

Mechanization of Conservation Agriculture

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Introduction

Conservation Agriculture refers to a range of soil management practices that minimize effects on composition, structure and natural biodiversity and reduce erosion and degradation. Such practices include direct sowing / no-tillage, reduced tillage / minimum tillage, surface-incorporation of crop residues and establishment of cover crops in both annual and perennial crops. As such the soil is protected from rainfall erosion and water runoff; the soil aggregates, organic matter and fertility level naturally increase and soil compaction is reduced. Furthermore, less contamination of surface water occurs, water retention and storage is enhanced, which allows recharging of aquifers.

Issues in Conservation Agriculture Mechanization

- Reduced tillage and direct seeding with appropriate machines that reduce costs of labor, Fuel and system of machinery.
- Increased opportunities for crop diversification which allow response to market opportunities as well as to the reduced supply of water. Example : Vegetables could be grown more profitably than rice and prevent soil structural degradation and hardpan formation from intensive rice cultivation.
- Mechanical weeding and inter-culture operations in dryland crops and other non-rice crops that reduce labor costs.
- Mechanical placement of fertilizers below the soil surface, leading to improved fertilizer use efficiency.
- Reduced seed requirement of a range of crops compared with conventional practices.
- Greater yields of all crops that can be obtained in response to better soil structure and surface drainage, more timely sowing because of direct seeding and other management operations.

Conservation Tillage

The term *conservation tillage* refers to a number of strategies and techniques for establishing crops in a previous crop's residues, which are purposely left on the soil surface. The principal benefits of conservation tillage are improved rain water conservation and the reduction of soil

erosion. Additional benefits include reduced fuel consumption, reduced soil compaction, planting and harvesting flexibility, reduced labor requirements and improved soil health.

Table 1 : Percent of residue left on the surface with different land preparation activities

<i>Type of land preparation</i>	<i>Resistant residues</i>	<i>Fragile residues</i>
Residues after harvest	80-95	70-80
Plough	0-15	0-10
Plough and chisel	0-10	0-5
Discs (2 operations)	15-20	10-15
Chisel (2 operations)	30-40	20-30
Cultivator (2 operations)	40-50	30-40
Cultivator (1 operation)	50-70	40-60
Direct seeding	80-95	60-80

Developing a crop residue management system to conserve resources to fit in one's farm operations requires careful consideration of various factors such as :

- Capability of the planting machine to handle crop residue.
- Spreading of straw and chaff in the field.
- Total crop residue and its condition, particularly after heavy crop or green and damp straw or lodged stalk.
- Tall standing stubble reduces erosion but may cause plugging during planting.
- A balance is needed between standing stubble and chopped residue on surface.

Table 2 : Considerations in various types of crop residue management

<i>Crop</i>	<i>Points to remember</i>
Pea / Gram	<ul style="list-style-type: none"> • Most difficult residue to handle • All vines must be picked up and then completely chopped and spread. • The tillers / cultivators usually just bunch the pea stubble into piles
Cereals	<ul style="list-style-type: none"> • Cereals straw relatively easy to chop and spread • Special attention is needed when lodged or damp. • Routine harrowing after combine harvesting improve the spread of straw. • Stubble taller than 40cm generally requires a subsequent field operation to chop and spread residue.

Three of the most common conservation tillage systems, Ridge tillage, No-till and Mulch till, are discussed below.

Ridge Tillage

Ridge tillage is a form of conservation tillage that uses specialized planters and cultivators to maintain permanent ridges on which row crops are grown. After harvest, the crop residue is left until planting time. The planter places the seed in the top of the ridge after pushing residue out of the way and slicing off the surface of the ridge-top. Ridges are re-formed during the last cultivation of the crop. Often, a band of herbicide is applied to the ridge-top during planting. With banded herbicide applications, two cultivations are generally used: one to loosen the soil and another to create the ridge. Because ridge tillage relies on cultivation to control weeds and re-form ridges, this system allows farmers to further reduce their dependence on herbicides as compared to either conventional till or strict no-till systems.

Maintenance of the ridges is critical to a successful ridge tillage system. The equipment must accurately reshape the ridge, clean away crop residue, plant in the ridge center, and leave a viable seedbed (Fig.1 & 2).The ridge-tillage cultivator not only removes weeds but also builds up the ridge. To harvest grain in ridged fields, one may need to put tall, narrow, dual wheels on the combine / harvesting machine. This modification permits the combine to straddle several rows, leaving the ridges undisturbed. Maintenance of the ridge becomes a consideration for each process

No-till

No-till systems, as the name implies, do not use tillage for establishing a seedbed. Crops are simply planted into the previous year's crop residue. No-till planters are equipped with coulters that slice the soil, allowing a double disc opener to place the seed at a proper depth. The slot is closed with a spring press wheel. Herbicides are typically used as the sole means for weed control in no-till systems. No-till methods have been criticized for a heavy reliance on chemical herbicides for weed control. Additionally, no-till farming requires careful management and expensive machinery for specially for seeding and harvesting applications (Fig.3 & 4.).

