Maize field (Maxon Simfukwe)

Conservation Agriculture in a semi-arid area (Namibia)

Lima nawa (Vambo/Rukwangali)

DESCRIPTION

Conservation agriculture using permanent water-harvesting planting basins, or rip-lines and fertilizer/manure application on low fertility dryland soils.

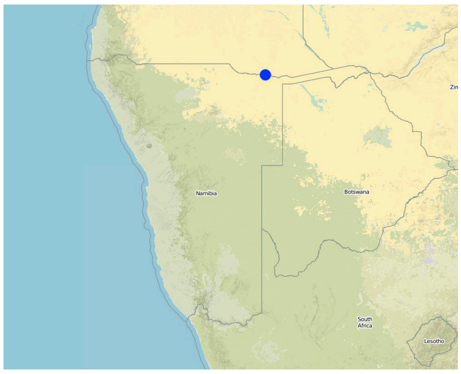
Farmers in north-eastern Namibia practice shifting/semi-permanent subsistence cropping, concentrating on pearl millet cultivation. Here, conservation agriculture (CA) was promoted to sustain and improve production and to reduce conversion of woodland to crops. CA comprises the three principles of minimum soil disturbance, permanent soil cover, and rotation. CA was tested on small plots with volunteers trained by a local NGO. The technology was characterized here by: (i) Early (pre-rains) preparation of the land with two alternative techniques; either: a) basins with a defined spacing opened by a hand hoe, with composted manure added (biochar has also been tested), or b) rip-lines prepared with oxen in lines and with manure application within the rip lines; (ii) Mulching the soil with crop residues, branches or sunnhemp, specially grown for the purpose; (iii) Protection against grazing of crop and mulch by livestock; (iv) Intercropping with vegetables or legumes. (v) Weeding.

CA has been promoted for four seasons, and now trained farmers are transferring their knowledge to others. The technology was promoted to substantially improve the low yields of traditionally practiced agriculture by improving fertility and soil structure as well as better capturing runoff. It was also aimed at avoiding further expansion of croplands into dry woodlands on low fertility arenosols. Eventually it is hoped that the well-being of local subsistence cropping communities will be improved and outmigration reduced.

Knowledge about CA comes from Zambia, where it has been has been practiced successfully for many years by small-scale farmers. A local NGO was engaged by an international project (www.future-okavango.org) which searched for volunteer farmers in the Kavango area. The first CA planting took place in 2011/12. These pioneer farmers were backstopped regularly and the number of farmers trained increased. The NGO monitored crops with contact farmers. 45 more farmers showed interest and were then trained by the contact farmers. Training and backstopping continued until August 2015.

The natural environment is semi-arid. Rainfall is concentrated from November to March. Mean annual precipitation is 570 mm, and mean air temperature is 26.2°C in the hottest month (October) and 16.2°C in the coldest month (July). The landscape forms part of the extended Kalahari basin in central-southern Africa. Deep and extended sands restrict people to living in areas close to surface water. Villages are located along the Okavango on the elevated river terraces – where they produce crops. Here, sedimentation of fine-grained soils, the accumulation of calcium carbonates in the subsoil and the activity of termites have resulted in soils of medium fertility which could potentially ensure yields of 500 kg/ha of millet, if well managed, and assuming good rainfall. Due to the growing population and restricted land availability, cultivation patterns have changed from shifting to semi-permanent and expanded to the adjacent woodlands on the deep Kalahari sands. Here, rapid degradation of soil fertility has caused further expansion and reduced crop yields to very low levels (ca. 150 kg/ha on average). Livestock graze and browse vegetation on the floodplains and in the woodlands. Due to night-time kraaling of livestock, manure is available as fertilizer: thus sustained cropping can be supported. The importance of the woodlands for ecosystem services including timber and firewood, for thatching grass, medicinal plants and biodiversity means they must be conserved and this acts as a reason to support the search for alternative crop production systems such as CA.

LOCATION



Location: Mashare, Kavango East, Namibia

No. of Technology sites analysed:

Geo-reference of selected sites
- 20.16, -17.9

Spread of the Technology: evenly spread over an area (approx. < 0.1 km2 (10 ha))

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)
- [ ] during experiments/ research
- [x] through projects/ external interventions

Demostration plot: Basins prepared and mulch distributed (Maxon Simfukwe)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- [x] improve production
- [x] reduce, prevent, restore land degradation
- [x] 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

Land use mixed within the same land unit: Yes - Agro-pastoralism (incl. integrated crop-livestock)

Cropland

- Annual cropping

Number of growing seasons per year: 1

Grazing land

- Semi-nomadic pastoralism

Water supply

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

Purpose related to land degradation

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

Degradation addressed

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

biological degradation - Bc: reduction of vegetation cover, Bf: detrimental effects of fires, Bl: loss of soil life

