FACT SHEET 2204-2216-0001

Department of Agricultural Research Services (DARS), Malawi, April 2022

Ministry of Agriculture

How to implement deep-bed farming technology in production of cereal and legume crops in Malawi

What is Deep-bed Farming?

Deep-bed farming is a new sustainable and profitable technology package that involves deep tillage to breakdown the soil's hard pan in the first year of cultivation. It follows contour lines with closed-end furrows to prevent soil erosion, building soil fertility and soil health, harvesting rain water, and improves infiltration of water into the root zone. The technology thereby improves root growth and development and resulting in the field with vigorous plants even in steep slopes and prolonged dry spell conditions.

The technology is climate smart as compared with conventional farming since there is construction of box ridges, use of manure, soil mulching, and regenerative agriculture. These provided solutions to loss of soil, low soil fertility, sub-soil hard pans, low yields and loss of soil biodiversity. It follows the principles and elements of Conservation Agriculture. It accommodates soil mulching so it regulates soil temperature and reduces soil water evapotranspiration. Vetiver grass is planted on contoured marker ridges and boarders to reduce water loses.

Deep bed farming has been regarded as one of the good crop husbandry practices developed and approved to be used by farmers in Malawi. It was developed by Tiyeni Organisation and validated by Department of Agricultural Research Services for its potential to be up-scaled in all farming communities national wide. The farmers in Mzimba, Rumphi, Nkhatabay, Dowa, Lilongwe, Mulanje and among others have adopted the technology basing on the fact that it is cost effective as compared to conventional farming.

Comparison of Deep-bed farming and Conventional Farming

Deep bed farming follows the principles of deep soil tillage and minimum soil disturbance in the subsequent five years. The Table and Figure 1 below compare the deep bed farming with conventional farming in figure 2. The comparison point are on applications, structural establishment, dimensions, pre-planting applications, planting crop management, environmental impacts

Table 1: Comparison of Deep bed farming with Conventional farming

Aspect	Deep bed farming	Conventional farm
Application	• Raised beds once in 5 years	• Flat or ridges every season
Structural establishment	• Deep ploughing to break the soil hard pan • Contour and bed alignments • Marking the field boundaries • Vetiver planting • Box ridges • Furrows	• Light or deep ploughing • Contour and ridge alignments • Box ridges
Dimensions	• 100 cm wide bed • 12.5 cm + 75cm + 12.5cm • 50cm furrow • 30cm depth	• Construct ridges 75cm apart • 30cm height
Pre-planting applications	• Land preparation • Apply compost or green manure	• Land preparation • Apply compost manure or green manure
Planting	• Two rows per bed 75cm apart leaving 12.5 cm on the edges of the bed • Plant one seed per station, 25 cm apart	• Plant on top of the ridge 75cm apart ridges • Plant one seed per station, 25 cm apart
Crop management	• Weed lightly • Apply fertilizer timely	• Remove the weeds as soon as they appear • Apply fertilizers timely
Environmental impacts	• Positive impacts • Soil organic matter build up • Soil erosion control	• Negative impacts –soil losses, compaction, organic matter losses, less water infiltration and soil erosion
Benefits	• Reduced drudgery in second and subsequent years	Labour intensive

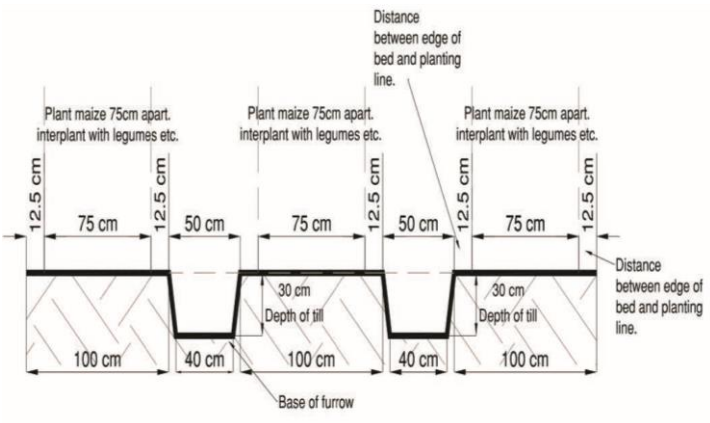

Figure 2 Dimensions for deep bed farming diagram

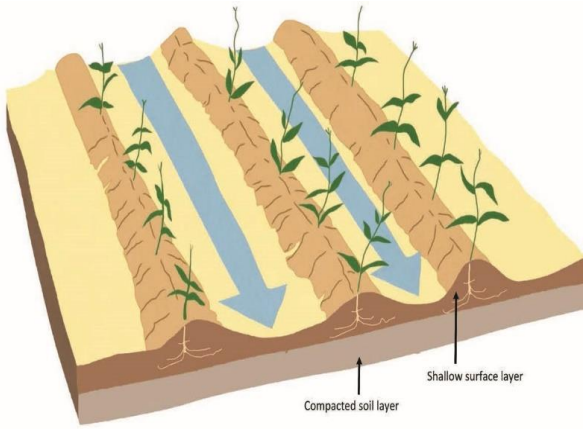

Figure 1, Conventional farming diagram

Key elements of Deep-bed Farming.