Also, increased insect and rodent pest problems have been reported. On the positive side, no-till methods offer excellent soil erosion control and require fewer trips across the field.. No-till methods take several years to prove themselves. It's best to allow at least five years and remember that proper tracking of the system will be necessary from time to time. Soil quality improvements will come slowly, as earthworms and other soil organisms increase in number.

Mulch Tillage

The soil is disturbed prior to planting. Tillage tools such as chisels, field cultivators, disks, sweeps, or blades are used. The cropping practices survey assumes any system with 30 percent or more residue after planting that is not a no-till or ridge-till system is a mulch-till system.

Crop stubble, Cover crop management under No –Till system

The objective of cover crop, residue management is to prepare the land for planting the subsequent commercial crop and to manage the weeds so that they cannot interfere with the crop

growth. In conservation agriculture systems, the management should facilitate penetration of direct seeding equipment into the soil and into a favorable environment for seed germination, without obstructing the implement performance.

It is desirable that the residues from a cover crop should protect the soil for quite some time against the impacts of rainfall and that liberates allelopathic chemicals to suppress the germination of weeds. The release of these chemicals should be slow and gradual until the commercial crop is able to compete with the weeds. One of the factors influencing the release of allelopathic chemicals is the decomposition of organic matter.

Mechanical management of residues and cover crops can be done by using machetes, knives or sickles, knife rollers, slashers, mowers etc.. or any similar implement. A common practice is to slash the weeds and residues of previous crops with a suitable device / machine before sowing. The residues are left on the surface and the subsequent crop is sown into it.

(B) Manually carried motorized device and Tractor operated crop stubble Slasher

The motorized device and T.O.crop stubble slasher are recommended where well designed mechanized equipment is not available. In the first instance the crop stalk / straw is cut to knee height using motorized device after the cob / ear head harvest. In the second instance the cut stubble is slashed using tractor operated machine prior to planting of the rabi crop, usually resulting in the uniform spread of the previous crop residue. It is usually a combination of operations to manage the residue to avoid intensive tillage operations to bury the crop residue. This way, there is no need to apply a high dose of herbicide to desiccate the vegetative cover, and will substantially reduce the crop production cost. If the crop stalk is cut, the stubble might re-sprout. Mechanical planting is also easier with specially developed planters, if the residues are slashed and spread but still in contact with the soil (Fig.8).

(A) Knife rollers or chopping rollers

The knife roller is used to bend over and crush the weed or cover crop vegetation prior to planting the commercial crop, usually resulting in the death of the cover crop. It is usually known as a tool for animal traction or for tractors (Fig. 9), but the same principle could be applied to small rollers or similar tools being dragged by humans. This operation is best carried out after flowering but before maturity of the seeds of the cover crop. This way, there is no need to apply a herbicide to desiccate the vegetative cover, and will substantially reduce the cost of production. In this case it is important that the knife roller only breaks and crushes but does not cut the cover crop plants so that they dry out and die. If the plants are cut, the stubble might re-sprout. Mechanical planting is also easier if the residues are not cut but still in contact with the soil.



A multi-purpose machine developed for Ridge till system

A combine developed for no till system



Animal drawn low till planter



Tractor operated No- till planter



Maize crop under No- till system

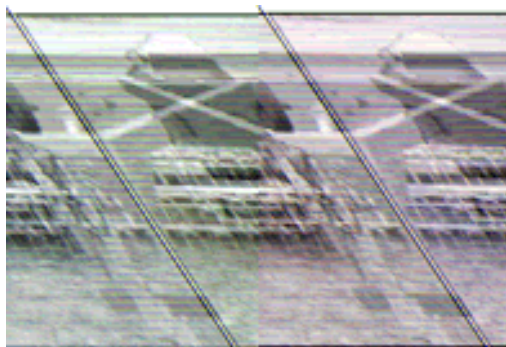
Cover crop chopping roller



Ridge – till machine



Crop stalk chopper cum Spreader



Cutter bar type crop stalk chopper cum Spreader



Manually carried motorized residue cutting device.