Mulch cover on planting pits (ICRISAT)

Precision Conservation Agriculture (Zimbabwe)

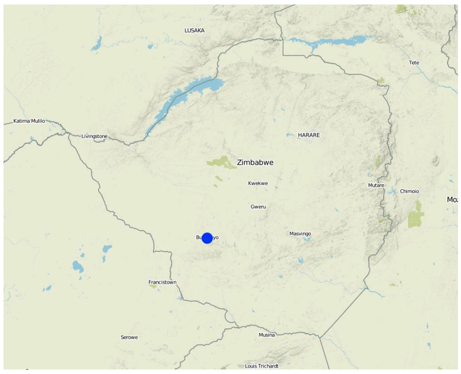
DESCRIPTION

Precision Conservation Agriculture combines aspects of conservation agriculture and precision application of fertilizer.

Precision Conservation Agriculture (PCA) is a combined technology that encompasses four basic principles: 1) minimum tillage – e.g. using planting basins which enhance the capture of water from the first rains and allow efficient application of limited nutrient resources with limited labor input; 2) the precision application of small doses of nitrogen-based fertilizer to achieve higher nutrient efficiency (from organic and/or inorganic sources); 3) combining improved fertility with improved seed for higher productivity; and 4) use of available residues to create a mulch cover that reduces evaporation losses and weed growth. Crop mixes are adapted to the local conditions and household resource constraints. Cereal/legume rotations are desirable. PCA spreads labor for land preparation over the dry seasons and encourages more timely planting, resulting in a reduction of peak labor loads at planting, higher productivity and incomes. Over four years these simple technologies have consistently increased average yields by 50 to 200% in more than 50,000 farm households. These strategies are promoted by ICRISAT, FAO and NGOs in Southern Africa focusing on low potential zones where most of the most resource-poor and vulnerable farm households exist.

Components of CF Planting Basins Package promoted in Zimbabwe:
1. Winter weeding: The first step in preparing a field using CF methods is to remove all weeds. This should be done soon after harvesting in May/June. Weeding is done using implements such as hand hoes and machetes that disturb the soil as little as possible. The importance of weeding before land preparation is to ensure that the plot is weed-free at basin preparation and also to prevent the dispersal of weed seeds.
2. Digging planting basins: Planting basins are holes dug in a weed-free field into which a crop is planted. The basins are prepared in the dry season from July to October. The recommended dimensions of the basin are 15×15×15 cm, spaced at either 75×60 cm for rainfalls of 650 to 900 mm and either 75x75 cm or 90×60 cm for Natural rainfalls of 400 to 650 mm. The basins enable the farmer to plant the crop after the first effective rains when the basins have captured rainwater and drained naturally. Seeds are placed in each basin at the appropriate seeding rate and covered with clod-free soil. The advantage of using basins is that they enhance the capture of water from the first rains of the wet season and enable precision application of both organic and inorganic fertilizer as it is applied directly into the pit and not broadcast.
3. Application of crop residues: Crop residues are applied on the soil surface in the dry season, soon after harvesting if available. Ideally the residues should provide at least 30% soil cover. The mulch buffers the soil against extreme temperatures (thereby reducing soil evaporation), cushions the soil against traffic, and suppresses weeds through shading and improves soil fertility.
4. Application of manure: Fertility amendments are applied soon after land preparation in the dry season. In CF, the application of both organic and inorganic fertilizers is recommended as they complement each other. Organic fertilizers such as manure and/or composts are applied at a rate of at least a handful per planting basin. More can be used in wetter areas.
5. Application of basal fertilizer: Inorganic basal fertilizer is also applied soon after land preparation before the onset of the rains. One level beer bottle cap is applied per planting basin and covered lightly with clod-free soil. This is equivalent to 80 kg of compound fertilizer per hectare. Application rates can be increased in wetter areas and may depend on crop types.
6. Application of topdressing: Nitrogen fertilizer is applied to cereal crops at the 5 to 6 leaf stage soon after the first weeding at a rate of one level beer bottle cap per basin. This is equivalent to 80 kg of ammonium nitrate fertilizer per hectare. Application is done on moist soils. Precision application ensures that the nutrients are available where they are needed. Application rates can be increased in wetter areas and may depend on crop types.
7. Timely weeding: In conventional tillage systems, farmers plough/cultivate repeatedly in order to suppress weeds. With reduced tillage, weeds can be a problem requiring more effort initially. One strategy is to weed in a timely manner (ie, when the weeds are still small) preventing the weeds from setting seed. Timely weeding in combination with mulch should

