Contour farming with fodder crops for land rehabilitation

Fanya juu (bank above ditch) contour planted with *Gliricidia sepium* in Mlali village, Kongwa district, Tanzania (Photo credits Jonathan Othong, 2014)

Authors: Anthony Kimaro (CIFOR-ICRAF), Elirehema Swai (TARI-HQ), and Mawazo Shitindi (SUA)

Description of the technology

Contour farming with fodder crops is a variant of contour farming with the planting of fodder crops on the contour ridges. It involves laying out a contour line along points of equal elevation across a sloping field and then constructing a bund or barrier along the contour. The technology's aim is to reduce runoff, soil erosion and nutrient loss, and and increase water filtration. Vegetation, especially fodder crops (grass or leguminous tree/shrubs) ,has been used to stabilize the bunds and to produce additional products (fodder and fuelwood), reduce land and improve the livelihoods of farmers in semiarid areas. Contours are generally constructed manually, with soil either being thrown upslope to form *Fanya juu* contours (banks above ditches) or downslope to form *Fanya chini* contours (banks below ditches). The *Fanya chini* contour is constructed along the upper field edge to capture water entering the field, while *Fanya juu* contours are laid in the field to capture runoff within the field. The banks and ditches intercept and slow runoff water, thereby conserving water and increasing infiltration to make more water available for crop production, and reducing soil erosion. Food crops are grown in the areas between contours to benefit from improved land productivity associated with soil and water conservation effects of this technology.

While the technology reduces the land area available for planting maize by about 10%, it does provide a potential additional income source from sales of fodder (or livestock products). It also helps to improve soil fertility. In addition, after the first few years, the yields of maize should improve sufficiently to balance out the loss of land area. This technology contributes to climate change mitigation through carbon sequestration into tree/plant biomass.

Key messages

Land rehabilitation: Soil loss reduced by 94% and runoff by 78% under semiarid conditions. Soil nitrogen (75%), phosphorus (81%), and organic carbon (28%), improved significantly after six years of contour farming.

Food Security: Maize grain and calories yields increased by 120% in contour protected fields compared to unprotected fields.

Fodder supply: Contour-stabilizing crops produced 13.5t/ha/year of foliage with a value of 392.81 USD/ha/year based on the farm gate price for fodder.

Fuelwood supply: Fuelwood produced on contour ridges after four years (3.45t/ha) is sufficient to meet the cooking energy demand of a 6-member family for 2 years, reducing labour and time women spend on firewood collection by 50%.

Economic benefits: Diversified income sources from maize yield, wood fuel, and fodder increased gross margin of contour farming with fodder crops by 431%

Conditions that favour uptake

Topography: Contour farming with fodder crops can be practiced in a wide range of topography. The technology is recommended for soil erosion control on gentle sloping areas with a maximum slope of 5%-7%. Also, integration of soil and water conservation (contours) with fodder production on the ridges makes this technology appropriate in soil erosion-prone and livestock keeping areas with inadequate rainfall.