1. Breaking the soil hard pan ONLY IN FIRST YEAR – no tilling thereafter
2. Constructing contours lines aligned permanently exactly on other beds
3. Constructing boxed furrows, closed ends and raised footpaths
4. Making and applying organic cover and manure such as compost or Mbeya fertilizers
5. Burning of crop residues is prohibited
6. Intercropping and crop rotation with legumes/companion plants are done
7. Planting and using of Agroforestry trees and Green Manure Cover Crops is done
8. Stepping on the beds thereby preventing soil re-compaction is prohibited
9. Using crop residuals as a mulch or raw materials for compost manure

Figure 3 Practical part of deep bed farming

How to start Deep-bed Farming?

The farmers must follow the steps aligned below to successfully implement Deep bed farming technology. They are also encouraged to form and work in groups and get necessary training to implement the technology. The group should identify land to serve as own leaning point.

Table 2: Steps to follow when implementing deep bed farming

STEPS	ACTION	BENEFIT
1. Breaking the "Sub-soil's hard Pan"	Where land has been continuously cultivated for several seasons it leads to development of a hard pan. This must be broken by digging with pick-axes to a minimum depth of 30 cm. Farmers only dig once in the first year.	This improves water infiltration in the soil. It allows water to percolate into the subsoil. Plants develop deep root system that help to extract water and nutrients from the depths of the soils hence plants are able to cope water stress conditions.
2. Create marker ridges	Careful survey the land using line levels. Thereafter, create marker ridges on the contour lines at intervals down the slope.	Marker ridges help to align the deep beds along the contour lines. This promote water infiltration and minimises run-off hence reducing soil erosion
3. Reinforce the marker ridges	Plant Vetiver grass. This is a non-invasive deep-rooted grass, planted to stabilise the marker ridge.	Vetiver grass helps to stabilise the marker ridge. When trimmed, the forage can be used for mulching. Vetiver grass is widely available in Malawi.
4. Create the holding ditch	Dig a ditch 0.5 metres wide and 0.3 metres deep along the marker.	By holding the water in the ditches, it allows slow percolation of water into the subsoil where crop roots can extract from the reserved water over a period of time.
5. Making the deep beds and footpaths	Deep beds should be 1 metre wide and excavated along the marker ridges. Raised footpaths created and the furrows "boxed" at 3 m intervals. When carrying out field activities, walk on the paths and avoid stepping on the beds to reduce soil compaction.	This minimise soil compaction on bed. On the other hand, footpaths are raised so that they should not develop into water ways that can facilitate soil erosion.
6. Use of manure and mulching	Apply manure made from different methods. Mulch the beds with crop residuals from the previous cropping season or adjacent fields after manure application.	Manure build up organic content of the soil, reduces use of artificial fertiliser, lowers PH, builds soil organisms, and improves water holding capacity among others. Mulching improves soil health conditions and increase soil organic carbon.
7. Planting the beds with main and cover crops	The beds are wide enough for planting 2 rows of maize and inter cropping. Plant cover crops timely.	Inter-cropping brings crop diversity. Provide insurance to crop failure. It also helps in control pests and diseases. Cover crops add nutrients, regulates soil temperature, suppress weeds, reduces evaporation and protect the soil surface from rain drop impact and 'crusting' by sun.
8. Crop rotation and agro forestry	Farmers should practice crop rotation and plant agro-forestry tree-species such as *tephrosia*.	Control Pests and diseases, improves soil fertility, reduces weed seed bank.

Step 1: Break up the hard pan. Use a pickaxe to break the compacted layer underground. This will allow roots, water and air to penetrate deeply into the soil. Crops with deeper rooting system can extract water and nutrients from sub soil and help the crops to withstand periods of dry spells

Step 2: Create marker ridges. Careful survey the land to identify the points to mark using line levels. Thereafter, create marker ridges on the contour lines at intervals down the slope. The beds will follow the contour lines up to end of the field.

Step 3: Reinforce the marker ridges. Plant Vetiver grass or other non-invasive deep-rooted grass, planted to stabilise the marker ridge. The grass will act as a barrier to surface water run-offs on a steep slope.

Step 4: Create the holding ditch. Dig a ditch 0.5 metres wide and 0.3 metres deep along the marker.

Step 5: Create the deep beds: Deep beds are designed to maximize water retention and infiltration by preventing water runoff. Construct deed beds using line levels by creating market ridges exactly along the contour lines of the terrain, at intervals down the slope. Each ridge has a ditch running alongside it (the ridge is created with earth excavated from the ditch). The deep beds are one-meter-wide, enough for two rows of maize or three rows of legume crops. Between two beds a ditch is also dug, 30 cm deep and the distance between two deep beds is 50 cm apart. The ditch consists of closed ends and boxed at 3 or 4 metre intervals, which become a holding reservoir for water after heavy rains and allows slow water percolation into the subsoil.