LOCATION



Location: Bulawayo, Zimbabwe

No. of Technology sites analysed:

Geo-reference of selected sites
- 28.58116, -20.17219

Spread of the Technology:

In a permanently protected area?:

Date of implementation: less than 10 years ago (recently)

Type of introduction
- [ ] through land users' innovation
- [ ] as part of a traditional system (> 50 years)
- [x] during experiments/ research
- [ ] through projects/ external interventions

eventually lead to effective weed control.
8. Crop rotation: Rotating crops is one of the key principles of CF. Cereal/legume rotations are desirable because the cereal benefits from nitrogen produced by the Rhizobium associated with the legume, and the legume benefits from the residues produced by the cereal. The advantages of crop rotation include improvement of soil fertility, controlling weeds, pests and diseases, and producing different types of outputs, which reduce the risk of total crop failure in cases of drought and disease outbreaks.

Application of a micro-dose of basal fertilizer (a compound applied prior to planting in the bottom of the planting pit) (ICRISAT)

Excavation of planting pits (Dimensions: 15 cm by 15 cm by 15 cm; Spacing: varies between 60 – 90 cm, depending on average rainfall) (ICRISAT)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- [x] improve production
- [ ] reduce, prevent, restore land degradation
- [ ] conserve ecosystem
- [ ] protect a watershed/ downstream areas – in combination with other Technologies
- [ ] preserve/ improve biodiversity
- [ ] reduce risk of disasters
- [ ] adapt to climate change/ extremes and its impacts
- [ ] mitigate climate change and its impacts
- [ ] create beneficial economic impact
- [ ] create beneficial social impact

Land use

Cropland
- Annual cropping

Water supply

- [ ] rainfed
- [ ] mixed rainfed-irrigated
- [ ] full irrigation

Purpose related to land degradation

- [x] prevent land degradation
- [x] reduce land degradation
- [ ] restore/ rehabilitate severely degraded land
- [ ] adapt to land degradation
- [ ] not applicable

Degradation addressed

soil erosion by water - Wt: loss of topsoil/ surface erosion

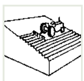
chemical soil deterioration - Cn: fertility decline and reduced organic matter content (not caused by erosion)

physical soil deterioration - Pk: slaking and crusting

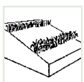
SLM group

- integrated soil fertility management

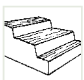
SLM measures



agronomic measures - A1: Vegetation/ soil cover, A2: Organic matter/ soil fertility, A3: Soil surface treatment (A 3.2: Reduced tillage (> 30% soil cover)), A4: Subsurface treatment, A5: Seed management, improved varieties, A6: Residue management, A7: Others



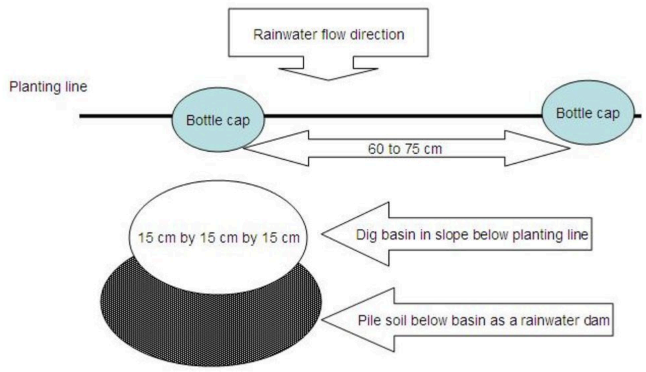
vegetative measures - V5: Others



structural measures - S11: Others

TECHNICAL DRAWING

Technical specifications
Vertical interval and spacing between structures / vegetative strips
Date: 1st November 2009
Technical knowledge required for field staff / advisors: high (Change in attitudes)
Technical knowledge required for land users: high (Change in attitudes)



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ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs
- Costs are calculated:
- Currency used for cost calculation: **n.a.**
- Exchange rate (to USD): 1 USD = n.a
- Average wage cost of hired labour per day: n.a

Most important factors affecting the costs
n.a.

