



# CONSERVATION AGRICULTURE IN GROUNDNUT-BASED CROPPING SYSTEMS

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Conservation Agriculture (CA), based on the interlinked principles of minimum mechanical disturbance, soil cover with crop residues/cover crops, and diversified crop rotations, is practiced over 180 M ha area in the world. According to FAO, CA is as an approach to managing agro-ecosystems for improved and sustained productivity, increased profits and food security while preserving and enhancing the resource base and the environment. CA provides several benefits like- it conserves soil and water, improves soil health, enhances water use efficiency, moderates soil temperature, gives stable yields, saves inputs, reduces cost of cultivation, helps in climate change mitigation and adaptation etc. However, there is need to develop and disseminate region and crop specific CA practices. Following package of practices were developed at ICAR-DGR, Junagadh for Conservation Agriculture in popular cropping systems of groundnut-wheat sequence system and groundnut+pigeonpea and groundnut+cotton intercropping systems in Saurashtra region of Gujarat.

## Conservation Agriculture in Groundnut- Wheat System:

### Conservation Agriculture on permanent broad bed and furrow system:

Permanent broad bed and furrow system (BBF) may be used in shallow to medium depth soils which are common in Saurashtra, and areas where waterlogging poses challenge to successful crop production during rainy season.

### Package of practices for groundnut:

**Field preparation:** Before shifting to CA subsoiling must be done to break the hard pans in the sub-soil. For groundnut, which produces economic part below the ground, minimum tillage should be done. After receipt of first monsoon rain or pre-sowing irrigation blade harrowing should be done to partially flatten the standing wheat stubbles and loosen the soil for sowing of groundnut (Fig. 1 a). Broad beds should be reshaped after blade harrowing.

**Sowing:** Sowing should be done with seed-cum-fertilizer drill having knife type tines wherein seed is placed between the rows of partially standing wheat stubbles (Fig. 1b). Four rows of groundnut may be accommodated on each broad bed of 1.1 m width keeping plant to plant spacing of 8-10 cm of Spanish bunch variety.

**Nutrient management:** The recommended dose of NPK (i.e.25:50:30 kg/ha) should be applied at the time of sowing below the seed in rows. To nullify the immobilization effect due to retention of crop residues 10-15 kg/ha of extra nitrogen may be applied 25-30 DAS if plant growth is poor. This amount of nitrogen may be substituted from nitrogen applied to succeeding wheat crop which gets benefitted from nutrients mineralized from crop residues. Other nutrients should be applied as per soil testing.

**Water management:** Adequate soil moisture is important for satisfactory crop germination. In the absence of sufficient rain water should be given through sprinklers immediately after sowing. Light irrigation may be repeated after four days of sowing. Subsequently, need based irrigation should be provided to the crop.

**Weed management:** The blade harrowing before sowing removes perennial weeds like *Parthenium* and sedges. For effective control of seasonal weeds pendimethlin (1.0 kg a.i. per ha) should be sprayed within 24 hours of sowing. Two manual weedings at 25 and 45 DAS control weeds effectively or alternatively Imazethapyr (50 g a.i. ha<sup>-1</sup>)+ Quizolofop ethyl (70 g a.i. ha<sup>-1</sup>) may be sprayed at 20-25 DAS for control of broad leaved and grassy weeds.

**Harvesting:** When crop is ready for harvesting run blade harrow at optimum soil moisture (Fig. 1d). Collect the uprooted plants manually and keep for sun drying.

### Package of practices for wheat:

**Field preparation:** Running blade harrow for harvesting of preceding groundnut crop will act as minimum tillage



for sowing of subsequent crop of wheat. Therefore, before sowing of wheat only broad beds may be reshaped, and if needed, the big size clods may be broken by tying a wooden attachment with the bed shaper (Fig. 1e).

**Sowing:** After reshaping of beds, sowing can be done with seed-cum-fertilizer drill having knife type tines. Five rows of wheat may be accommodated on each broad bed of 1.1 m width.

**Nutrient management:** The recommended dose of nutrients i.e. 120 kg ha<sup>-1</sup> N, 60 kg ha<sup>-1</sup> P and 60 kg ha<sup>-1</sup> of K should be applied as per recommendation in the region. The extra dose of N applied to groundnut may be subtracted from N dose of wheat.

**Water management:** Like in groundnut, sufficient water should be given through sprinklers immediately after sowing to ensure proper germination. Light irrigation may be repeated after four days to facilitate satisfactory germination. Subsequently, need based irrigation may be provided to the crop.

**Application of mulch:** *Cassia tora* harvested from road side and waste lands, where it grows profusely during the rainy season, may be used for covering the soil surface in wheat. *Cassia tora* must be harvested at flowering stage as delayed harvesting would also transport seeds in the field. The harvested *Cassia tora* biomass can be stored for subsequent use as mulch in wheat after cutting in smaller pieces of about 10 cm size. Application of *Cassia tora* mulch at least at 5.0t ha<sup>-1</sup> is required to observe any significant effects (Fig. 1f).

**Weed management:** For effective control of weeds in wheat under minimum tillage pendimethlin (1.0 kg a.i.ha<sup>-1</sup>) should be sprayed immediately after sowing. Two hand weeding at 25 and 45 days after sowing control weeds effectively.

