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Conservation Agriculture Policy –Perspective and Future Scope

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1. Introduction

Agriculture is an energy conversion process. It is both a producer and a consumer of energy. Agriculture provides food, feed and fibre. The introduction of high yielding varieties of major crops like wheat, rice etc. in India in mid-sixties paved the way for important technological changes and led to unprecedented rise in the crop yield and land productivity in many parts of the country. Green revolution led to self-sufficiency in food grains with the production reaching 203 millions tons (Mt) in 1998-99 as against 50 Mt in 1950-51. This increase production could be achieved due to increased use of inputs such as fertilizer, irrigation water, diesel, plant protection chemicals, electricity etc. which demands more energy in the form of human, animal and machinery. Total commercial energy use in agriculture increased nearly five fold with growth rate of 11.8 percent between 1980-81 to 1994-95, but the share of agriculture in total energy consumption in the country increased marginally from 2.3 to 5.3 percent during the same period. These gains of green revolution were accompanied by widespread problems of resource degradation and environmental pollution, which now pose a serious challenge to the continued ability to meet the demand of an increasing population and lifting people above the poverty line. Apart from this, Green House Gas (GHG) emissions are also accounted for enteric fermentation from livestock, manure management, rice cultivation, and burning of agriculture residues.

The fuel crisis in 70's and growing uncertainty in the supply of hydrocarbons and the concern on growing environmental pollution caused by inefficient use of energy were the main factors which led to increasing emphasis on energy efficiency and conservation the world over. With conventional energy sources depleting at a fast rate on account of increasing demand, energy has emerged as one of the most important considerations in design and management of agricultural operations in recent times. Increasing demand on energy from agricultural sources has resulted in large scale deforestation, soil erosion and loss of fertility on one hand and in manifold increase in the requirement of commercial energy in the farm sector on the other. The highly mechanized food system of USA uses about 16.5 per cent of total national energy, about 80 per cent of which is provided by petroleum products in the form of fuel for engines, synthetic fertilizer and agro-chemicals.

One of the most productive agricultural regions of the world is the Indo-Gangetic Plains (IGP) of the sub-continent. This is the home of the rice-wheat system that occupy 24 million ha of cultivated land in Asian subtropics. Nearly 1.8 billion people of South Asian countries of Bangladesh, India, Nepal and Pakistan depend on food and 60 per cent of them on gainful employment and livelihood on agriculture. Rice-Wheat systems are critical to South Asian food security. About 30% of rice and 42% of wheat in the region is grown in the IGP of India, Pakistan, Bangladesh and Nepal. The average area under rice-wheat systems in the sub-continent is about 13.5 m-ha (India 10.5 m-ha, Pakistan 1.6 m-ha, Bangladesh 0.8 m-ha and Nepal 0.6 m-ha). The rice-wheat system occupy another 10. m ha in China. Rice-wheat

cropping system is an important cropping system in India and contributes to 52% of India's total food production. Practicing rice-wheat systems for past several decades have however fatigued, the natural resources base resulting in declining factor productivity in many areas. The pressure on natural resources are immense: soils are less able to sustain crops as a result of continuous and intensive cropping and reduced organic matter levels. The development of sodicity and salinity on irrigated land and depletion of ground water in areas irrigated by tubewells and water quality concerns have brought about heightened awareness of the need for the judicious use of water. Tillage costs are rising, which accentuates the already serious labour shortage during peak periods of land preparation and harvest. For these and other reasons, the sustainability of these systems is in question. This has forced the scientists to develop new technologies that are able to enhance the sustain cereal production without compromising the quality of natural resources. A Consortium of South Asian National Agricultural Research Systems (Bangladesh, India, Nepal and Pakistan), International Centres (CIMMYT, CIP, ICRISAT, IRRI & IWMI), Advanced Research Institutions (ARIs), NGOs and private enterprise and farmers group was formed to address concern of the rice-wheat systems. This consortium known as the Rice-Wheat Consortium (RWC) for the Indo-Gangetic Plains (IGP) is convened by CIMMYT and is one of the eco-regional initiatives of the CGIAR. This brought together researchers, extension services, farmers and machinery manufacturers to interact and bring out technologies to sustain rice-wheat system and introduction and adoption of conservation tillage and conservation agriculture.

In India, the extensive cultivation of crops to get higher yields have resulted in intensive resource degradation problems, for example declining water tables in the high productivity northwest irrigated region seriously constrain productivity and ecology of the region. High level of fertilizer use and decreasing use efficiency are increasingly contributing to groundwater pollution and increased emission of green house gases (GHGs). High level of pesticides used in many areas have become a major health hazard . Thus with continuously deteriorating resources, widespread problem of water contamination and eroding ecological foundation, sustainability of agriculture is becoming highly unsustainable and many farmers have committed suicide due to crop failure and debt. Hence, efforts have been made to conserve resources by following Conservation Agriculture (CA).

Tillage, interculture, irrigation, harvesting and threshing operations consume maximum energy. As tillage consumes maximum energy hence, efforts were started world over in 70's to reduce energy use on the farm by efficiently applying different inputs and by reducing the number of tillage operations to bare minimum for seed bed preparation to get higher or equivalent yield. This led to development of Zero-till drills & gave rise to the concept of Conservation Tillage. Conservation Tillage are practices that leave crop residues on the surface which increases water infiltration and reduces soil erosion.

Zero till drills are specialized machines which can directly sow a crop in the standing stubbles of previous crop without any land preparation. A good number of studies have been conducted to compare the effect of zero-till drills and conventional methods in India, Bangladesh, Pakistan and Nepal . Results of the studied showed that there was no difference in yield between zero drilled crops and conventionally sown crops. Use of these zero-till drills resulted in saving in fuel, time, labour and cost of operation.

The Conservation Tillage studies resulted in adoption of Conservation Agriculture (CA) to reduce excessive use of inputs, such as seeds, fertilizer, chemicals, water and excessive tillage resulting in degradation of land and environmental pollution. The CA refers to the system of raising crops without tilling the soil while retaining the crop residues on the soil surface. The aim of CA is to conserve, improve and make efficient use of natural resources, such as soil, water, fossil fuels through integrated management. It also aims to conserve environment and helps in sustainable and enhanced agricultural production. It also helps in maintaining a permanent or semi permanent soil cover which act as a mulch. This mulch helps to protect the soil from sun, rain and wind and also act as a feed to soil biota. The soil microorganisms and soil fauna take over the tillage function and soil nutrient balancing. A good number of equipment such as rotavator, laser land leveler, zero-till drill, roto-drill, strip till drill, one pass equipment, happy seeder, sprinklers, straw cutter cum spreader, straw baler, straw combine have been developed and are being propagated for CA. Keeping in view the increase use of natural resources and environmental pollution, a large number of studies on conservation tillage and conservation agriculture have been conducted world over and these are discussed in the paper along with CA policies being followed and their implications.

2. Conservation Agriculture

In India, due to increased population, the demand for food production has increased and it has put pressure on land to get more output from the same field. This has resulted in over exploitation of natural resources with the result, the water table has gone down, in some places due to building of canals to apply water, the water table in these areas have gone up with the result the salts have leached above soil surface, the excess application of chemicals have polluted the ground water and burning of farm residue to clear the fields for sowing next crop have resulted in environmental pollution and CHGs. This has resulted in adoption of Conservation Agriculture (CA). This word is an offshoot of Conservation Tillage studies conducted for promoting use of zero till drills and reduced tillage.

