiteracy, poor skills, and lack of finance appear to be a hindrance in wider adoption of technologies
- In some parts of Mewat, canal irrigation has caused groundwater levels to rise resulting in severe problems of waterlogging and salinity

Observations

An early assessment of the region has thrown up the following issues that is likely to impact the fate of agriculture in the region:

- Continued high temperatures following failure of normal rains in July-August has resulted in delayed planting of mustard with a higher

probability of yield loss. Positive aspect of this event is reduced pest incidence.

- Reduced humidity has directly affected fruit setting and resulted in enhanced irrigation needs.
- Practically no rainfall during early monsoons and heavy rains in the later months has led to reduced recharging of soil profile and lowering of the ground water table.

These are the very issues that the project will look to address through the NAIP initiative.

Interventions

The project will direct overall efforts aimed at demonstrating and building capacity of farmers for adoption of CA. This will be done through efforts directed at cereal based resource conservation, crop-livestock interface & integration, and micro-irrigation related interventions. Through these interventions, the project consortium will aim to enhance crop productivity and farm income.

To operationalise these interventions, Mewat region has been divided into three agro-ecological clusters, based on natural resource endowments of the region. The intervention clusters are clearly depicted in the outline map shown on following page.

Cluster I (Pink colour in map) is a resource-rich region in terms of natural resource endowments like good quality ground water and medium textured soil. Farmers in this region are generally progressive, and



Stakeholder Consultation at Mewat Project Site

agriculture constitutes main source of livelihood. Cropping pattern is generally Pearl Millet (Bajra)-Wheat, Sorghum-Wheat, and Pearl Millet (Bajra)-Mustard. Irrigation needs are mostly met through ground water.

Cluster II (Yellow colour in map) is a relative resource-deficient rainfed region with poor quality soil and water, and irrigation needs met in a limited way through use of ground water. Animal husbandry constitutes an important activity for the farming community to meet livelihood and food security needs.

Cluster III (Red colour in map) is distinct from above clusters, with vegetable production dominating and serving as a viable income generation activity for farmers. Major vegetables grown are onion, chilli, brinjal and cauliflower.