**Harvesting:** Wheat may be harvested with combine harvester at the height of about 25 cm from ground level. The loose wheat straw may be removed for use as fodder for animals while standing stubbles will act as covering material on soil surface in succeeding groundnut.



a



b



c



d



e



f

Fig. 1 Blade harrowing to prepare field for sowing of groundnut (a), sowing of groundnut with seed-cum-ferti drill having knife type tines (b), groundnut crop under minimum tillage (c), harvesting of groundnut (d), reshaping of BBFs for sowing of wheat (e), and zero till wheat crop with *Cassia tora* mulch (f).



### Conservation Agriculture on flat bed system:

In Saurashtra, majority of the farmers sow wheat in 10 cm wide strips followed by 40 cm wide gap through specially designed seed drills rather than line sowing at 22.5 cm spacing (Fig. 2a). The relatively high temperature during rabi causes poor and unsynchronised tillering in wheat and hence, strip sowing is preferred for ensuring uniform maturity in wheat. After harvesting of wheat with combine harvester, the loose residues can be removed mechanically (Fig.2b) for use as fodder. The 40 cm wide area between the standing wheat stubbles can be prepared for sowing of groundnut through row zone tillage while keeping the wheat stubbles in place. The customized tillage implements can be used to make the soil pulverized with minimum required tillage just after the harvesting of wheat when some moisture is available in the soil to effect better tillage (Fig.2c). Between the two strips of wheat stubbles one line of semi-spreading groundnut can be sown with seed-cum-ferti drill (Fig.2d). Alternatively two rows of bunch type groundnut bordering wheat stubbles can be sown between two strips of wheat stubbles. Sowing of groundnut between standing wheat stubbles maintains soil moisture for longer duration and saves crop from mid- and late-season moisture stresses which are common in the region. The wheat stubbles also keeps soil porous for better peg entry. In case of pre-monsoon sowing, sufficient irrigation water should be applied through sprinklers for proper germination, and further need based irrigation should be applied if deficit rain occurs. Weed management may be done through pre- and post-emergence herbicides as mentioned previously. Other management practices may be followed as in case of CA on permanent BBF system.

### Conservation Agriculture in Groundnut+Pigeonpea and Groundnut+cotton intercropping systems:

Groundnut+pigeonpea and groundnut+cotton are popular intercropping systems in several parts of the country. These systems are mostly followed under rainfed situations on relatively less fertile soils. Shifting to CA can better help reduce the climate variabilities related moisture and heat stress effects on crops, and also improve the soil fertility for sustainably higher production.

### CA package of practices:

**Minimum tillage:** Minimum tillage with one pass of cultivator just after harvest of pigeonpea/cotton when some residual moisture is available should be done. Sub-soiling after 3-4 years should be done to break hard layers.

**Residue application:** After final picking of cotton balls, the stalks should be cut with residue shredder and spread on soil surface. Similarly, in case of pigeonpea after harvesting of grains the remaining biomass should be chopped in smaller pieces and spread on soil surface.

**Sowing:** Sowing of groundnut can be done with seed-cum-fertilizer drill having knife type tines. Sowing should be done in the direction perpendicular to minimize tillage operation. Sowing of intercrops of pigeonpea and cotton can be done manually in the recommended row ratio (e.g. 3:1). Pigeonpea should be sown after 30 days of groundnut sowing to reduce the intercrop competition.

**Nutrient management:** The recommended dose of NPK (i.e. 40:50:30 kg/ha) for groundnut should be applied at the time of sowing. Full amount of NPK for pigeonpea (i.e. 40:60:40 kg/ha) and cotton (i.e.240:50:150 kg/ha) should be applied as per the recommendation. Others nutrients may be applied as per soil test report. In pigeonpea lower hard portion which decomposes slowly causes nutrient immobilization during early phase of crop growth hence, 10-15 percent extra dose of nutrients may be applied if needed.

**Water management:** Sufficient soil moisture should be available for satisfactory crop germination. These being the rainfed systems, supplementary irrigation may be provided during drought like situations through sprinkler system if water is available.

**Weed management:** For effective control of seasonal weeds pendimethlin (1.0 kg a.i. ha<sup>-1</sup>) should be sprayed within 24 hours of sowing. Two manual weedings at 25 and 45 days after sowing controls weeds effectively during groundnut season. One weeding should be done manually in pigeonpea and cotton after harvesting of groundnut.

**Harvesting:** Harvesting of groundnut should be done manually by pulling the plants. Pigeonpea and cotton may be harvested manually as per the practice in the region.





**a**



**b**



**c**



**d**

**Fig 2.** Strip sown wheat crop (a), collection of loose wheat straw after harvesting (b), Row zone tillage between standing wheat stubbles (c), and groundnut crop sown between wheat stubbles.

### **Benefits observed due to Conservation Agriculture practices:**

1. Higher system productivity and profitability
2. Improved soil physical (bulk density, porosity, permeability, water infiltration, soil aggregate stability), chemical (CEC, organic carbon, aggregate associated carbon, available NPK) and biological (microbial biomass-carbon, enzymatic activities, earthworm population) properties of soil.
3. Improved soil moisture content over longer duration.
4. Moderating influence on soil temperature and lowered canopy temperature.
5. Eco-friendly disposal of crop residues.





**a**



**b**



**c**



**d**



**e**



**f**

Fig. 3: Pigeonpea and cotton residues retained (a & b), minimum tillage plot (c), zero tillage plot with rodent holes (d), cotton intercropped with groundnut (e) and pigeonpea intercropped with groundnut under minimum tillage (f).