Excessive tillage causes the soil to become denser and compacted, increases run off and soil erosion and reduces organic content due to burning of crop residues. It also leads to droughts becoming more severe and soil becoming less fertile and less responsive to fertilizer. To address to these concerns it is felt that sustainable production system can be achieved when the basic principles of good farming practices are applied. The terminology adopted

for such systems by FAO, ECAF & other organization is Conservation Agriculture(CA). Many definition of CA have been given by different researches which are given below.

CA refers to the system of raising crops without tilling the soil while retaining the crop residues on the soil surface. Land preparation through precision land leveling and bed and furrow configuration for sowing crops further enables improved resource management.

CA aims to achieve sustainable and profitable agriculture and subsequently aims at improved livelihoods of farmers through the application of three CA principles; minimal soil disturbance, permanent soil cover and crop rotation.

CA aims to conserve, improve and make more efficient use of natural resources through integrated management of available soil, water and biological resources through integrated management of available soil, water and biological resources combined with external inputs. It contributes to environmental conservation as well to enhanced and sustained agricultural production. It can also be referred to as resource efficient/resource effective agriculture

Conservation Agriculture can also be defined as a range of soil management practices that minimize effects on composition, structure and natural biodiversity and reduce erosion and degradation. Such practices may include precise land leveling by laser leveler to save water, direct sowing or drilling/ no-tillage reduced tillage/tillage for timely sowing, surface-incorporation of crop residues and establishment of crop in annual and perennial crops to add organic matter to the soil and avoid burning of straw thereby reducing pollution and use of straw combine followed by bailer to collect the straw lying in the field. The soil is thus protected from rainfall erosion and water runoff, the soil aggregates, organic matter and fertility level naturally increase, soil compaction is reduced and use of fossil fuels and GHG emissions are also reduced. Furthermore less contamination of surface water occurs, water retention and storage is enhanced, which allows recharging of aquifers.

CA can be seen as a new way forward, for conserving resources and enhancing productivity to achieve goals of sustainable agriculture, which demands a strong knowledge base and a combination of institutional and technological innovation. It is being perceived by practioners as a valid tool for sustainable land management. Hence, it is being promoted world over including IGP.

Conservation Agriculture permits management of soil and water for agricultural production without excessively disturbing them. Presently CA has assumed importance in view of the widespread degradation of natural resources leading to increased cost of production, unsustainable resource use, environmental pollution and health of ecosystems. Therefore, it is very important that CA practices are adopted in different agro-ecological regions without delay. Govt. in world over started giving incentives to the farmers to practice

CA and some even formulated conservation policies. Various conservation tillage practices such as zero tillage, minimum tillage, reduced tillage, ridges and furrow method, broad bed and furrow & raised & sunken beds of different widths have been evaluated in different types of soils to reduce land preparation operations and to save energy.

Conservation Agriculture has the potential to emerge as an effective strategy to the increasing concerns of serious and widespread natural resources degradation and environmental pollution, which accompanied the adoption and promotion of green revolution technologies since the early seventies. The key challenge today is to adopt strategies that will address the twin concerns of maintaining and enhancing the integrity of natural resources and improved productivity; while improvement of natural resources takes a lead as it forms the very basis for long term sustained productivity. CA practices in different agro-ecological regions, identifying the technological, socio-economic policy and institutional constraints, defining agenda for R&D and identifying institutional mechanisms for promoting the strengthening participation of range of stakeholders as a means of seeking a way forward.

Strong linkages between resource degradation and poverty and that CA must be considered a route to sustainable development. Globally CA systems are being adopted in over 80 million ha largely in the rainfed areas. The countries where the system is being adopted and promoted extensively include US, Brazil, Mexico, NewZeland, Australia, Argentina, Canada, South Asia, China etc. Unlike, in the rest of the world, in India and other South Asian countries spread of CA technologies is taking place in the irrigated Indo-Gangetic plains where rice-wheat cropping system dominates. CA systems have not yet taken roots in other major agro-eco regions, like rainfed, semi-arid tropics, the arid regions or the mountain agro-ecosystems in India. While the basic principles, which form the foundation of CA practices , i.e. no-tillage and surface managed residues are well understood, adoption of these practices under varying situations is the key challenge. Issues related to technology needs and inputs management addresses some of these basic issues for transition to CA. The Technologies challenges related to development, standardization and adoption of farm machinery for seeding with minimum soil disturbance, developing crop harvesting and management systems with residues maintained on soil surface and developing and continuously improving site specific crop, soil and pest management strategies will optimize benefits from the new system.

Emphasis needs to be given to enhancing livelihood opportunities rather than increasing yields. CA marks an evolutionary change through a process of learning that offers the opportunity and a means to achieving policy goals. CA has to offer a way to address broader livelihood issues. The new institutional arrangements must be based on a good understanding of the features that distinguish the principles and practices of CA from the conventional R&D approach. Institutional mechanisms are required to ensure that CA is seen

as a concept beyond agriculture. Institutionalizing the role of research, extension and farmers in such a way that the partnership among these stakeholders might be strengthened right from the beginning of the project, which helps building up sense of enabling of ownership among them. CA must aim at broad livelihood strategies and move towards forming conservation villages with appropriate agribusiness strategies to increase employment in areas where it is adopted. However, caution must be taken to avoid blanket adoption of CA just every where, it should be site specific and need based. CA is now considered a route to sustainable agriculture. Spread of CA, therefore will call for a greatly strengthened research and linked development efforts. CA requires a new way of thinking from all concerned, Along with this “new way of thinking agriculture”, there is already enough technical and agronomic evidence that could positively influence farmers contemplating the adoption of CA principles.

It is estimated that about 2 billion ha. area in the world is affected by various forms of land degradation which include water erosion (1.1 billion), wind erosion (0.55 billion), chemical degradation (0.24 billion) and physical soil degradation (0.08 billion). According to latest estimate using global assessment of soil degradation of guideline, about (188 m. ha; 57%) of land is potentially exposed to various degradation forces, of which water erosion constitutes a major section of 148.9 m. ha; 45 % and the remaining 38.9 m ha ;12% suffer from wind erosion (13.5 m ha; 4.1%), chemical degradation (13.8 m ha; 4.2%) and physical degradation (11.6 m ha:3.6%). The major factors responsible for large scale degradation are deforestation, unsustainable fuel wood and fodder extraction, shifting cultivation, overgrazing, non adoption of adequate soil conservation measures, improper crop rotation, indiscriminate use of agrochemical such as pesticide, improper planning and management of irrigation system and extraction of groundwater in excess of the recharged capacity.

Since land and water will be shrinking resources for agriculture, there is no option in the future except to produce more food and other agricultural commodities from less per capita arable land and irrigation water. In other words, the need for more food has to be met through higher yields, per unit of land, water, energy and time. Hence, there is need to evolves a scientifically land use system, a sound Conservation Agricultural Policy and Mission Oriented Programme.

According to National Agriculture Policy, India must achieve a growth rate of 3-4% per annum in agricultural sector, and food grain production of 400 m.t. by 2020. Now the question is how to achieve this target and growth rate. This can only be achieved through mechanization, use of efficient machines and developing agronomics practices suited to agricultural machines and following Conservation Agriculture.