Establishment activities
1. 1.Layout of contours with the use of an A-frame before land preparation, place wooden pegs along the contours (Timing/ frequency: during dry season)

Maintenance activities
1. Direct seeding /fertilizer (NPK) banding using no-till drill (Timing/ frequency: Eearly November)
2. Direct seeding /fertilizer (NPK) banding using no-till drill (Timing/ frequency: Eearly November)
3. Leave fields to fallow for 18 months, apply herbicide if needed (Timing/ frequency: afther harvest)
4. Leave fields to fallow for 18 months, apply herbicide if needed (Timing/ frequency: afther harvest)

Maintenance inputs and costs

Specify input	Unit	Quantity	Costs per Unit (n.a.)	Total costs per input (n.a.)	% of costs borne by land users
Labour					
labour	ha	1.0	108.0	108.0	
Equipment					
hand hoes	ha	1.0	7.0	7.0	
Fertilizers and biocides					
fertilizer	ha	1.0	69.0	69.0	
Total costs for maintenance of the Technology				**184.0**	
Total costs for maintenance of the Technology in USD				*184.0*	

NATURAL ENVIRONMENT

Average annual rainfall
- < 250 mm
- 251-500 mm
- ✓ 501-750 mm
- ✓ 751-1,000 mm
- 1,001-1,500 mm
- 1,501-2,000 mm
- 2,001-3,000 mm
- 3,001-4,000 mm
- > 4,000 mm

Agro-climatic zone
- humid
- sub-humid
- ✓ semi-arid
- ✓ arid

Specifications on climate
Summer rains October/November to March 79 to 179 days

Slope
- flat (0-2%)
- ✓ gentle (3-5%)
- moderate (6-10%)
- rolling (11-15%)
- hilly (16-30%)
- steep (31-60%)
- very steep (>60%)

Landforms
- ✓ plateau/plains
- ridges
- mountain slopes
- hill slopes
- ✓ footslopes
- valley floors

Altitude
- 0-100 m a.s.l.
- 101-500 m a.s.l.
- ✓ 501-1,000 m a.s.l.
- ✓ 1,001-1,500 m a.s.l.
- 1,501-2,000 m a.s.l.
- 2,001-2,500 m a.s.l.
- 2,501-3,000 m a.s.l.
- 3,001-4,000 m a.s.l.

Technology is applied in
- convex situations
- concave situations
- not relevant

- [ ] > 4,000 m a.s.l.

Soil depth
- [ ] very shallow (0-20 cm)
- [x] shallow (21-50 cm)
- [x] moderately deep (51-80 cm)
- [ ] deep (81-120 cm)
- [ ] very deep (> 120 cm)

Soil texture (topsoil)
- [ ] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- [ ] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Topsoil organic matter content
- [ ] high (>3%)
- [ ] medium (1-3%)
- [x] low (<1%)

Groundwater table
- [ ] on surface
- [ ] < 5 m
- [ ] 5-50 m
- [ ] > 50 m

Availability of surface water
- [ ] excess
- [ ] good
- [ ] medium
- [ ] poor/ none

Water quality (untreated)
- [ ] good drinking water
- [ ] poor drinking water (treatment required)
- [ ] for agricultural use only (irrigation)
- [ ] unusable

Is salinity a problem?
- [ ] Ja
- [ ] Nee

Occurrence of flooding
- [ ] Ja
- [ ] Nee

Species diversity
- [ ] high
- [ ] medium
- [ ] low

Habitat diversity
- [ ] high
- [ ] medium
- [ ] low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- [x] subsistence (self-supply)
- [ ] mixed (subsistence/ commercial)
- [ ] commercial/ market

Off-farm income
- [ ] less than 10% of all income
- [ ] 10-50% of all income
- [ ] > 50% of all income

Relative level of wealth
- [ ] very poor
- [x] poor
- [x] average
- [ ] rich
- [ ] very rich

Level of mechanization
- [x] manual work
- [x] animal traction
- [ ] mechanized/ motorized

Sedentary or nomadic
- [ ] Sedentary
- [ ] Semi-nomadic
- [ ] Nomadic

Individuals or groups
- [x] individual/ household
- [ ] groups/ community
- [ ] cooperative
- [ ] employee (company, government)

Gender
- [ ] women
- [ ] men

Age
- [ ] children
- [ ] youth
- [ ] middle-aged
- [ ] elderly

Area used per household
- [ ] < 0.5 ha
- [ ] 0.5-1 ha
- [ ] 1-2 ha
- [ ] 2-5 ha
- [ ] 5-15 ha
- [ ] 15-50 ha
- [ ] 50-100 ha
- [ ] 100-500 ha
- [ ] 500-1,000 ha
- [ ] 1,000-10,000 ha
- [ ] > 10,000 ha

Scale
- [x] small-scale
- [ ] medium-scale
- [ ] large-scale

Land ownership
- [ ] state
- [ ] company
- [x] communal/ village
- [ ] group
- [ ] individual, not titled
- [ ] individual, titled