SLM group

- integrated soil fertility management
- cross-slope measure
- water harvesting

SLM measures

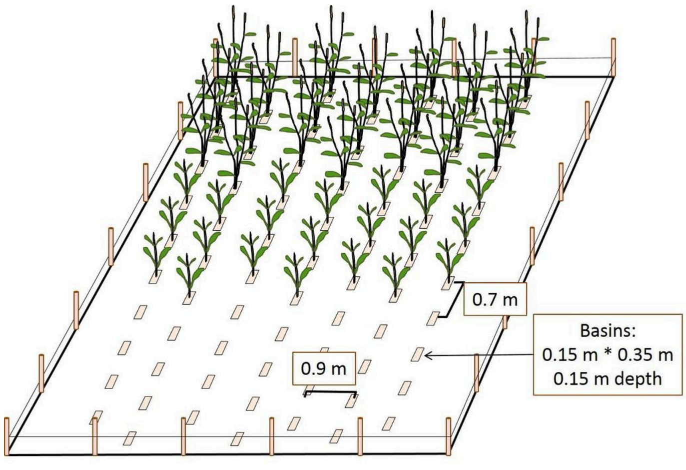
agronomic measures - A3: Soil surface treatment

management measures - M2: Change of management/ intensity level

TECHNICAL DRAWING

Technical specifications

Scheme of CA field with basins
Within the fenced area, basins are dug per hand-hoe in lines with about 15 cm width, 35 cm length and 15 cm depth and in 70 cm distance. To keep the line and position, a rope with knots every 70 cm is used. Each basin is refilled with 2 cans of manure mixed with part of the soil material. Maize or pearl millet - two stages shown on the graph
Location: Mashare. Kavano East/Namibia



Author: Maxon Simfukwe

Technical knowledge required for field staff / advisors: moderate
Technical knowledge required for land users: low
Main technical functions: increase in nutrient availability (supply, recycling,…)
Secondary technical functions: increase / maintain water stored in soil, increase of biomass (quantity)

Early planting
Remarks: Planting basins prepared in dry season, planting can occur by first rainfalls (earlier than plough-d

Mixed cropping / intercropping
Material/ species: Maize / Millet /Cowpea
Remarks: Cultivated in parallel lines

Mulching
Material/ species: Grasses & crop residues & sunhemp
Remarks: sunhemp cultivated on the CA field and cut to produce mulch

Green manure
Material/ species: branches of fertilizer tree

Manure / compost / residues
Material/ species: Composted manure from cattle post

Rotations / fallows
Material/ species: Maize / Millet /Cowpea
Remarks: Planted in lines and shifted annually

Minimum tillage
Material/ species: Riplines by oxen

Pits
Material/ species: planting basins by hand hoe

Retention/infiltration ditch/pit, sediment/sand trap
Spacing between structures (m): 0.7
Depth of ditches/pits/dams (m): 0.15
Width of ditches/pits/dams (m): 0.15
Length of ditches/pits/dams (m): 0.35

Structural measure: ripline
Spacing between structures (m): 0.7
Depth of ditches/pits/dams (m): 0.25
Width of ditches/pits/dams (m): 0.1

For water harvesting: the ratio between the area where the harvested water is applied and the total area from which water is collected is: 1:8,3
Change of land use practices / intensity level: More specific soil management; crop protection by fencing; earlier seeding
Major change in timing of activities: To a large part, land preparation can be carried out throughout dry season, independent of rainfall level

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated:
- Currency used for cost calculation: **Nam $**
- Exchange rate (to USD): 1 USD = 15.5 Nam $
- Average wage cost of hired labour per day: n.a

Most important factors affecting the costs

CA was designed to require minimal financial investments; theoretically, everything apart from wire for the fences and inorganic fertilizer can be created or gather by the household. This turns CA into a very labour intensive farming practice. The high Dollar values above result from multiplying the (free) family labour invested in farming with the typical hourly wage rate of an external worker

Establishment activities

1. (Timing/ frequency: dry season)

Establishment inputs and costs

Specify input	Unit	Quantity	Costs per Unit (Nam $)	Total costs per input (Nam $)	% of costs borne by land users
Labour					
labour	ha	1.0	1104.0	1104.0	100.0
Construction material					
Wire for fencing	ha	1.0	224.0	224.0	100.0
sticks & poles	ha	1.0	1114.0	1114.0	100.0
Total costs for establishment of the Technology				**2'442.0**	
Total costs for establishment of the Technology in USD				*157.55*	

Maintenance activities
1. Repairing fences and de-bushing of the fields (Timing/ frequency: (May - July))
2. Gatering and spreading of mulch cover (Timing/ frequency: July - Dec)
3. Cutting sunhemp and applying as additional mulch (Timing/ frequency: Feb-Mar)
4. Re-digging the planting basins (Timing/ frequency: August)
5. Manure collection, Planting & fertilizer application (Timing/ frequency: September - December)
6. Sowing of main crops and sunnhemp and fertilizer application (Timing/ frequency: November - December)
7. Intercropping with legumes like groundnuts and cowpeas normally two weeks after germination of cereals. (Timing/ frequency: None)
8. Weeding (Timing/ frequency: None)
9. Harvesting (Timing/ frequency: April - May)