2.1 Need for adoption of CA and mechanism for accelerating adoption

Due to intensive cropping the quality of soil is on decline. Current nutrient management practices result in inefficient use of nutrients applied through chemical

fertilizers, resulting in increasing environmental problems, decline in the quality of groundwater due to either rising of salts in soil due to water logging or due to either leaching of salts into the soil, increasing emissions of GHGs etc. Current Cropping systems (R-W) in IGP are also carrying out exploitation of groundwater resources, reinforcing that current agricultural practices and policies are contributing to fast degradation of resource base and unsustainability of production system. Hence, the important question is how to stop this degradation and make agriculture more sustainable. This can be met by adopting CA which will differ from soil type, to rainfall, climate and socio economic situations. Hence, technologies have to be evolved keeping in mind the rural situation in a participating mode.

In “Green Revolution” era in India efforts were to enhance productivity of certain crops but the new challenge is efficient resource use and conservation to ensure that earlier gains can be sustained and further enhanced to emerging challenges and needs. CA has emerged as a new way forward to achieve the goals of sustainable Agriculture in response to resource conservation challenges. This will call for developing new strategies and promotion of new technologies to enhance production, productivity and formulation of long-term perspective.

Some of the doubts about CA are whether it can applied to small farms, disease problems due to residues left in the field, application only to grain crops or other crops and whether applicable to all type of soils and works in certain climates. Well it can be applied to all farm size, there are no disease problem and it will depend upon crop rotations followed. It can be used in wide range of other crops such as sugarcane, potatoes, pigeon pea, cotton, potato, fruits and vine. It can be practiced in all type of climates and soils. The only caution that needs to be taken is to control weeds.

R-W systems occupy 12 m. ha. and contribute more than 80% of the total cereal production in the RWC countries. The continuous production of rice-wheat has resulted in degradation of land, lowering of water table, contamination of water, environmental pollution of air due to burning of straw, excessive fuel usage to run the tractor and engines for performing various farm operations, thus threatening food security in the region and declining factor productivity in many areas. Satisfying the demand of growing population, preserving the agricultural natural resource base, and improving livelihoods are huge challenges.

For accelerating the adoption of these Resource Conservation Technologies (RCT), there is need to expand stakeholders participation, encourage farmer testing, use modern knowledge management tools and provide suitable logistic support as adopted by the Rice-wheat Consortium and it has been a success.

2.2 Advantages of CA

- Reduces labour, time and fuel costs
- Reduces overall cost of operation
- Reduce use of fossil fuel leads to less environmental pollution
- Reduces soil compaction due to less trafficability
- More yields in dry years.
- Saving in water.
- Less soil erosion.
- Less environmental pollution, Carbon sequestration (green house effect).
- Less bleaching of chemicals & solid nutrients into ground water.
- Less pollution of water
- Increased crop intensity
- Recharge of aquifers due to better infiltration

2.3 Disadvantages of CA

- Formation of hard pan below soil surface due to zero tillage and requires use of sub-soiler to break hard pan after 5-7 years.
- Need to control weeds by using herbicides thus increasing cost.
- Not suitable to all crop rotations.
- May result in soil borne pests and pathogens in transition stage.
- High cost of machinery such as, laser land leveler, zero-till drill, strip till drill, raised bed planter, straw cutter cum incorporator, straw combine, straw baler, biomass digesters.
- It may also result in low yields.

3. Studies on Conservation Agriculture

3.1 Conservation Tillage/Reduce Tillage/ Minimum Tillage/ Zero Tillage Studies conducted by different Countries

Tillage is mechanical manipulation of soil to get condition favorable for crop growth. Primary tillage is done to open the soil which is followed by secondary tillage to break the clods into small sizes followed by planking to get a leveled well prepared seedbed. Tillage of one of the such operation which is responsible for 30% of the total expenditure on crop production. Increased energy cost, increased soil erosion, environment pollution and rising cost of crop production and protection have led agricultural producer and scientists to adopt Conservation Tillage practices. Different equipment such as, mould board plough, disc plough, rotavator, disc harrow, cultivator and leveler are used to obtain a well pulverised seedbed. Tillage consumes a large amount of energy (1600-MJ/ha for wheat and 2200-2600 MJ/ha for paddy). The energy consumed depends upon type of equipment used, width and depth of operation, soil condition like, moisture content, type of soil, crops grown etc. To

reduce energy use during tillage different equipment like rotavator, zero till drill, strip till drill, happy seeder etc. have been developed and are being used world over.

To reduce energy requirement during tillage operations a large number of studies have been conducted to see the effect of reduced tillage on soil loss and yield. In a study conducted by Bateman and Bowers(1962) on Agricultural Engineering Experiment Field and at farmers' field in Illinois there was found to be no difference in yield of corn between conventional tillage and minimum tillage fields. As can be seen from Table 1, minimum tillage gave higher yields than conventional tillage in 12 of the 70 comparisons, and lower yields in 13 of the comparisons. Both the decreases and the increases averaged 13 bushels an acre. According to conservative estimates, only about half as much soil is lost with minimum tillage as with conventional tillage.

Table1. Studies on Conventional and Minimum Tillage

Comparison made	No. of Comparisons ⁿ	Harvest population per acre		Yield, bushel per acre	
		Conventional Tillage ^b	Minimum Tillage ^c	Conventional Tillage ^b	Minimum Tillage ^c
RESEARCH RESULTS ON AGRICULTURAL ENGINEERING FIELD					
Total comparisons	70	14,500	14,000	95	93
Comparisons in which minimum tillage gave higher yields than conventional tillage	12	13,800	14,800	97	110*
Comparisons in which conventional tillage gave higher yields than min ^m tillage	13	13,900	12,300	90	77*
RESULTS OF DEMONSTRATION FIELDS					
Total comparisons	16	11,800	11,200	100	103

Source: Bateman and Bowers(1962)

n Each comparison was based on average of three to six replications for each treatment.

b Soil was ploughed and disked one to three times before planting.

c. Soil was ploughed and planted with no major tillage operation between three operations. Methods included plough-planting; ploughing, with or without clodbuster, then planting; and ploughing then planting in the tractor tracks.

* **The difference between minimum-tillage yield and conventional tillage yield is significant.**

Fuel crisis during 70s' forced the scientist to look for alternate sources of energy and its impact was also felt in agriculture. As tillage consumes maximum energy efforts were made to reduce tillage operation to bare minimum by following reduce tillage/ minimum tillage and zero tillage. This resulted in development and introduction of zero till drills/direct drilling machines, which could sow the crop without tilling and in the standing stubbles of the previous crop. Hence, experiments were conducted world over to see the effect of reduced tillage and zero tillage. A good number of specialized zero-till drills with floating-one, two and three disc openers were designed and introduced. At that time the idea was to obtain

comparable yield by reducing tillage operation to reduce fuel costs. As zero tillage involved sowing in fields of standing stubbles of previous crops hence, controlling of weeds using herbicides was felt. Few herbicides companies abroad and in India promoted zero tillage for their own selfish interest to sell their herbicides-“gramoxone”. Experiments on reduced tillage and zero tillage were also conducted in U.K. The yields of zero tillage and conventional tillage fields were observed to be the same or comparable as given in Table 2. There was considerable reduction in fuel costs due to use of zero tillage.

Table 2. Comparison of Conventional Tillage, Reduce Tillage & Zero Tillage in wheat in U.K.

