Extension manual for agroforestry technologies in semi-arid Tanzania

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The Africa Research In Sustainable Intensification for the Next Generation (Africa RISING) program comprises three research-in-development projects supported by the United States Agency for International Development (USAID) as part of the U.S. Government's Feed the Future initiative.

Through action research and development partnerships, Africa RISING is creating opportunities for smallholder farm households to move out of hunger and poverty through sustainably intensified farming systems that improve food, nutrition, and income security, particularly for women and children, and conserve or enhance the natural resource base.

The three regional projects are led by the International Institute of Tropical Agriculture (in West Africa and East and Southern Africa) and the International Livestock Research Institute (in the Ethiopian Highlands). The International Food Policy Research Institute leads the program's monitoring, evaluation and impact assessment.

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Chapter 1: The concept of tree/shrub intercropping

Intercropping cereals with leguminous crops or tree/shrub species is a common practice under smallholder farming systems in East and Southern Africa (ESA). Typically, cereals constitute the main crop in the system while legumes are integrated as a companion crop. Farmers often select grain legume crops for food supply and income (e.g., Pigeonpea, cowpea or groundnuts), but leguminous tree/shrub (*Gliricidia sepium* and *Acacia angustissima*) are used mainly for improving soil fertility and fuelwood and fodder supply. Leguminous trees/shrub species provide other ecological benefits like soil cover crops (*Canavalia* spp.), and as a key input to organic farming through Integrated Pest Management (IPM) and compost making (*Tephrosia vogelii*, *Tithonia diversifolia*). Nitrogen fixing tree/shrub intercropped for soil fertility improvement are generally called *fertilizer trees*. A number of fertilizer trees have been evaluated and promoted in East and Southern Africa, including Tanzania. These include *Gliricidia sepium*, *Cajanua cajan*, *Calliandra calothyrsus, Tephrosia vogelii*, *Sesbania sesban*, *Leucaena* spp., and *Tithonia diversifolia* and *Acacia angustissima*. Indigenous fertilizer tree species tested and promoted in the region include *Acacia polyacantha*; Albizia spp., and *Fadherbia albida*.

Tree/shrub-based intercropping is an agroforestry technology whereby fast growing nitrogen-fixing woody trees are simultaneously grown with annual crops on the same piece of land. This is usually done to improve soil fertility, crop yields and fuelwood supply. The technology also contributes to climate change adaption and mitigation mainly through improved soil health and use efficiency of growth. While the trees are on the land throughout the year, the crops planted at the beginning of the rainy season dominate during the growing season. In Tanzania, tree/shrub intercropping were promoted in Tabora and Shinyanga regions and in Gairo, Morogoro by ICRAF, SUA and National partners. The scaling of this technology to degraded and drought prone in semiarid areas in central Tanzania is still limited. This is largely due to extensive grazing and limited awareness of the impacts of tree/shrub intercropping in this agroecological zone.

Chapter 2: Gliricidia sepium Intercropping

Introduction

Intercropping *Gliricidia sepium* (Gliricidia) with cereals can be simultaneous where both tree and crop components are planted at the same time on the same piece of land or temporal intercropping in which gliricidia and cereal crops are planted at different time on the same piece of land as in crop rotation. The latter is called improved fallow and it is practiced in areas where land is not limiting, and it has the benefit for eliminating direct interspecific competition between crop components. Gliricidia leaves are high quality green manure that decompose fast and release over 80% of nutrients within 4 weeks. Besides organic matter build up, the nutrients supply benefit of applying gliricidia green manure to the companion crop is occurs during this leaves decomposition period and little or no benefit is expected in beyond one cropping season. In this context, intercropping of gliricidia and cereals more preferred than sequential intercropping so as to provide the green manure annually.

Ecology and propagation of *Gliricidia sepium*

Gliricidia is a small to medium sized leguminous tree attaining heights of 2 to 15 meters. It may be either a single or multiple stem tree with trunk diameters reaching 30 cm. The native range of gliricidia is the dry and sub-humid lowlands tropical forests of the Pacific coasts of Mexico and Central America. The is widely planted in the Caribbeans, Philippines, Africa, Southeast Asia and Australia at elevation, temperature and mean rainfall ranging from 0-1200 m a.s.l, 14 – 36 ° C, and 600 – 1,500 mm/year, respectively. It survives the dry season 3 to 8 months; a typical length range found in most semiarid areas. Gliricidia occurs in a wide range of deep, medium-textured, well drained fertile soils with pH 4.5-6.2. It is also adapted to calcareous and infertile soils but is intolerant to high Aluminium (Al) saturations and, waterlogging and frosts.