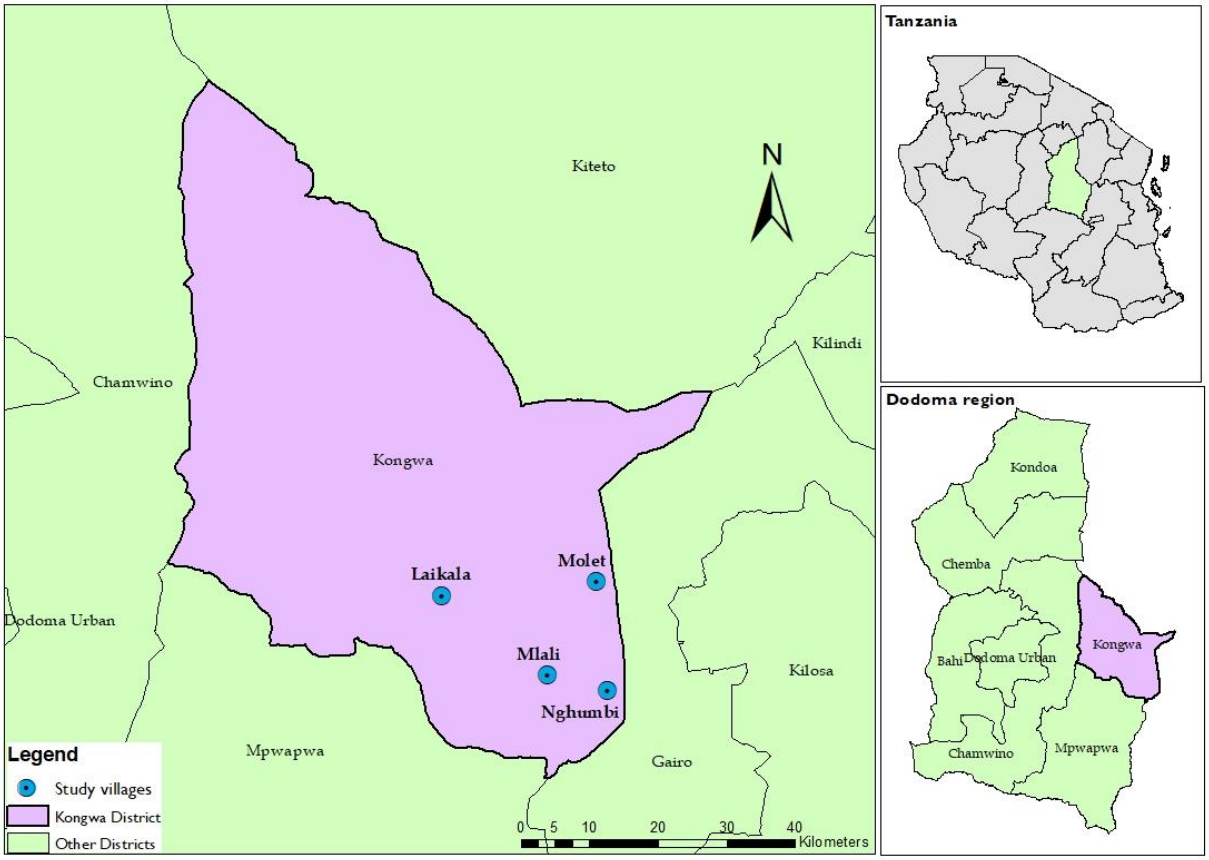
Access to inputs and market: Readily availability of quality tree seeds and seedlings of appropriate tree species determines the uptake of this technology. The use of farmer- and community-based tree nurseries has been effective in supplying quality tree seedlings since the tree germplasm in most rural areas is not well established. Also, access to local and external markets and market information on diverse products (crop produce, fodder, fuelwood) helps farmers to maximize their income from sales of surplus produce, making this technology attractive and beneficial to farmers.

Collective action: The best results are achieved when farmers in a landscape practice contour with fodder crops. The collective action approach used in the Africa RISING program in Ethiopia and Tanzania has proven successful in scaling landscape-based technology like contour farming with fodder crops. The approach also effectively mitigates resource use conflicts between upstream and downstream farmers, which may arise in case of water overflow from ditches due to heavy rains or poor maintenance of ridges and ditches.

Livestock presence: Inadequate supply and poor quality fodder during off-season largely affect livestock productivity in semiarid areas. Thus, the integration of livestock (poultry keeping, zero grazing, and supplemental feeding practices) adds value to fodder produced on ridges and can favor the adoption of this technology as it mitigates the challenges of off-season feeds availability and quality. Also, our experience suggests that early adaptors who do not own livestock earn about 32 USD per month from local sales and/or exchange of fodder with manure. These economic benefits may favor interest in adopting the technology.

Where was the technology validated

The contour with fodder crops was validated through farmer-led trials conducted in four villages (Mlali, Molet, Laikala and Nghumbi) in Kongwa district. 96 farmers (40% Female) tested this technology in their fields. Each farmer committed at least 0.4ha (one acre) and established 2-3 contours depending on the slope of the area and availability of land and labour. Africa RISING researchers trained two lead farmers to guide the construction of contours and planting of fodder crops (Elephant grass and *G. sepium*) on the ridges. Seedlings of *G. sepium* were produced in the village by community tree nursery groups. After six years the technology spread to over 6,040 farmers and institutions in six districts of Dodoma and in other regions (Arusha and Singida) through the collaboration with scaling partners and projects implemented by partners such as LEAD Foundation, Sustainable Agriculture Tanzania (SAT), and the ICRISAT led Biovision project.