Hectares sown in 40 hr week	Treatments	Fuel consumed (litres)	Cost/ha (£/ha)	Man hr requirement per hectare
7.7	Conventional tillage (1 ploughing +3 disking)	6.66	46.50	5.2
10.8	Reduced cultivation (2 chisel plough + 2 disc harrowing)	3.88	37.50	3.7
40.0	Direct drilling (zero tillage + gramaxone)	1.15	25.00	1.0

Source: Anonymous. “The ‘Cult’ of winter cereals” ICI Publication

3.2 Conservation Tillage Studies conducted in India and other countries

Rice-wheat crop rotation is the main rotation in South Asia, Nepal, Pakistan and Bangladesh. About 50% of land i.e. 402 m.ha of land of these South Asian countries is devoted to Agriculture For these nations, intensively cultivated irrigated rice-wheat system of Indo-Gangetic Plains are of great significance for the nations food security, fodder and food for the livestock and for hundreds of millions of rural and urban poor. Agriculture policies in the 1960 -70’s also focused on increased coverage of high yielding varieties, use of external inputs, and provision of irrigation. The Green Revolution technologies have remained the corner stone for South Asian Strategy for food security, rural development, conservation of natural resources and poverty alleviation.

Now there is evidence that rice-wheat system have fatigued the natural resource base. In the last decades, high growth rates for food grain production (wheat 3% & rice 2.3%) in these countries have kept pace with the population growth. However, the food security in these regions is under continuous threat due to increase in population. It is expected that these countries need to double their production by 2020 to meet the demand of the ever growing population from marginal quality land and water resources and also at the same time sustain environmental quality.

Anticipating a major upward shift in the energy demand and energy use pattern in the agriculture sector, the Indian Council of Agricultural Research(ICAR), New Delhi in the year 1971 initiated a multi-location project in the form of an All India Coordinated Research Project entitled “Energy Requirements in Intensive Agricultural Production” subsequently renamed and as ”Energy Requirements in Agricultural Sector”. The project envisaged to assess the energy use in various farm operations for different production sub-sectors of agriculture; locate critical components of use, and technique to improve system efficiency by reducing wasteful uses and make assessment of future energy demand. Intensive studies were undertaken on various aspects of energy usage in production agriculture in different agro-climatic regions in order to capture the dynamic energy use patterns in the country and to identify energy conservation techniques. A large amount of data has been collected with respect to energy use pattern for major crops in different categories (small, medium and large farms). The results have provided a bench mark of spatial and temporal variations in the energy use patterns in Indian Agriculture. The status of energy use efficiencies has been brought out along with possible ways to effect improvements. It has also generated a national perspective on research on energy use and management aspects in the country.

Efforts to promote zero tillage in India were started in 80’s. The technology was promoted by Imperial chemical Industries Limited of U.K. to promote their chemical “Gramoxone” to control weeds in zero tilled wheat. One of the basic requirement of zero tillage is that the weeds must be controlled. Late sowing of wheat is a major problem in paddy-wheat cultivated areas, which results into decreased yield @ 1-1.5 % per day when planted after November. This happens due to late harvesting of paddy especially long duration basmati rice. Sowing of wheat with traditional method requires 7-8 days in field preparation that also delays sowing of wheat resulting in decrease in yield. Hence, for timely sowing of wheat, a conventional zero-till drill was developed by Shukla, Tandon & Verma (1981) at Punjab Agricultural University, Ludhaina. It consisted of conventional tractor drawn seed cum fertilizer drill with disc coulters attached in front of the fixed type furrow openers. It was used for sowing wheat in fields where paddy had been sown earlier. The performance of the zero till drill was found to be satisfactory and comparable yields were obtained under conventional tillage. It also resulted in saving in time, labour and fuel costs. The result of the study are given in Table 3.

Table 3. Comparitive performance of No-Tillage and conventional Tillage Systems for Growing wheat after paddy.

Field No.	Plot No.	Treatment	Moisture Content of soil in percentage	Average germination count/m	Wheat Yield (Quintal/ha)
I	1.	No-till	12.00	41.50	31.61
	2	1 discking + 2 cultivator +1 planking	12.50	39.00	30.12
II	3	No-till	14.00	43.10	34.58
	4.	1 discking + 2 cultivator +1 planking	14.00	41.30	34.58

From the table above it can be seen that the germination count and wheat yield was higher in case of Field No.I and in case of Field No. II there was no difference with respect to germination count and yield between no-till planted fields as compared to conventionally sown fields.

As the reversible furrow openers provided behind disc coulters of the no-till drill resulted in formation of clods, which though allowed the seed to germinate but did not allow it to emerge above the surface. Hence, these reversible shovel furrow openers were replaced by boot type furrow openers. The modified drill was used for sowing wheat in fields where paddy had been grown earlier and in fallow land.

Table 4. Comparisons of zero tillage and reduced tillage for sowing wheat after paddy and in fallow field

Treatments	Av germination count per meter length/No.	Average grain to straw ratio	Yield, Q/ha	Type of weeds

	of tillers /plant			
1.No tillage (paddy- wheat)	43.00/3.144	1:1.35	34.90	Lamb's quarter/Che nopodium album,Mexi can prickly poppy (<i>Argemone mexicana</i>)
2.One disking (Paddy- wheat)	57.00/2.34	1:1.95	41.16	Lamb's quarter/Che nopodium album, Cynodonda ctylon
3.No- tillage(Fa llow- wheat)	54.00/2.56	1:0.77	21.32	<i>Canobis sativa, Chanopodiu m album</i>

Source: Tandon & Powar (1985)

From the study conducted, it can be seen that there was not much difference in yield between zero till drilled fields and fields where one disking was done. The fallow –wheat rotation gave lowest yield. In the zero till drilled plots the incidence of weeds was less, mostly broad leaf weeds were observed. It has been recommended that after every five to six years of following zero tillage, deep ploughing needs to be carried out to break the hard pan formed below the soil surface by using chisel plough.

These furrow openers were later replaced by inverted “T- type” furrow openers in 90’s. During mid 90’s again zero till drill concept gained importance due to sanctioning of 100 zero till drills by Indian Council of Agricultural Research and about a dozen manufacturers started manufacturing of these drills. Great success was achieved in the State of Haryana in India due to use of these zero till drills. This idea of zero-till was also promoted under a “National Agriculture Technology Project” of ICAR. Efforts were made by approximately 30 centres located at different ICAR institutes and State Agriculture Universities to promote Zero till drills under Rice-Wheat Consortium. Under this project efforts were also made to develop wheat varieties (early sown short duration) suitable for sowing with zero till drill.

The Rice-Wheat Consortium (RWC) for the Indo-Gangetic plains was formed to address to problem of R-W system. It is an alliance of the National Agricultural Research Systems of the South Asian countries of Bangladesh, India, Nepal and Pakistan. In collaboration with several International countries and agricultural research institutes, the RWC fosters sustainable productivity in rice-wheat farming systems. Under rice-wheat

consortium, efforts were also made to introduce zero-till drills and raised bed technology in India, Pakistan, Bangladesh and Nepal. The zero-tillage helped in early planting of wheat and thus helped in controlling Phalaris minor, a weed that has developed resistance to a common herbicide isoproturon in North-West India. The wheat crop shades out this weed. Also, in no-tillage since the soil is not disturbed as much as in conventional tillage, fewer weeds germinate. In India, zero till drills have been demonstrated in Punjab, Haryana, Uttar Pradesh and Bihar at farmers' fields and also in Pakistan and Nepal. About 3 million ha has been covered under zero-tillage In India alone. Use of zero-till drill resulted in saving of INR 2000-3000/ ha, higher yields in many cases (1-2 q/ ha), less lodging, no crop yellowing after first irrigation, less tractor use/ wear of parts, better germination in salt affected soils, less need of herbicide, improved residue management and saving in time (30-40%), labour and fuel (60 lit/ ha) and 30-50% less incidence of Phalaris minor all of which contribute to enhanced yield (1-3 q/ ha) and profits. Farmers reported less incidence of stem borer in direct drilled wheat. The concept of zero tillage has also picked up in other states such as Bihar and Bengal due to low yield of wheat. Zero-tilled drills, strip till drills, roto till drill, till planter, happy combo seeders have been developed for direct drilling of wheat after paddy. Some of these machines have also been introduced in Pakistan and Nepal. Sowing of wheat on raised bed have resulted in saving in water. Use of zero till resulted in saving in fuel (72%), labour (76%) and amount of agro inputs as can be seen from Table 5.