Gliricidia has naturalized in Tanzania for many years. The Ministry of Agriculture maintains the field genebank of gliricidia at the research farm of the Tanzania Agricultural Research Institute (TARI) Tumbi Centre (TARI-Tumbi). The genebank is one of the main sources for gliricidia seeds, including those used in the Africa RISING program since 2014. The tree/shrub is easily propagated by cutting or seed. Seeds are either germinated and seedlings cared in the nursery prior to out planting or sown directly in the field. Germination is generally high (90%) without any pre-treatment but clipping and soaking the seeds overnight in water will cause them to swell and hasten germination. For direct seeding, it is recommended to plant 2 to 3 seeds per planting position at a depth of 1 to 2 cm. Cuttings are recommended in sub-humid and humid areas while seedlings are the main planting material in semiarid areas. Vegetative propagation using cuttings is recommended in humid areas where soil moisture is adequate. The cuttings quickly and easily root and grow into new trees. However, trees established from cutting will have a shallow root system and may be susceptible to uprooting by strong winds.

Readily availability of quality tree seeds and seedlings of appropriate tree species determines the scaling of agroforestry technologies throughout ESA. Unlike cereal crops, the supply system of tree germplasm in most rural areas is not well established. Thus, the use of farmer- and community-based tree nurseries has been effective in supplying quality tree seedlings for research and farmers under the Africa RISING program (Fig. 1). The following guidelines can be used by farmers interested in producing tree seedlings, including gliricidia, in the nursery:

- ***Site selection***: The nursery site should: be accessible year-round, have space to accommodate the number of seedlings to be produced and allow for possible expansion of the nursery, have a reliable water supply for irrigation, and have a well structure soils with good drainage and little or no risk of water logging.

Figure 1: Women farmers from Sustainable Agriculture Tanzania (SAT) Visiting Moshi's Nursery at Mlali village during a training session conducted by ICRAF in February 2021 (a) and Loti Malekela displaying Gliricidia seedlings produced by his group at Ngumbi village, Kongwa District. Both Farmers were trained under Africa RISING and they now supply tree seedlings for several projects, including projects led by SAT and LEAD Foundation. Photo credits: Anthony Kimaro/CIFOR-ICRAF.

- ***Seed source:*** High quality seeds are obtained from national tree seed centres. Farmers may also be trained to collect tree seeds, especially indigenous tree seeds, from mother tree with superior qualities.

- ***Potting mixture and pot filling:*** Potting mix substrate used to grow plants in containers. Farmers in the Africa RISING program were trained to make the potting mixture using locally available materials (top forest soil, sand, manure/compost) in a ratio of 3:1:1. The mixture is moistened before potting and then pressed into polythene tubes to a depth of about three-quarters of the height of tubes. Polythene tubes are topped up more loosely with mixture and pressed down lightly to about 2 cm below the top. Water lightly the filled tube before sowing seeds.

Polythene tubes that are 4 inches in diameter and 10 cm deep can be used for sowing gliricidia seeds in a nursery. Sow about 2 to 3 seeds per pot at a depth of 1 to 2 cm.

- ***Seeds pre-treatment and sowing:*** Seed pre-treatment is necessary to overcome seed dormancy and enhance seed germination. The pre-treatment is mainly done through hot warm water soaking in hot, seed scarification, clipping. Gliricidia seed is can be sown without pre-treatment. But clipping and soaking the seeds overnight in water will cause them to swell and hasten germination. Each type of seed has a specific pre-sowing process that will overcome dormancy, and allow germination to take place. Thus farmers are advised to consult forest extension officers for guidance on the appropriate seed pre-treatment method for the tree species of their interest. Gliricidia seeds are either germinated in the seed bed or sown directly in the field. After germination, the seedlings are pricked out carefully, transplanted into pots and cared in the nursery prior to out planting.