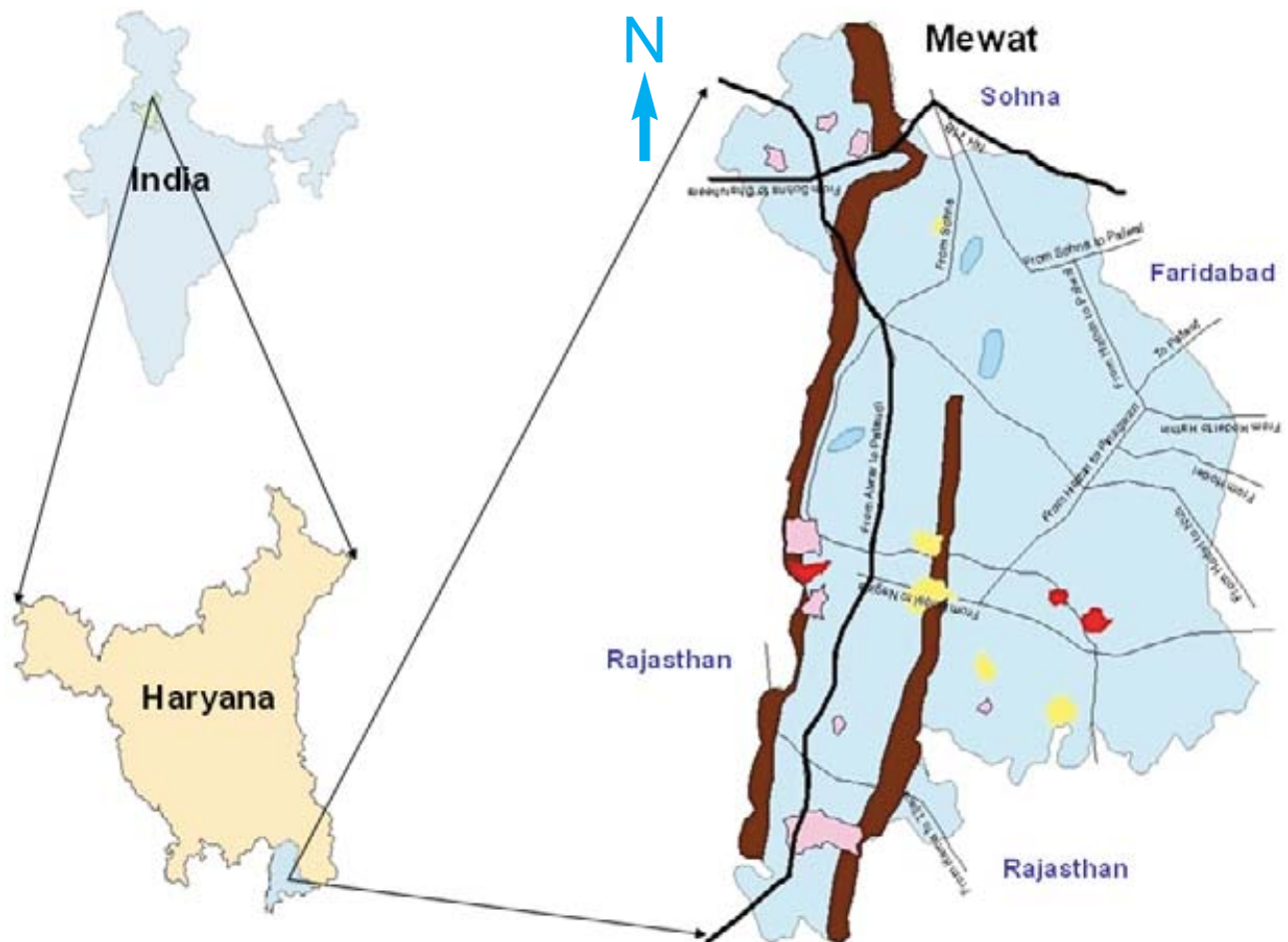
To address field efforts, stakeholder consultations were organised by National Centre for Agriculture Economics and Policy Research (NCAP) at Mewat between July and October, 2009. These consultations were attended by all consortium partners and was a preliminary initiative to help develop a sound understanding of various regional dynamics, with a view to address project needs more effectively, as also validate early hunches.

PACA’s Role in Project

Within these overall project efforts, PACA

aims to promote the pursuit of CA with a focus on sustainable livelihoods. Activities will closely align with primary interventions identified in the project document and would largely constitute:

- RESEARCH STUDIES: Mewat constitutes a rainfed ecology with diverse resource use dynamics in the clusters identified for interventions. Livestock being a major portion of livelihoods along with agriculture, will have major implications for CA adoption in the district given the pressure on crop residue for needs of fodder. Major research studies would aim at:
 - o Understanding crop-livestock interactions while identifying opportunities and challenges for crop residues
 - o Understanding the scope and relevance of CA to small holder farmers in rainfed areas.
 - o Understanding resource use dynamics in the three project clusters. This to be done with a view to explore the current response strategies to resource degradation and scarcity
 - o Understanding market linkages for horticulture and dairy produce for developing avenues of income for smallholder farmers through peri-urban market linkages



Map of Mewat district indicating project clusters

- **TRAINING FOR FARMERS & WOMEN:** PACA is to organize training programmes as below to help farmers with supplemental on-farm activity leading to improved income and living conditions:
 - o Training programmes for vermi-composting, mushroom cultivation, and livestock nutrition management
 - o Training programmes for women on health & nutrition, farmers functional literacy and entrepreneurial activities, value addition and market linkages
- **ADVOCACY & CAPACITY BUILDING:** The following initiatives are proposed to be pursued:
 - o Workshops including consultations with major stakeholders for creating resource use consciousness and developing a higher level of sensitization for deliberating the role, utilization and conservation of elements of water, soil and energy.
 - o Installation of biogas plants, distribution of seeds for fodder crops, mineral mixtures, and green leafy vegetables while consciously linking them to training programmes
 - o Knowledge Management: Efforts will be directed at analysing and documenting project efforts pursued, and bringing out newsletters, publications and reports. Paper based efforts will be supported by electronic media presence shared through the web