Table 5. Comparison of zero till, strip till, roto till and conventional tilled wheat.

Sr. No.	Parameters	Zero-till drilling	Strip till drilling	Roto till drilling	Convention al tillage sowing
1	Time required for sowing (h/ha)	2.98 (76.24)	4.05 (67.70)	5.85 (53.35)	12-54
2.	Fuel used (l/ha)	11.50 (72.93)	17.80 (58.10)	24.85 (41.50)	42.48
3	Operational Energy (Mj/ha)	672.46 (70.06)	985.82 (56.11))	1364.24 (39.26)	2246.15
4	Cost of operation (Rs./ha)	690.12 (67.36)	998.46 (52.78)	1365.72 (35.41)	2114.50

Source: S. K. Rautray (2003) Figure in brackets give percentage

The conservation tillage as compared to conventional practice showed higher performance in terms of increased benefit cost ratio (3.7-15.4%) and lower operational energy (5.1-26.1%). The reduced tillage system reduced cost of cultivation due to reduced energy requirement and yield returns were similar to the conventional practice as can be seen from Table 6. In zero tillage the specific energy and operational energy were found to be the least (1.93 MJ/kg) as compared to other three treatments.

Table 6. Comparative performance of zero till drill, strip till drill, roto till drill and conventional tillage

Sl.No.	Particulars*	Zero tilled drilled wheat	Strip till drilled wheat	Rota till drilled wheat	Conventional tillage seedling
1	Grain yield (t/ha)	3.71	3.66	3.70	3.80
2	Cost of Product – (Rs./ha)	9746	10328	11064	11825
3	Benefit cost Ratio	2.47	2.30	2.17	2.09
4	Operational energy (Mj/ha)	7176	8604	9216	9708
5	Specific Operational energy (MJ/kg)	1.93	2.35	2.49	2.55
6	Specific Cost of Production (Rs. /kg)	2.63	2.82	2.99	3.11

- **Sale price of wheat Rs.6.50/ kg.**
- **Source: S. K. Rautray (2003)**

The experience of zero tillage /direct drilling showed that there are many benefits in keeping the soil undistributed for long periods as nature intended. It was found that due to zero tillage, the soil drainage improves with draught cracks - worm channels - old root systems & soil pores all linking together to help to remove rain water quickly and therefore avoiding the sponge effect created by normal cultivation. Since researches found that worm population are higher and that root system are stronger and deeper in direct drilling system.

Soil structure is also improved with the organic matter being retained near the surface. This helps to improve and build up a natural surface tilth which requires little preparation for cereal sowing in addition the crumb stability or soil strength is increased.

No tillage is being practiced in different European & Asian countries in about 46.533 m.ha area as given in Table 7.

Table 7 : Area under Zero Tillage in different Countries.

Sr. No	Name of the country	Area under Zero tillage
1	USA	19,347,000
2	Brazil	11,200,000
3	Argentina	7,270,000
4	Canada	4,080,000
5	Australia	1,000,000
6	Paraguay	790,000
7	India	3,000,000
8	Mexico	500,000
9	Bolina	200,000
10	Chile	96,000
11	Uruguay	50,000
12.	Others	1,000,000
Total		46,533,000

Source : Rolf Derpsch (1999)

3.3. Conservation Practices in Paddy

Paddy is sown in puddled soil and requires large amount of water and irrigation is to be given every alternate days under upland cultivation. Efforts were made to overcome ill-effects of puddling on soil, structure in rice-culture, reducing drudgery of rice planting without yield penalty and developing double no-till system to grow rice, wheat and other

crops. In India, paddy (root washed seedlings) is raised in nursery and when the seedlings are 20-25 days old, then these are uprooted and transplanted in well puddled field having standing water. Transplanting is done manually and requires large amount of labour and drudgery. Hence, efforts were made to introduce mat type nursery raising technique and then transplanting using manual or automatic mat type paddy transplanters. The mat type nursery raising requires regular application of water and care during nursery raising. When seedling are 20-25 days old then these are transplanted in the field by the transplanters. As nursery raising requires regular care and watering, hence, this has not been adopted in India, except in southern part of India where it has been a success due to plentiful water availability and good rain.

Hence, pre-germinated paddy seeders (4-6 rows) have been introduced and are also being used for direct sowing of paddy in puddled soil with only 1 cm standing water. Use of these have found to give higher yields and reduce labour requirement as compared to transplanted crop.

Under Rice-Wheat Consortium, the direct seeding of rice using zero till drills on flat beds and furrow-irrigated raised bed system was tried and its performance was compared with unpuddled wet seeding and transplanted rice in reduced till conditions. *Sesbania sisban* was grown along with rice in treatment combinations. Weeds were controlled through use of 'sofit' a post sowing, pre-germinated herbicide. The farmers liked inter-cropping of *Sesbania* for brown manuring in rice culture because of i) no need of additional irrigation water for raising *Sesbania sisban* crop in summer before rice when evaporative demands are close to 13 mm/ day; ii) brown manuring keeps soil moist for long (less soil cracking) thereby obviating the need to irrigate rice frequently; iii) improves soil fertility; and iv) helps control weeds (weed population reduces by 40-50% - personal communication with the farmers).

3.3.1 Bed Planting Technology

This technology called Furrow Irrigated Raised Bed System (FIRBS) was brought from CIMMYT in Mexico for trying in IGP for sowing wheat by Rice-wheat Consortium. In this technology the seedbed is prepared conventionally and raised beds and furrows are prepared using raised bed planter. The machine makes two beds of 70 cm width and can plant 2 to 3 rows in each bed. The farmers and scientists in India have found that use of FIRBS results in 50% saving in seed, 30-40% saving in water, higher yields than conventional method, reduction in lodging, facilitates mechanical weeding by tractor, offers opportunity for last irrigation at grain filling, avoids temporary water logging problems, allows subsurface basal and top dressing of fertilizer, thus reducing N losses and promote rain-water conservation. This technology has been adopted in India and Pakistan.

In village Desna in Haryana, rice was established on 125 ha of land by dibbling manually on the raised land. It was a late seed rice crop. There were no weeds when the crop was 67 days old. Farmers were of the opinion that 1) bed planted crop needed less water, and ii) crop condition although good could improve further if, irrigated or if it rains. There is no soil cracking even through crop was irrigated a week before.

In another experiment conducted in Karnal (Haryana), the result suggested that seed rate in direct seeded rice should be kept at 20-25 kg/ ha for good results. Higher seed rate results in lodging, incidence of plant hopper and deficiency of nitrogen. The bed planted rice in farmers field saved six irrigation as compared to conventionally tilled rice. Direct seeded rice was found to result in saving of US \$ 70 – 102/ ha as compared to puddle transplanted rice. The tillage induced saving were mainly through reduced cost of land preparation (77%), irrigation water (15%) and labour (8%).