Alignment with household resource endowments

Contour farming with fodder crops can be implemented at any level of resource endowment. The technology requires large land size (at least 0.4ha) which is available in semiarid areas where land degradation is highly and land size ranges from 4-20ha. In high potential and steep areas that are prone to erosion the technology can be implemented in smaller farm plots as it is completed with bench terraces to better results. Families with limited labour to construct contours have benefited from the group and collective action approaches implemented by Africa RISING. Also income generated by this technology can be re-invested to maintain and expand the contours even in households with the scarcity of labour. This approach has been used by one of the Africa RISING Champion farmers who manages the mother site demonstration site for this technology that belongs to his senior farther. Our experience also shows that household owning livestock recycle manure from livestock to complement land soil and water conservation effects on crops productivity. The exchange of fodder with manure that has been practiced at Mlali Village also make it possible for farmers who do not own livestock to access manure for improving soil fertility.

Necessary ingredients for implementation

Appropriate variety: Locally adapted and browse-resistant fodder crop species are recommended to maximize the benefits of this technology. *G. sepium* is the fodder crops that meet this condition while providing fuelwood as a bonus product. Locally adapted grass fodder like Elephant grass (*Pennisetum purpureum*) is preferred due to dual purpose for livestock feed and bank stabilization.

Training: For the best results, farmers or service providers (including champion farmers) should be trained on the use of levelling devices to make contour lines, construction of contours, and production and planting of quality tree seedlings. Training farmers on the use of fodder crops as livestock feeds (e.g., feeds formulation using locally available materials) is also necessary to support livestock integration to form a bundle of SI technology with multiple benefits to farmers and the environment. Tree management is a knowledge-intensive practice requiring appropriate training for farmers to effectively manage trees (e.g., pruning & thinning) to maximize positive benefits (e.g., reduced soil erosion) and minimize the negative ones (e.g., competition).

Soil amendments: In semiarid areas, contours are often established on impoverished soils, which are prone to soil erosion and require initial nutrient inputs to kickstart crops production while building integrated soil fertility management options to sustain soil fertility require nutrient inputs to sustain crop production. There is little advantage to using foliage biomass from fodder trees/shrubs planted on the ridges because trees on the contour are too few to produce a sufficient amount of green manure for this purpose. However, fodder crops (grass and leguminous trees/shrub) can be fed to livestock, and manure recycled back to the field to replenish soil nutrients. Farmers who do not own livestock have also exchanged fodder with manure to improve soil fertility.

Adaptation possibilities

Other contour-stabilizing crops: Fodder crops used for validating this technology were selected to reflect semiarid conditions in the test site. Other fodder crops, such as Napier grass (*Pennisetum purpureum* Schumach.), can be used for stabilizing ridges in humid highlands areas. Farmers have also used food crops like sweet potatoes to reinforce the ridges. However, this would require annual maintenance of ridges because of possible damage that can happen when harvesting sweet potatoes.

Agro-inputs: This technology is promoted to rehabilitate highly degraded soils which are prone to soil erosion. It is therefore recommended to add fertilizer (inorganic and organic) to complement soil and water conservation effects on crop production under this technology. Our analysis found that soils in Dodoma, where this technology was validated, are deficient in phosphorus, and this was also reflected in fodder crops and manure. Farmers have used livestock manure, but this practice will require P inputs to mitigate the deficiency of this element in the soil. Specific guidelines on the types and rates of inputs to be used will depend on the test crops and can be obtained from extension officers and national fertilizer recommendations.

Benefits to users

Land rehabilitation: Contour farming with fodder crops reduces soil loss by 94% and runoff by 78% under semiarid conditions. Also, soil fertility, especially nitrogen (75%), phosphorus (81%), and organic carbon (28%), improved significantly after six years of contour farming, even on depleted soils in Kongwa, Tanzania, where this technology was validated (Table 1). Recycling of livestock manure exchanged from fodder, and the reduction of soil loss largely account for improved soil fertility under this technology.