The above activities have been chosen after a detailed analysis of needs of the region and will be carried out in a targeted manner. The NAIP project is based on the principle of consortium based project management and all efforts will be managed in close coordination with other partners of the project (details can be found in PACA Newsletter 8).

The consortium will take into consideration current and planned efforts being pursued by government and civil society institutions, and will align its efforts to be in tune to such efforts. Prominent among these institutions are Department of Agriculture, Mewat Development Agency, Regional Research Station, and Krishi Vigyan Kendra, Mandkola.

PACA's endeavor will be to develop and leave behind a community of CA practitioners with a view to make agriculture a viable and sustainable option for addressing livelihood and food security needs in rainfed regions. Efforts will be taken up in a manner that are self-sustaining beyond the project term.

Climate Change and Agriculture - Email Discussion Summary

A nationwide email discussion was organized by Solution Exchange, India pertaining to the subject of climate change and agriculture with the consolidated summary being uploaded on 8th September, 2009. The main objective of this discussion was to understand whether climate change was impacting agriculture sector, and if so, how were the farmers using their traditional knowledge, and what adaptive strategies are being adopted by them to combat this. Researchers and people from various NGOs from different parts of country responded to this with relevant examples.

Discussions clearly brought out that climate change is impacting agriculture largely through changes in temperature and precipitation. On a macro scale, global warming has accelerated the process of glacier retreat, resulting in a change in the flow of perennial rivers causing greater and wider damage to agricultural fields. Increased climatic variability and changes are directly or indirectly impacting agriculture via; crops, soil, livestock, and pests. Uncertainties associated with agriculture are now getting further intensified with climate change; as the amount, intensity, duration, and frequency of precipitation are becoming more unpredictable. Association of high temperature and low crop yields are a common phenomenon in many parts of India. Increase in temperature is also responsible for migration of some species to higher elevations, thus impacting overall ecology.

Indian farmers have responded to climate change differently at different places. Farmers of Uttarakhand are sticking to their traditional crops as they found that these local varieties are more resistant to climate change parameters. Farmers of Maharashtra region feel benefited by the adoption of Agro-Horti-Forestry model and inter-cropping practices. Farmers in Vidharbha have found the solution in organic farming. All of these initiatives are largely farmer driven with some institutional support.

The discussion pointed to a strong need to understand the dynamic relationship between agriculture-farmers initiative and climate change in order to gain sustainability. Some of the measures as suggested in this discussion include; no-till farming, adoption of intensified agriculture, crop rotation, mixed/inter cropping, use of traditional/locally adapted plants and animals, efficient resource utilization, agro-forestry, and adoption of biological soil inputs. In addition to field interventions, there is a need to establish nationwide early warning system, documentation of scattered adaptive measures, strengthening of institutional arrangements, micro level assessment of problems, and integration of agro-climatic zone concept at the planning and execution level.

SNIPPETS

NEWS

2010 No-Till Conference

The 22nd High Plains No-Till Conference will be held at Burlington Community Center, Colorado, on 2nd and 3rd February 2010. The aim of this Conference is to bring together producers, agricultural business professionals and educators to learn new techniques and latest technology about equipment and research for no-till, minimum-till, and conservation practices, and to discuss current farming issues. For more details, visit the link below:

<http://www.highplainsnotill.com/conference/CCTAConfBrochure2010.pdf>

Zero-Till Workshop and Trade Show in Minot, North Dakota

The North Dakota Zero Tillage Farmers' Association Workshop will be held in Minot, ND from January 11-13 2010. The theme of the workshop is "Changing with the Times" to help producers move no-till to the next level. It will also provide producers ideas for improving productivity, decreasing costs, while providing high quality food produced in a sustainable manner. The workshop intends to cover topics such as "Keeping the soil permanently covered for high profitability and sustainability" and "Environmentally friendly and productivity agriculture – the role of conservation agriculture for ecosystem management." For more info, visit the link below:

http://www.mandakzerotill.org/Annual_Workshop.htm

International Conference on Food Security and Environment Sustainability

The Department of Agricultural and Food Engineering, IIT Kharagpur, is organizing an International Conference on Food Security and Environment Sustainability from 17-19 December 2009. The aim of this conference is to bring together different stakeholders of agricultural enterprises from different parts of the world to exchange views and share knowledge so as to build a roadmap for achieving food security and environmental sustainability. The conference theme includes Power and Machinery Systems, Renewable Energy Sources and Management, Water Resources and Watershed Management, Sustainable Agricultural Production, Precision Agriculture, Agricultural Biotechnology etc. For info, visit the link given below:

<http://www.agri.iitkgp.ernet.in/fses2009/index.html>

Assistantships at Pennsylvania State University

The Pennsylvania State University is providing Assistantships for an MS or PhD Graduate degrees in Agronomy, Ecology, and Soil Science to study sustainable cropping systems based on ecological principles. For a recently funded 3-year project, with a team of Penn State and USDA-ARS scientists, graduate applications are being sought for the year 2010-2011. Students will have

the opportunity to interact with a diverse set of researchers and other graduate students in Horticulture, Crop and Soil Sciences, Entomology, researchers from The Rodale Institute, and the US Department of Agriculture.

For more information, contact: Dr. Heather Karsten or Dr. Douglas Beegle, Department of Crop and Soil Sciences (hdk3@psu.edu; 814-863-3179; dbb@psu.edu).

PUBLICATIONS

Jirina Svitakova, Petr Kosina, Roberto La Revere. 2009. Impacts of CIMMYT's international training linked to long-term trials in conservation agriculture: 1996-2006 <http://www.cimmyt.org/english/docs/impacts/impactstrainingca.pdf>

John N. Landers. 2007. Tropical crop-livestock systems in conservation agriculture, The Brazilian experience, Integrated Crop Management Vol. 5 <http://www.fao.org/ag/ca/8.html>

Tristram O. West and Wilfred M. Post. 2002. Soil Organic Carbon Sequestration Rates by Tillage and Crop Rotation: A Global Data Analysis. Soil Sci. Soc. Am. J. 66: 1930-1946 <http://ecoport.org/ep?SearchType=reference&ReferenceID=558810>

Better Soil Better Yields- A Guidebook to Improving Soil Organic Matter and Infiltration With Continuous No-Till, Conservation Technology Information Centre 2001 <http://www.conservationinformation.org/Publications/BetterSoilBetterYields.pdf>

Reicosky, D.C. 2008. [Carbon sequestration and environmental benefits from no-till systems](#). Carbon sequestration and environmental benefits from no-till systems. In: Goddard, T. *et al.*, editors. No-till Farming Systems. Special Publication No. 3. Bangkok, Thailand: World Association of Soil and Water Conservation. p. 43-58. http://www.ars.usda.gov/research/publications/publications.htm?SEQ_NO_115=213063

Proceedings of a 3-day Regional SAARC Workshop on "Nutrient Use Efficiency in Agriculture" organized at Central Soil Salinity Research Institute, Karnal, from September 9-11, 2009, is now available and can be downloaded from link given below: <http://www.cssri.org/saarc.pdf>

Reicosky, D.C. 2007. Conservation Agriculture: Environmental Benefits of Reduced Tillage and Soil Carbon Management in Water-limited Areas of Central Asia. In: Lal, R., Suleimenov, M., Stewart, B.A., Hansen, D.O., Doraiswamy, P., editors. Climate Change and Terrestrial Carbon Sequestration in Central Asia. New York, NY: Taylor & Francis. p. 199-209.