In different states of India (Punjab, Haryana, U.P. & Uttranchal) rice was also direct seeded on side of raised beds without puddling. The rice transplanted on raised beds yielded 10-15% more grain and saved 14% irrigation water as compared to conventionally tilled puddle transplanted rice. Direct seeded rice saved more than INR 6000/ha as compared with traditional rice culture.

3.4 RC through Surface Seeding in Water Logged Area

This is the simplest form of zero-tillage system and is sustainable for excessively moist conditions of poor textured, poorly drained soil commonly found in the low-lying areas of eastern Indo-Gangetic Plains in Nepal, India and Bangladesh. These soils generally cannot be tilled for normal planting. In this method, wheat is broadcasted in the wet soil surface either before or after rice harvest. The seeds germinate and the roots follow the saturations fringe as the water recedes. As the soil is wet hence no machine can go inside the field, so surface seeding is a very appropriate system for resource poor farmer as no equipment is needed. This system allows the farmer to take one more crop instead of keeping the field fallow and get 3-4 tons/ ha of grain. It is also very popular system in Yangtze River valley of China.

The lowlands of Bihar, West Bengal and Bangladesh suffer frequent flooding during Kharif season, which subsequently results in excessive soil moisture and water logging problems. The excessive soil moisture restricts entry of machines in the field. Hence, surface seeding of wheat by broadcasting method was attempted for timely crop establishment. It saves labour, fuel and tillage costs and also makes use of residual soil moisture and improves crop productivity through timely planting.

3.5 R.C. through Use of Laser Land Leveler

Land is leveled after seed bed preparation using either a wooden log tied behind bullocks or a planker attached behind a tractor. This method is crude and does not give a smooth leveled field. Unevenness in the soil surface adversely affects even distribution of irrigation water in the fields, leads to poor crop stand and over irrigation. Precision in leveling can help eliminate this inefficiency and reduce water requirement through transmission losses and uniformity in moisture distribution to ensure uniform crop establishment and growth through the season.

The total water requirement for rice wheat system is estimated to vary between 1382 mm to 1938 mm in the Indo-Gangetic Plains, accounting to more than 80% for the rice growing season. Thus to save on water, saving must be affected during rice growing season, the major water user in R-W system. Precision land leveling helps in uniform application of water and better crop stands. Laser assisted precision land leveling saves irrigation water, nutrient & agro chemicals. It also enhances environmental quality and crop yields. The laser land leveler have been imported and are being used for land leveling. It also increase water application efficiency up to 50%, cropping intensity by about 40%, labour requirement by 35% and crop yields by 15 to 66% (wheat 15%, sugarcane 42%, rice 61% and cotton 66%). In the state of Punjab, 100 laser land leveler and in UP about 60 laser land leveler have been purchased by the farmers and are being used on custom hire basis. A farmer is able to recover the cost of the machine within 2-3 years. The total water use in wheat and rice in laser leveled field was reduced to 50% and 32%, respectively. In raised bed planted wheat about 26% water can be saved through laser land leveling.

When land leveling is combined with zero-tillage, bed planting and non-puddled rice culture, the plant stands are better, growth is more uniform and yields higher. In Pakistan's (Punjab Province), average water saving with laser land leveling, zero tillage and bed planting over the traditional method was 715, 689 and 1329 m³/ ha for the year 1999-2000.

Keeping in view the all-round shortage of irrigation water, receding water tables, uncertain rains and drought, greater emphasis on water management is needed in India and other countries of IGP. The laser land levelers need to be demonstrated at farmers field. The Govt of India is considering giving subsidy on laser land leveler. Under micro-management scheme of Department of Agriculture & Cooperation, a good number of laser land levelers have been sanctioned to different states for conducting frontline demonstrations.

It is estimated that extension of laser assisted precision land leveling system to just two million hectare of area under rice wheat-system would save 1.5 million hectare meter of irrigation water and save diesel upto 200 million litres (equivalent to US \$ 1400 million) and improve crop yields amounting to US \$ 1500 million in three years and reduce GHG emissions equivalent to 500 million Kg. It will also increase cultivated area by 3 to 6% due to

reduction of bunds and water channels in the field. In laser leveled fields, the performance of different crop establishment option such as zero tillage raised bed planting and surface seeding are known to improve significantly.

3.6 Residue Management & Reduction of Environmental pollution through CA practices

In most of the South Asian countries the paddy straw is burnt before sowing wheat. This contributes to soil degradation through loss of organic matter and soil erosion and also causes environmental pollution. Management of crop residues and plant into loose residues is a key issue not only to avoid burning and environmental pollution but addressing issues of organic matter decline and nutrient depletion/ mining in IGP and promoting ground water recharge. Strategy for incorporating the silica-rich rice residues seems inevitable in acidic soils of Eastern Gangetic Plains to address liming problems. Liming of these soils reportedly improved the yields of wheat and other upland crops. Incorporation of silica-rich rice residues into isoelectric soil manipulates the charge characteristics in a manner that improves the net negative charge, base saturation on the exchange complex and reduces fixation of applied Phosphorus.

Hence, efforts have been made to develop machines to cut, spread and incorporate the paddy straw in the field to help in sowing wheat after harvesting paddy to avoid burning of the straw. A Happy combo seeder in collaboration with Australia has been developed for direct seeding of wheat in fields where paddy had been grown earlier. This machine cuts the paddy stubbles left in the field after combining and throws it at the rear of the machine. Efforts are on to use the cellulosic paddy biomass to obtain ethanol. About 1000 kg of biomass will approximately given 1.0 litre of ethanol.

In wheat fields to obtain the wheat straw from the combine harvested fields, a straw combine (reaper) has been developed which helps in recovery of 1000 kg of straw/ha and about 40-50 kg of grain/ha. This help the farmer to recover the wheat straw which can be fed to the cattle and also fetches additional income to the farmers.

It can be seen from above that resource conservation studies are being carried out by the different Institutes of the Indian Council of Agricultural Research and the State Agricultural Universities under the Rice-wheat Consortium in IGP. All efforts are being made to reduce the input use through efficient application and use of resource conservation technologies and equipment. Conservation Agriculture does not as per definition include the water management, which is one of the most important component needing attention of the scientist word over. Growing of rice on raised bed is also being propagated to save water instead of growing paddy in standing water. Seeing the outcome of use of laser land leveler in reducing water requirement by 30-50 %, the farmers in India are purchasing these by forming groups and using these under custom hire basis. Similarly efforts are on to develop good

quality efficient machines for application of different inputs. The zero tillage concept has been adopted by few states and efforts are being made to demonstrate these in other states. Govt. is also giving subsidy on purchase of zero till drills and other resource conservation equipment for straw management and incorporation in the field.

