

Zero Tillage Cultivation of lentil in lowland rice fallow

Gulab Singh Yadav¹, Subhash Babu², M Datta³, Anup Das⁴ and Poulami Saha⁵

ICAR Research Complex for NEH Region, Tripura Centre, Lembucherra, Tripura West-799210

Conservation agriculture (CA) is a new paradigm in crop production for maintaining the sustainability, improving soil health and clean environment with proper residue management. It is possible to get about 397-513 kg/ha of lentil seed yield and extra income 11588 - 16308 ₹/ha to the farmer and increase their cropping intensity 200% from existing 100% following conservation agriculture practices like reduced and zero tillage cultivation of lentil in rice fallow. The rice productivity in successive years increases due to fixation of nitrogen by leguminous crop (lentil), addition of organic matter due to better residue management and improvement in physico-chemical and biological parameters of the soils.

Increasing crop productivity and maintaining a clean environment are major challenges to agricultural scientists in the 21st century. Besides that farming in rainfed Tripura is a high risk activity and characterized as complex-diverse-risk prone type. An intensive natural resource mining and continuous degradation of natural resources (soil, water, vegetation) under conventional agriculture practices will not ensure farm productivity and food security for the coming years. To meet these challenges, crop production practices need to be modified for obtaining higher yields and minimized environmental pollution. The



Reduced tillage lentil without irrigation

management of crop residues and improvement of soil fertility is a key component of sustainable cropping systems. In order to keep production system in different land situations sustainable, conservation agriculture based on minimum/zero tillage (no-till), residue retention/incorporation and crop diversification is an alternative to conciliate agriculture with its environment and overcome the imposed constraints of the climate change and high input cost. Conservation agriculture is a new

paradigm in crop production for maintaining the sustainability, improving soil health and clean environment with proper residue management. Conservation agriculture practices are designed to achieve sustainability by implementation of sustainable management practices that minimize environmental degradation and conserve resources while maintaining high yielding, profitable systems, and also improve the biological functions of the agro-ecosystem with limited mechanical practices and judicious use of external inputs. Resource Conserving Technologies using locally available resources encompasses practices that enhance resource or input-use efficiency and provide immediate, identifiable and demonstrable economic benefits such as reduction in production costs, saving of irrigation water, fuel, labour requirements, and timely establishment

^{1,3} and ⁵Scientist, Joint Director, Project Assistant, Division of Agronomy, ICAR Research Complex for NEH Region, Tripura Centre, Lembucherra, Tripura West-799210, ²Scientist, Division of Agronomy, ICAR (RC) NEH Regional Sikkim Centre, Sikkim, ⁴Sr. Scientist, NRM Division, ICAR (RC) for NEH Region, Barapani, Meghalaya

of crops resulting in improved yields, soil health and income. Conservation agriculture is characterized by following linked principles:

- Minimum mechanical soil interruption or reduction in tillage - The ultimate goal is zero tillage or controlled till seeding for all crops in a cropping system if feasible.
- Retention of adequate amount of crop residues or permanent organic soil cover on the soil surface: The ultimate goal is surface retention of sufficient crop residues to protect the soil from water run-off and erosion, improve water infiltration and reduce evaporation to improve water productivity, increase soil organic matter and biological activity and enhance long term sustainability.
- Diversification of crop species grown in progression and/or associations or use of sensible crop rotations: The ultimate goal is to employ economically viable, diversified crop rotations to help in moderation of possible weed, disease and pest problems, enhance soil biodiversity, take advantage of biological nitrogen fixation and provide farmers with new risk management opportunities.
- Improved economic benefits and livelihoods from sustainable conservation agriculture systems: The ultimate goal is secure farm level economic viability and stability.

Major advantages of conservation agriculture are purported to be reduced wind and water erosion of topsoil, increased water use efficiency through improved water infiltration and retention, increased nutrient use efficiency through enhanced nutrient cycling and fertilizer placement adjacent to seed, reduced oscillation of surface soil temperatures, increased soil organic matter and diverse soil biology, reduced fuel, labour and

overall crop establishment costs, and more timely operations.