Land use rights
- [ ] open access (unorganized)
- [ ] communal (organized)
- [ ] leased
- [ ] individual

Water use rights
- [ ] open access (unorganized)
- [ ] communal (organized)
- [ ] leased
- [ ] individual

Access to services and infrastructure

IMPACTS

Socio-economic impacts

Crop production	decreased ✓ (at right end) increased	Quantity before SLM: 400 kg/ha Quantity after SLM: 1520 kg/ha increase varies between 50-200%, depending on rainfall regime, soil types and fertility, and market access
fodder production	decreased ✓ (at right end) increased	Quantity before SLM: 600 kg/ha Quantity after SLM: 2200 kg/ha
fodder quality	decreased ✓ (second from right) increased	
risk of production failure	increased ✓ (at right end) decreased	
product diversity	decreased ✓ (at right end) increased	
land management	hindered ✓ (at right end) simplified	
farm income	decreased ✓ (at right end) increased	

Socio-cultural impacts

food security/ self-sufficiency	reduced ✓ (at right end) improved	Quantity before SLM: 1.8 ha Quantity after SLM: 0.6 ha Household meets food needs from less land
cultural opportunities (eg spiritual, aesthetic, others)	reduced ✓ (at right end) improved	

community institutions	weakened							✓	strengthened	Community work groups using establishment
SLM/ land degradation knowledge	reduced							✓	improved	
situation of socially and economically disadvantaged groups (gender, age, status, ehtnicity etc.)	worsened							✓	improved	

Ecological impacts

water quality	decreased						✓		increased	Dependent on number adopting in community/catchment
harvesting/ collection of water (runoff, dew, snow, etc)	reduced						✓		improved	
surface runoff	increased						✓		decreased	
evaporation	increased						✓		decreased	
soil moisture	decreased						✓		increased	
soil cover	reduced					✓			improved	
soil loss	increased					✓			decreased	
soil crusting/ sealing	increased					✓			reduced	
soil compaction	increased					✓			reduced	
nutrient cycling/ recharge	decreased						✓		increased	
soil organic matter/ below ground C	decreased						✓		increased	
biomass/ above ground C	decreased						✓		increased	
beneficial species (predators, earthworms, pollinators)	decreased					✓			increased	
emission of carbon and greenhouse gases	increased					✓			decreased	

Off-site impacts

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Short-term returns	very negative						✓		very positive
Long-term returns	very negative							✓	very positive

Benefits compared with maintenance costs

Short-term returns	very negative						✓		very positive
Long-term returns	very negative							✓	very positive

CLIMATE CHANGE

Gradual climate change

annual temperature increase	not well at all				✓		very well	

Climate-related extremes (disasters)

local rainstorm	not well at all						very well	Answer: not known
drought	not well at all				✓		very well	

Other climate-related consequences

reduced growing period	not well at all				✓		very well	

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- single cases/ experimental
- 1-10%
- 11-50%
- > 50%

Of all those who have adopted the Technology, how many have done so without receiving material incentives?

- 0-10%
- 11-50%
- 51-90%
- 91-100%

Has the Technology been modified recently to adapt to changing conditions?

- Ja
- Nee

To which changing conditions?

- climatic change/ extremes
- changing markets
- labour availability (e.g. due to migration)

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

Strengths: compiler’s or other key resource person’s view

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

- PCA spreads labour for land preparation over the dry season and encourages more timely planting, resulting in a reduction of peak labour loads at planting, higher productivity and incomes
- Over four years these simple technologies have consistently increased average yields by 50 to 200%, depending on rainfall regime, soil types and fertility, and market access

- None
- None
- None

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome

- Availability of residues to achieve the minimum 30% soil cover Accept that in agro-pastoral systems where residues are at a premium demonstrate benefits of residues management – but allow households to decide
- Access to fertilizer at cost effective prices Input market development and identification of enabling government policies
- Rotations and legumes poorly adopted Allow households to become familiar with technology and meet subsistence food requirements before promoting rotations. Ensure availability of good quality seeds and markets to meet extra legume production

REFERENCES

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Editors

Reviewer
Deborah Niggli
Alexandra Gavilano

Date of documentation: April 22, 2010

Last update: Aug. 22, 2019

Resource persons
Stephen Twomlow - SLM specialist

Full description in the WOCAT database
https://qcat.wocat.net/af/wocat/technologies/view/technologies_1327/

Linked SLM data
n.a.

Documentation was faciliated by

Institution
- n.a.

Project
- Book project: SLM in Practice - Guidelines and Best Practices for Sub-Saharan Africa (SLM in Practice)

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