4. Conservation development situation in the world and member countries- Policy Implication of CA

Due to increasing pressure of population, efforts are on to produce more to feed the burgeoning population. This has led to increase use of natural resources such as water, seed, chemicals etc to produce more for sustainable agriculture. This has also led to widespread problem of natural resource degradation and environmental pollution. Conservation agriculture is being practiced on about 80 m.ha mostly in South & North America and in rainfed areas. CA is being widely adopted in America, Australia, U.K., Argentina, Brazil & Canada. CA is also finding favour with farmers of Latin America and South Asian countries. Many countries are promoting CA by giving incentives, such as easy credit loan/subsidy on purchase of machines, extension programmes etc. Some countries enforced land retirement due to excessive soil erosion and also taxes due to soil erosion. Some countries have also been encouraging pasture conversion by providing free seedlings. But it has been felt that public policies that require tax payers to bear the burden would be effective in terms of cost per unit of controlled erosion but would become a fiscal problem, especially during an era of government budget deficits and raising debt. Hence, studies have remained inconclusive and site-specific nature of many results suggest that a universal approach is not possible. But in some countries CA has found favour with introduction of policy decision in this regard. In Europe, France, Spain, CA was adopted in about 1 m. ha area under annual crops. In Europe, European Agriculture Federation(EAF), a regional lobby group, United National Associations in France, Germany, U.K., Spain, Portugal and Italy has been founded. It is also being adopted in Southeast Asian countries such as Japan, Malaysia, Indonesia, Nepal & Bangladesh. The community led initiative strongly supported by R&D organization rather than as a result of usual research- extension system efforts is the reason for widespread adoption of CA system in many countries.

Although a targeted policy approach may be more appropriate (i.e. say for example bringing 100 m ha under no tillage & 400 m. ha under watershed development) for the design of programmes directly promoting CA but there are some alternative policy presumptions that may be more universally applicable. Some times the farmers can take pride in telling that he has obtained maximum yield due to adoption of no tillage and this may motivate others to follow suit. In India, in the State of Punjab, paddy-wheat is the main crop rotation. Excessive use of ground water for paddy cultivation has resulted in lowering of groundwater. Hence, Govt. is motivating farmers to grow other crops rather than rice and has been offering incentives. So both pride and peer pressure may be important form of motivation for adoption

of CA and Govt. policies may be available to contribute to this front. For e.g. in Canada, Ontario's Environmental Farm Plan(EFO) programme represents an innovative approach to environmental conservation on the farm through the voluntary participation of farmers to assess the environmental risks and raise environmental awareness on their farms. It is a farmer driven process supported by Govt. through funds and technical advise. Compliance and interest among farmers is high especially relative to traditional Government led regulatory approaches.

In the absence of appropriate incentives farmers are unlikely to get enthused with only "potential benefits" over long period in terms of resource base quality improvement. This would call for a re-look at policy incentives which encourage certain crops and cropping systems, resource use practices and consequent short and long term impact in terms of productivity and ecosystems health. Diversification to other crops along with effective procurement, infrastructure for providing services for resource conservation technologies at the local level and monitoring of resource base are the main policy and institutional requirements that need due attention.

4.1 Resource Conservation Technology of rice-wheat system in Pakistan

The Resource Conservation technology such as zero tillage, laser leveling and bed and furrow cultivation of wheat and mechanical transplanting of rice were demonstrated in various districts of Punjab, Province of Pakistan under R-W Consortium. The Zero tillage method of wheat cultivation was found to be the most economical and attractive option for farming followed by laser leveling and bed and furrow cultivation. Wheat sowing by conventional method proved to be economically less favourable. Mechanical transplanting of rice on sampled farms remained economically less feasible as compared to non-mechanical rice transplanting due to its higher transplanting cost.

4.2 Resource Conservation Technology in Nepal

Many on-station and on-farm experiments at Ranighat, Pparawanipur, and Bhairahawa in terai, lowland belt and at Naldung in the mid-hills near Katmandu have been conducted under R-W Consortium. In these experiments, the performance of various crop establishment methods(bed planted, direct seeding with Chinese seed drill, drum seeded rice system for rice intensification(SRI); nutrient management strategies(N management with the help of leaf colour chart); long-term integrated nutrient management; crop varieties; water management and weed management strategies were evaluated.

In Nepal, Zero tillage has been introduced for sowing wheat after paddy by using Chinese power tiller operated zero till drills. The farmers have obtained higher yield using zero till technology. In some parts of Nepal, there is enough moisture in the field which restricts entry of man and machine in the field hence, surface seeding has been introduced.

The wheat crop is broadcasted in the standing paddy crop ready for harvesting after draining the water from the fields. This helps in germination of the wheat timely and avoids delay in planting of wheat. This method has been adopted in large areas of Nepal which has water logging problem.

The study highlighted the following concerns that need immediate attention such as, large runoff losses of surface soil which carry away a huge amount of organic carbon, phosphorus and potassium, imbalance use of fertilizer, low productivity of rice and wheat in terai region, water logging and water and heat stress at physiological maturity of wheat, susceptibility of rice cultivar to blast and infestation due to higher dose of N, fertility management in mid-hill terraces, weed management in direct seeded rice and zero-till sown wheat and low input use by the farmers.

4.3 Resource Conservation Technologies in Bangladesh

Bangladesh has diverse environments, which offer many opportunities for crop diversification lased with challenges and limitations. The challenge facing Bangladesh Agriculture is to grow more food from the marginal and productive lands at lower production costs. Rice, jute, wheat and sugarcane are the main crops. The agricultural scenario has the complexity of small scale farm economic, yearly problems of monsoon floods, changing water courses of tributaries and other physiographic changes within small distances. The traditional tank irrigation in irrigate area has gone down by more than 9 % over the past few decades. Most soils are deficient in N, P and sulfur. The problem facing Bangladesh agriculture is to grow more food from the marginal and productive lands at lower production cost. Some of the key constraints leading to low productivity or even productivity stagnation in rice-wheat systems are; late transplanting and late-maturing photosensitive varieties of rice; low integrated use of organic and chemical fertilizers; multiple nutrient deficiencies; low use of external nutrient inputs by the farmers; inefficient management of irrigation and rain-water; continued rice cropping leading to grater incidence of insect and pests; soil acidity and non-availability of liming material; short growing season for wheat and non-availability of agricultural farm implements. Under R-W consortium studies on direct seeded rice, and bed planted rice were carried out. The bed planted rice gave good yield. Zero tilled drilled wheat reduced weed infestation and enhanced water efficiency and ultimately gave higher yield.

5. Conservation Policies and Programmes

Many countries have launched Conservation Agriculture programmes/studies. Conservation agriculture case studies were carried out jointly by the African Conservation, Tillage Network (ACT), the French Agriculture Research Centre for International Development(CIRAD), the Swedish SIDA funded Regional land Management Unit(RELMA in ICRAF) and FAO. The study throws light on controversial issues such as the challenges

farmers face in keeping soil covered in gaining access to adequate equipment, in controlling weeds and on the challenges projects and institutions face in implementing true participatory approaches to technology development.

5.1 Conservation & the Farm Bill: Agricultural Stewardship in America

The farmers and ranchers all across America are participating in programmes to restore wetlands, protect habitat, conserve resources and reduce runoff. A Farm Bill has been launched to implement conservation programs which lay emphasis on conservation, clean water, improvement of Grassland habitat and biofuel. Land affected by erosion, rivers and streams harmed by farm related pollution and wetlands and grasslands converted to agricultural fields are all being restored through incentives provided in the Farm Bill Conservation Programs.

The Nation Resource Conservation Sources (NRCS) of US, the State Agencies Foundation and other organizations are offering resource Conservation Programmes in the State of Arkansas such as, conservation reserve program, conservation security program, emergency conservation program, emergency watershed protection program, environmental quality incentive program, farm and ranch lands protection Programme, Grassland reserve program, wetland reserve program and wildlife habitat incentive program. These programs are described below in brief:

5.1.1 Conservation Security Program(CSP)

The Conservation Security Program (CSP) is one of the newest voluntary programs offered by the U.S. Department of Agriculture Natural Resources Conservation Service (NRCS). Under this program farmers and ranchers can receive income support for their efforts to maintain and enhance the quality of the soil, water, air and habitat on their operations. The Conservation Security Program currently offers three tiers of enrollment based on the scope of resources addressed and the amount of farmland involved. Contracts are for five to 10 years with an annual payment based on the duration of the contract. The best stewards can received up to \$45,000 per year.