Legumes are ideal crops for two components of conservation agriculture—soil cover and rotation—either as a growing crop or as residue. The major advantage of legumes is the addition of fixed nitrogen (N) to the soil and non depletion of existing soil N reserves because of their ability to meet their own N needs through fixation. Legumes contribute high quality organic matter to the soil because of their high N to carbon ratio and are effective in breaking disease cycles of particular cereal crops because of their genetic dissimilarity with cereals and thus host different sets of pests and diseases. Many legumes are deep rooted, contributing to nutrient cycling and water infiltration in the soil. Further, some legumes access nutrients otherwise unavailable to other crops, by mechanisms such as dissolution by root exudates, and render those nutrients available to subsequent crops. Lentil is very good crop for rice fallow for breaking the monotony of rice monocropping and cover the soil during fallow period.

Opportunity of reduced/zero tillage for lowland rice fallow

Rice is the main staple food of regions occupying an area of 2,32,160 hectare which is more than 90% of net cultivated area in Tripura. The cropping intensity in the region is varying from about 140-170%. Conventionally, after *kharif* rice, fields remain fallow in lowland, mainly due to excess moisture owing to seepage from surrounding hillocks during the time of sowing of crops and mild to severe moisture stress at the time of flowering and grain-filling stages. Draining water from rice field completely at physiological maturity (about 10 days before harvest) creates favourable condition for successful cultivation of *rabi* pulses like lentil, lathyrus etc. A simple drainage channel of 30 cm width and 20 cm

Table 1. Effect of reduced and zero tillage on productivity and economics of lentil

Particulars	Reduced tillage	Zero tillage
Seed yield (kg/ha)	513	397
Stover yield (kg/ha)	1,624	1,257
Cost of cultivation (₹/ha)	12,575	10,775
Return from seed (₹/ha)	25,635	19,848
Return from stover (₹/ha)	3,247	2,514
Total return (₹/ha)	28,882	22,363
Net return (₹/ha)	16,308	11,588
B: C ratio	2.30	2.08

depth at 5 m interval creates the desirable soil moisture situations and use of crop residue or rice stubble in zero tillage to reduce the moisture stress. Reduced tillage can be more beneficial with one light ploughing with power tiller to break the surface crust and soil pore continuity to reduce the capillary water loss through evaporation.

Advantages of reduced and zero tillage

- Timely sowing of lentil after harvest of rice.
- Residuals moisture from rice crop is conserved and used for second crop.
- Reduce cost of cultivation.
- Saves fuel, labour and energy.
- Less erosion due to intact soil and surface residue layer.
- Build-up in soil health due to less disturbance and enhanced microbial activity.
- Increase in cropping intensity (%).
- Higher net income.

Characteristics of lowland rice ecosystem in hills

Lowland rice is cultivated during April to November in Tripura depending upon the amount of rainfall. Main rice (*Aman*) is transplanted during first fortnight of July and harvested during November. After rice harvest, the moisture level remains high owing to release of moisture from surrounding Tilla lands. Cultivation of second rice is not possible due to non-availability of sufficient irrigation water. Under such

situation, cultivation of low water requiring crops like lentil, lathyrus etc. is possible following reduced and zero tillage after rice harvest for enhancing cropping intensity, farm income and livelihood.

Cultural practices for zero tillage lentil in lowland rice fallow

- When rice crop reaches physiological maturity, provide a narrow drainage channel (30 cm width × 20 cm depth) around the standing rice crop at an interval of 5 m. This will ensure a fairly good condition of field for sowing of lentil within 15-20 days of rice harvest.
- Harvest rice by leaving at least 20 cm standing stubble above the ground uniformly.
- Weeds are killed by spray of a total weed killer (Glyphosate @ 4 ml/litre water).
- Herbicides should be applied at least 7 -10 days prior to sowing/planting operations.
- Open a narrow furrow using manual furrow opener/wooden *deshi* plough in between two rows of previous rice crop and sow the water primed seed of lentil.
- Plant to plant spacing in a row should be maintained at 1-2 cm.
- This practice requires 40-45 kg seed/ha
- Before sowing the seed in field, soak the seed 24 hours in water and then dry in shade for 4-6 hours.
- Treat the seed with rhizobium and PSB @ 200 gram packet of each for 10 kg seed.
- Apply 20 kg N (40 kg urea), 40 kg P₂O₅ (250 kg SSP) and 20 kg K₂O (30 kg MOP) for one hectare of field area.
- Fertilizers and seeds are placed in the narrow furrows created by a 'V' shaped furrow opener.
- Cover the seeds with the soil after placing fertilizer and seeds.
- Alternatively, the water primed lentil seed can be broadcasted in

the field just one week before rice harvest if soil moisture condition is good (only moist field and no standing water). However requirement of seed is higher in this method, about 50 kg/ha.