Step 6: Use of manure and mulching. Apply manure made from different methods. Manure build up organic content of the soil, reduces use of artificial fertiliser, lowers PH, builds soil organisms, and improves water holding capacity among others. Mulching is important in deep beds after manure application to act as a barriers to water surface run-off and decomposed material also increase soil organic carbon.

Step 7: Planting: Planting the beds with main and cover crops by a range of crops including maize, legumes, pumpkins and other local crops. For maize, create two rows on top of the deep bed 75 cm apart, leaving 12.5 cm on both sides of the deep bed. Under rain fed conditions, planting is done after first rains, when the soils are sufficiently wetted to a depth of 15cm. This is mainly between October and December.

For planting maize, plant one seed in rows/ridges per stations spaced at 25cm apart. During the second and subsequent seasons, leave the standing stalks and plant maize between the stalks. The roots of such stalks once decomposed contribute to organic matter build up.

For legumes such as cowpeas, soybeans and common beans in sole cropping the same planting spaces are encouraged except in double row planting.

Intercropping maize and legumes is recommended under deep bed farming. Grain legumes such as common beans, cowpeas, pigeon pea are planted between maize rows. Plant legumes on twin rows spaced 25 cm away from each maize row. Intercropping maize with legumes has several benefits including soil erosion control, soil fertility enhancement, weed control, disease and pest control among others.

Field management practices

Weeding: As the plants grow, weeds are cut or pulled up and laid on the surface as mulch, alongside crop residues and other agroforestry residues (if any). The residues help to protect the soil from the direct impacts of raindrops, help reduce the soil temperatures and contribute to organic matter build up in the long term. Do light weeding as the weeds appear while standing in the furrow without trotting on the deep beds to prevent compaction. This keeps the crop in the field free from competing with weeds for sunlight and other soil nutrients. It also assists in prevention of some pests. Weeding can be done manually or using herbicides.

Fertilizer application: Apply compost or manure before planting at the recommended rate of 4 tons per hectare. Make high quality compost using livestock droppings/faecal matter as raw material. Apply chemical fertilizer at the recommended rate of 92 kg N ha-1 that is supplied as 100 kg N:P:K ha-1 (23:10:5+6S+1Zn) at planting and 150 kg urea ha-1 (46% N) approximately three weeks after planting. For legumes under intercrops with maize, legumes will benefit from the fertilizer applied to maize. For soybean, use 50 g of inoculant on 10-15 kg soybean seed at planting. Six sachets of inoculant amounting to 200 g are enough to cover one hectare for large seeded soybean.

Pest and diseases: Managed pests and diseases using field hygiene, physical, biological and chemical control methods. The main pests are Fall armyworm, Stalk borers, leaf rollers, grasshoppers, aphids, mites, maggots, white grubs, nematodes, and among others. The main diseases are caused by viruses, bacteria and fungus. Use tolerant varieties to pest and diseases to minimize the crop losses when implementing deep bed farming.

Figure 4, Bumper harvest due to deep bed farming *Photo @ Tiyeni Manual*

It is recommended to harvest the crops when they completely dry up. Maize can be stoked for some time to ensure that it has dried. Further drying is done at home after primary processing such as shelling, threshing and winnowing,

Storage maize and other grain crops in bags after treating with storage pesticides such as Actellic upon recommendations on safe use and correct application rates.

Used Resources

Dixon A., Mukumbwa E., Kumwenda G., and Chavula I. (2017). The Tiyeni Deep-Bed Farming System: A Field Manual. Tiyeni Organisation. Mzuzu. Malawi.

Gondwe F.M., (2020). Profitability of deep bed farming: A focus group survey.

Simwaka P., Ngwira A., Chavula I., Siyeni D., and Makoko K. (2021). A proposal to release deep bed farming system for farmers use in Malawi. Department of agricultural Research Services, Lilongwe. Malawi.

Tiyeni Organisation. Mzuzu. Malawi. Tiyeni Organisation (2020). The steps of deep bed farming: From barren to fertile from hunger to food security. Web link: https://www.tiyeni.org/static/0d9adffa914e4a22350d10348458bee2/10_steps_of_dbf.pdf

Note: Credits to all photographs and figures are for Tiyeni Organisation

Authors

[1]Benjamin Chisama, [1]Pacsu Simwaka, [1]Amos Ngwira, *PhD*, [1]Donwell Kayira, *PhD,* [1]Hector Malaidza and [2]Isaac Chavula

Department of Agricultural Research Services

P.O. Box 30779,

Lilongwe 3. Malawi.

Email: benchisama@gmail.com | pacsusimwaka@yahoo.com

Tiyeni Organization

P.O. Box 429

Mzuzu

Malawi

Email: isaacchavulamonjo@yahoo.com

Acknowledgements

Tiyeni *Promoting sustainable farming in Malawi*

IFAD INTERNATIONAL FUND FOR AGRICULTURAL DEVELOPMENT