5.1.2 Conservation Reserve Program(CRP)

The Conservation Reserve Program(CRP) was established in 1985 to help farmers reduce soil erosion. It pays farmers to take croplands out of production and plant grasses year-round cover to stabilize soils and improve wildlife habitat values. "Continuous enrollement" allows farmers to sign up any time for assistance with planting grasses and trees along streams to reduce stream-bank erosion. Land owners receive rental payments and up to 50 percent cost-sharing.

5.1.3 Wetlands Reserve Program(WRP)

The Wetlands Reserve Program(WRP) helps restore and protect wetlands on agricultural lands. WRP pays for conservation on enrolled lands and provides up to 100 percent funding for habitat restoration work. Approximately 1.8 million acres of wetlands have been restored till date.

5.1.4 Grassland Reserve Program(GRP)

The Grassland Reserve Program(GRP) helps landowners protect and restore grasslands, pasturelands, rangelands and other lands supporting shrubs and forbs. The program funds up to 90 percent of restoration cost and pays landowners for conservation easement or an annual rental agreement.

5.1.5 Farm and Ranchlands Protection Program(FRPP)

The Farm and Ranchlands Protection Program(FRPP) helps protect agricultural land from urban sprawl and other development. The land owners agrees to a permanent conservation easement and receive a onetime, up-front payment equal to the fair market value of the development rights and continued use of the land for agricultural purposes. This permanent easement keeps the land from being developed.

5.1.6 Environmental Quality Incentive program(EQUIP)

The Environmental Quality Incentive Program(EQUIP) assists farmers with technologies and practices to reduce air and water pollution, energy use and wildlife habitat impacts, while maintaining operations that are productive. EQUIP offers up to 75 percent cost sharing for approved conservation measures.

5.2 California Wetlands Conservation Policy

A Wetland Conservation Policy has been launched by California and its goal is to establish policy framework and strategy that will ensure no overall net loss and achieve a long term net gain in the quality and performance of wetlands acreage and values in California in a manner that fosters creativity, stewardship and respect of private property; reduce procedural complexity in the administration of the State and Federal Wetland Conservation program and encourage partnership to make landowner incentive program and cooperative planning efforts the primary focus of wetland conservation and restoration. To implement this policy and to achieve the objectives state wise policy initiatives have been taken such as, wetland inventory, support for wetland planning, improved administration of existing regulatory programs, strengthening landowner incentives to protect wetlands,

supporting for mitigation banking, developing and expansion of other wetland programs and integration of wetlands policy and planning with other environmental and land use processes. For successful implementation of the policies and programs mentioned, regional projects have been developed to serve as pilots for implementing the policy. An interagency wetlands task force has been created to direct and coordinate administration and implementation of the policy.

Thus various conservation programs have been launched by the Govt. of US to provide financial and technical assistance to the farmers to conserve natural resources of the country.

The Govt. of India is being forced to continue and further distort policies to protect farmers profitability, notwithstanding widespread and extensive resource degradation problems for example, declining water table in the high productivity northwest irrigated region will seriously constrain productivity and ecology of the region. High levels of fertilizer use, decreasing resource use–efficiency and burning of plant residue are increasingly contributing to groundwater pollution and increased emission of green houses gases (GHGs). With continuously deteriorating resources, widespread problem of soil and water contamination and eroding ecological foundation, sustainability of agriculture is becoming highly questionable. Hence, there is need to develop Conservation Agriculture Policy for sustainability. In India the Govt. of India has launched Watershed Development Programmes which ensure protection of land by conserving water and reduction of soil loss. Use of zero-till drills is being propagated and govt. is giving subsidy on these drills. Front line demonstrations of these zero-till drills and other machines such as laser land leveler, raised bed planter, straw combine, straw baler are being carried out by the State Department of Agriculture to promote CA. A rice-wheat consortium has also been formed by the Indian Council of Agricultural Research which is promoting CA technologies for R-W system but as such no CA policy has been formulated. The developing countries cannot afford to have policies like US where a large amount of incentives are being given to the farmers for practicing CA.

To promote Conservation Agriculture by the farmers, the government needs to provide few incentives so that this technology is adopted by the farmers instead of enforcing it on the farmers. There should be free involvement of the farmers and the entrepreneurs in the CA programmes of the Govt. instead of using the Govt. machinery of extension for propagating the technologies. The following incentives be provided by the Govt. for adoption of CA by the farmers.

- 1) Minimum support price for growing other crops in place of paddy or crops using excessive water.**

- 2) **Subsidy on buying farm equipment such as, rotavator, laser land leveler, zero till drill, straw combine, strip till drill, roto-till, raised bed planters, drip and sprinklers, straw combine, straw cutter cum spreader, straw baler etc.**
- 3) **Institutional financing at a low rate of interest for purchase of Agriculture machines mentioned above.**
- 4) **Increased tariff on electricity, removing free distribution of electricity.**
- 5) **Public Private Partnership to adopt RCTs and development of new equipment.**
- 6) **Consolidation of land to increase efficiency of farm implements.**
- 7) **Encouraging formation of cooperatives to take up CA practices.**

6. Conservation Agriculture strategies adopted in India

a) Conservation of Water through

- Paddy sown in unpuddled soils
- Paddy sown on side of ridges
- Less frequency of irrigation
- Introduction of laser land leveler – saving in cost and 25% saving in water

b) Conservation Tillage studies

- Development and demonstration of zero-till drill strip till drill, roto-till drill, till planting machine and raised bed planter.

c) Farm Residue Management through

- Stubble shaver
- Straw chopper cum incorporator, both aid in direct drilling
- Straw combine
- Straw baler
- For exhaust gas emissions norms have been set up for tractors & other road vehicles.
- Fuel standards have been set up & have resulted in reduction in air pollution .
- Compressed natural gas use in buses trucks, Auto & Taxis in some metropolitan cities – resulted in reduction of air pollution.
- Introduction of biofuels & their mixing with fuel (5-10 %) is recommended – save foreign exchange & reduce GHGs

7. Conclusions

Conservation Agriculture and productivity enhancing measures have become complementary. Earlier the emphasis was to increase productivity by growing high yielding varieties and increase use of inputs without any concern for environment. A shift in concept has become necessary in view of the widespread problems of resource degradation, which accompanied the past strategies to enhance production with little concern for resource integrity. Hence, there is need to integrate productivity by giving due attention to resource conservation technologies, quality and environment. A good number of equipment for conservation of agriculture such as, laser land leveler, zero till drill, strip till drill, roto drill, till planting machine, raised bed plant, pre-germinated paddy seeders, Happy combo seeder, sprinklers, straw baler, straw combine, straw cutter cum incorporator have been developed in India and abroad. These need to be demonstrated and popularized by conducting front line demonstrations at farmer's field. The Govt. should provide subsidy on purchase of these costly machines to cooperatives or self help groups. The Govt. of India has launched Rice-wheat Consortium to promote Conservation Agriculture through the use of equipment technologies generated. Following CA would help in utilizing the different inputs efficiently and effectively, reduce soil degradation, conservation of different resources, reducing cost of production and also thereby help in enhancing productivity and production and reducing GHG Emissions.

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