- The lentil seeds get germinated before rice harvesting.
- Urea or DAP solution (2%) (20 g urea or DAP/litre of water) may be applied as foliar spray just before flowering.
- Rest of the cultural operations (weeding, application of pesticides, life saving irrigation if required) are done as recommended.

Cultural practices for reduced tillage lentil in lowland rice fallow

- Provide a narrow drainage channel (30 cm width × 20 cm depth) around the standing rice crop at an interval of 5 m during physiological maturity of the rice crop. This will ensure a fairly dried field for ploughing within 10-15 days of rice harvest.
- Harvest rice by leaving at least 10-20 cm standing stubble above the ground uniformly.
- Plough the field 1 or 2 times through power tiller for breaking the surface crust and destroy the existing weed plants.
- Sow the lentil by opening a narrow furrow using manual furrow opener/wooden made *deshi* plough at 25-30 cm row spacing.
- Plant to plant spacing in a row should be maintained at 1-2 cm.
- This practice requires 30-35 kg seed/ha.
- Before sowing the seed in field, sock the seed 24 hours in water and then dry in shade for 4-6 hour.
- Treat the seed with rhizobium and PSB @ 200 gram packet of each for 10 kg seed.
- Apply 20 kg N (40 kg urea), 40 kg P₂O₅ (250 kg SSP) and 20 kg K₂O (30 kg MOP) for one hectare of field area.

- Fertilizers and seeds are placed in the narrow furrows created by a 'V' shaped furrow opener.
- Cover the seeds with the soil after placing fertilizer and seeds.
- Urea or DAP solution (2%) (20 g urea or DAP/litre of water) may be applied as foliar spray just before flowering.
- Rest of the cultural operations (weeding, application of pesticides, life saving irrigation if required) are done as recommended.

Results

On farm demonstration on reduced and zero tillage cultivation of lentil in rice fallow after harvest of rice under NAIP was conducted at Maracherra and Balaram, Dhalai Tripura. Fifty farmer beneficiaries were selected for lentil cultivation after harvest of rice. All the farmers are grouped in two categories: Farmer for reduced tillage cultivation of lentil with a total area 4 ha and farmer for zero tillage cultivation of lentil with a total area 4 ha. The WBL-77 variety of lentil was testified for both reduced as well as zero tillage. Results showed that the growth performance of lentil was good under both reduced and zero tillage system. Reduced tillage recorded higher seed yield (513 kg/ha), stover yield (1,624 kg/ha), net return (16,308 ₹/ha) and B: C ratio (2.30) as compared to zero tillage (Table 1). This may be due to moisture stress in zero tillage fields at flowering and grain-filling stages. However, total cost of cultivation was lowest with zero tillage cultivation of lentil. The cultivation of reduce and zero tillage lentil gave extra income 11,588 – 16,308 ₹/ha to the farmer and increase in their cropping intensity 200% from existing 100%.

SUMMARY

Conservation agriculture is a new paradigm in crop production for
(Continued on page 36)

Zero Tillage Cultivation...

(Continued from page 30)

maintaining the sustainability, improving soil health and clean environment with proper residue management. Conservation agriculture practices are designed to achieve sustainability by implementation of sustainable management practices that minimize environment degradation and conserve resources while maintaining high yielding, profitable systems, and also improve the biological functions of the agro-

ecosystem with limited mechanical practices and judicious use of external inputs. It is possible to get about 397-513 kg/ha of lentil seed yield and extra income of 11,588–16,308/ha to the farmer following reduced and zero tillage practice in rice fallow. The rice productivity in successive years increases due to fixation of nitrogen by leguminous crop (lentil), addition of organic matter due to better residue management and

improvement in physico-chemical and biological parameters of the soils. Therefore, the practice of reduced and zero tillage lentil is a viable resource conserving technology for Tripura for increasing cropping intensity, employment, nutritional security and higher income. Realizing very good potential of reduced and zero tillage lentil in rice fallow large scale field demonstrations would be undertaken in farmers' field. ■