Table 1: Improved soil fertility, crop and biomass (wood) yields under contour farming with fodder crops at Mlali Village, Kongwa District, Tanzania

Parameter	No Contour	Contour	Change (%)
Soil pH (water)	4.39	5.40	23
Total nitrogen (%)	0.04	0.07	75
Phosphorus (mg/kg soil)	13.1	24.5	81
Organic carbon (%)	0.53	0.68	28
Maize grain yield (t/ha)	3.11	6.82	120
Biomass yield (t/ha)	9.44	32.9	249
Gross margin (USD/ha)	649	3,445	431
Calories (kcal/ha)	11,243	24,701	120

Food and Nutrition Security: Yields of food and fodder crops also increased with improved land productivity. Farmers practicing this technology can potentially increase their maize and calorie yields by 120%, in addition, to producing biomass (fuelwood and fodder) from the ridges (Table 1). These additional crops provided a safety net for farmers during years of adverse weather when food crop productivity may fall.

Livestock productivity: Contour-stabilizing crops (Grass and leguminous trees/shrubs) integrated with this technology provide good quality fodder for livestock and can improve the productivity of livestock, including poultry (no specific data from this study). These crops produced 13.5t/ha/year of foliage biomass, which was used to feed livestock by farmers. Farmers who do not own livestock sold or exchanged fodder with manure for applying in their fields to improve soil fertility. Our 3-year analysis (2018-2020) estimates the value of fodder sold and exchanged at 392.81 USD/ha/year (32.73 USD/ha/month). This steady income was critical in improving access to food, especially during the lean period as the grass fodder was harvested throughout the year except September, October and November when the supply was very low due to drought. The fodder-based income was also used for meeting other immediate family needs, contributing to improving the adaptive capacity of farmers.

Climate Resilience: Diversified income sources from maize yield, wood fuel, and fodder increased the economic benefits of contour ridges with fodder crops by 421% (Table 1). Also, crop diversification under this technology provided farmers with resilience and risk mitigation benefits, especially during adverse growing conditions caused by weather extremes. Fodder and tree-based incomes offset the loss from poor maize yield in seasons with severe drought, like the 2019 cropping season in Kongwa, Tanzania.

Fuelwood supply: Fuelwood produced on the ridges after four years (3.45t/ha) was sufficient to meet the cooking energy demand of a 6-member family for 2 years (6 months annually) based on the estimate of 5 kg per family per day when using a traditional three-stone stoves. While being labor demanding at the establishment phase, this analysis demonstrate that technology can reduce labor and time women spend in collecting fuelwood by 50%. Pruning trees to harvest fuelwood is done during site preparations or at planting, and thus labor and time released are directly re-invested into farming operations at a time when it is needed most. The technology therefore contribute to reducing drudgery to women who are the main source of labour for fuelwood collection and farming operations.

Things to worry about

Resource use conflicts: There are potential conflicts with downstream farmers in case of water overflow from ditches due to heavy rains or poor maintenance of ridges and ditches. Promoting a landscape approach and participatory conflict resolutions can help to mitigate this challenge and rehabilitate a wide area as opposed to the fields of few farmers.

High initial cost and labor: The initial costs of purchasing quality tree seedlings and high labor demand for the initial construction of contour can deter farmers from adopting this technology. However, multiple economic benefits from different crops integrated with this technology offset the initial investment costs, making the technical beneficial to farmers 3-4 years. Building the capacity of farmers to produce high-quality tree seedlings, as it was done for Africa RISING, can reduce input costs and improve access to quality tree seedlings by majority of farmers.

Long-term nature of the technology: Tree planting and contour structures have some degree of permanence. Farmers are adopting need to have long-term access to and tenure of the land to realize the benefits of this technology.

Initial reduction of crop yields: Yields of food crops may also decrease initially due to an approximately 10% reduction in land area available for these crops. After 3-4 years, maize and other produce yields improve sufficiently to offset the loss of land area.