Maintenance inputs and costs

Specify input	Unit	Quantity	Costs per Unit (Nam $)	Total costs per input (Nam $)	% of costs borne by land users
Labour					
labour	ha	1.0	848.0	848.0	100.0
Plant material					
seeds	ha	1.0	22.0	22.0	100.0
Fertilizers and biocides					
fertilizer	ha	1.0	159.0	159.0	100.0
compost/manure	ha	1.0	276.0	276.0	100.0
Construction material					
Wire for fencing	ha	1.0	220.0	220.0	100.0
Total costs for maintenance of the Technology				**1'525.0**	
Total costs for maintenance of the Technology in USD				*98.39*	

NATURAL ENVIRONMENT

Average annual rainfall
- [ ] < 250 mm
- [ ] 251-500 mm
- [x] 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
- [x] semi-arid
- [ ] arid

Specifications on climate
Thermal climate class: subtropics

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

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

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

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

Soil texture (topsoil)
- [x] coarse/ light (sandy)
- [x] 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%)
- [x] medium (1-3%)
- [x] low (<1%)

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

Availability of surface water
- [ ] excess
- [ ] good

Water quality (untreated)
- [x] good drinking water

Is salinity a problem?
- [ ] Yes
- [ ] No

- [x] 5-50 m
- [ ] > 50 m

- [ ] medium
- [x] poor/ none

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

Water quality refers to:

Occurrence of flooding
- [ ] Yes
- [ ] No

Species diversity
- [ ] high
- [x] 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
- [x] 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
- [x] women
- [x] men

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

Area used per household
- [ ] < 0.5 ha
- [ ] 0.5-1 ha
- [ ] 1-2 ha
- [x] 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
- [x] state
- [ ] company
- [x] communal/ village
- [ ] group
- [ ] individual, not titled
- [ ] individual, titled

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

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

Access to services and infrastructure

health	poor	✓			good
education	poor	✓			good
technical assistance	poor	✓			good
employment (e.g. off-farm)	poor	✓			good
markets	poor	✓			good
energy	poor	✓			good
roads and transport	poor		✓		good
drinking water and sanitation	poor		✓		good
financial services	poor	✓			good

IMPACTS

Socio-economic impacts

Crop production	decreased							✓	increased	
expenses on agricultural inputs	increased		✓						decreased	not measured but assumed
farm income	decreased							✓	increased	
workload	increased			✓					decreased	not measured but assumed

Socio-cultural impacts

food security/ self-sufficiency	reduced				✓				improved	
health situation	worsened				✓				improved	
cultural opportunities (eg spiritual, aesthetic, others)	reduced				✓				improved	
recreational opportunities	reduced				✓				improved	
conflict mitigation	worsened			✓					improved	Envy and gossip were observed
situation of socially and economically disadvantaged groups (gender, age, status, ehtnicity etc.)	worsened				✓				improved	
contribution to human well-being										Improved and stabilized yields help rural families to adapt

decreased ✓ increased — to modern lifestyles. However, the long-term contribution of CA to the well-being of the local farmers cannot be foreseen. The establishment of family-owned fenced areas for crop production is likely to have an influence on the social structure of the rural communities.

Ecological impacts

evaporation — increased ✓ decreased — not measured but assumed

soil moisture — decreased ✓ increased — not measured but assumed

soil cover — reduced ✓ improved — not measured but assumed

nutrient cycling/ recharge — decreased ✓ increased — not measured but assumed

soil organic matter/ below ground C — decreased ✓ increased — not measured but assumed

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

Climate-related extremes (disasters)

drought — 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?

- Yes
- No

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

- Saves labour over time
- Can use less land compared to conventional system for the same harvest/yield

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

- A strength of the system is the timely land preparation
- The advantage of permanent planting stations results from the higher availability of nutrients to crop roots.
- The moisture retention within the rooting space is improved by the surface structure and the increase in soil organic matter
- The rotations of crop rotations is encouraged
- All inputs can be used precicely, there is less wastage of inputs

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

- The weed management is labour intensive and the impact of pests might be a future challange. The application of more mulch and the weeding regularly in the first part of the season is supposed to reduce weeds.

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

- To start with this technology is labour intensive at the beginning. In this moment, the hard pan caused by years of ploughing has to be loosened. Because the basins/riplines are permanently maintained in CA, the preceding land preparations become easier. Also since land preparation starts before on-set of rains, one can spread labour by starting just after harvesting crop

- There is a general problem of constructing fences around fields in communal lands, as state authorities declare this land as being owned by the state. By agreeing with the local leadership to allow those doing CA to fence off their fields for proper keeping of residues and basins/riplines that might be prone to free livestock grazing after crop harvests.

REFERENCES

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Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_1297/

Linked SLM data
n.a.

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- n.a.

Project
- Book project: Making sense of research for sustainable land management (GLUES)
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