- ***Nursery cultural practices*** (watering, root pruning and drought hardening): Nursery cultural practices are tending operations implemented in the nursery to produce high seedlings in terms of size, health, and growth rate. The practices include irrigation, weeding, root pruning and disease management.
    - *Watering:* Watering using clean water is essential for seedling growth in the nursery. The amount of water needed depends on many factors, including seedling age, amount of sunlight, and soil type. Thus, watering should be done to keep the seedbeds or pots moist and should not be done at regular/ a fixed time each time. Avoid excessive watering as this may cause moss and algae growth and diseases. About one month before the date of planting, the amount of water and frequency of watering in the nursery are reduced to prepare tree seedlings for harsh condition when planted in the field. This process is called drought hardening.
    - *Weeding:* Weed control is necessary to minimize seedling competition for light, water, and nutrients with weeds. For individual/small nurseries this can be done by uprooting weeds in the seedbed or pots by hand. Mulching materials (rice husks and sawdust) can also be spread on the nursery bed to control weeds.
    - *Root pruning:* Root pruning is the process of severing the roots of tree seedlings penetrating into the soil. It helps tree seedlings to develop a well-established root system for improved growth in the nursery and survival at planting out in the field.
    - *Disease management:* Nursery hygiene and avoiding too much shade and over watering are the main cultural practices to control most of diseases of tree seedlings in the nursery. Damping off is a condition young seedlings rot at the root collar, die and fall over. It is caused by parasitic fungi and associated with over watering. Keeping the nursery area clean, using the appropriate seed sowing depth, and reducing irrigation and shade levels can control the diseases. If necessary, fumigants and fungicides are available to control disease development.

- ***Grading, handling, and transportation:*** tree seedlings/Field planting: Gliricidia seedlings are ready for planting after 2-3 months in the nursery. Grading involves selecting for healthy quality seedlings with a minimum height of 30 cm for transplanting. Tree seedlings should be handled well during transportation to the fields to minimize damage and stress at planting out. Lifting trees seedling from the nursery bed by holding the pot instead of holding the seedling will reduce the risk of damaging the root system. Packing the seedlings in a sturdy container during transportation is recommended. Protect the seedlings against windy damage during transportation by a vehicle.

- ***Record keeping:*** Keeping records of various nursery operations (date of sowing, tree species, number of seedlings, visitors, etc) is necessary for nursery management and planning. Farmers are trained on record keeping and/or provided the customized logbook to organize and guide with recording keeping.

Description of the technology

Gliricidia intercropping is an agroforestry technology involving the planting of maize between rows of gliricidia. The technology is established mainly for improving soil fertility and soil organic matter through biological nitrogen fixation, application of green manure obtained from pruning stems during the cropping seasons and litter falls during the off-season. The benefits of the technology in improving restoring degraded farmlands and climate resilience has also been reported. Fuelwood is produced from stems which are pruned during site preparation to reduce competition for light and growing space. Usually 3-4 rows of cereal crops (Maize or Sorghum) planted between two rows of gliricidia trees, depending on the planting spacing of both maize and the tree/shrub species. gliricidia - cereal intercropping has been promoted widely in East and Southern Africa. In Tanzania, gliricidia has been integrated in the agricultural landscapes under other agroforestry technologies such as fodder bank, woodlots, improved fallow, Climate Smart Agriculture (CSA) practice. The spices also has various application in organic farming, especially as a component in compost making. The selection of gliricidia as the main component of tree-based intercropping in Kongwa and Kiteto districts under the Africa RISING was based on the fact that the species adapted to the semi-arid conditions and tolerate grazing pressure from free grazing because fresh leaves produce a deterring smell. As a result, it provides extended ground cover to reduce wind erosion and produce large amount of litter to improves soil nutrients and organic matter.

Intercropping gliricidia with cereals (maize or Sorghum) and/or pigeonpea (Fig. 2) is a major agroforestry technology introduced in Africa RISING sites in Tanzania, Mali and Zambia. Gliricidia was introduced as component in integrated soil fertility management practices for intensifying maize mixed cropping systems by improving soil fertility and crop and fuelwood yields and climate resilience in Tanzania and as component of soil and water conservation for land rehabilitation in Tanzania and Mali. In Malawi and Zambia, the tree/shrub specie was used as a component of the conservation agriculture (CA) and for livestock feeds.

Benefits of the technology

Intercropping gliricidia with cereals and/or pigeonpea to take the advantage of differential growth rate and root utilization zone (niche separation) for these crop components to produce multiple benefits. Pigeonpea has slow initial growth rates compared to cereals and this gives advantage for annual crops to reach maximum growth rate while pigeonpea is at the vegetative growth stage. Deep roots of gliricidia and pruning regime employed allows the tree/shrub species minimize competition with both cereal crop and pigeonpea during the cropping seasons. As a result, Gliricidia intercropping has recorded the following main benefits:

- ***Improved soil fertility:*** The soil improvement capacity of Gliricidia is mainly due to its high nitrogen fixing capacity, growth rates and litter quality. Under good conditions, the tree/shrub species fix an average of 166 kg N ha-1 over a period of nine months, which is sufficient for cereal crop production in many tropical soils. Gliricidia intercropping also recycle other soil nutrients and build organic matter on the topsoil via litter fall and decomposition. Under semiarid conditions, gliricidia trees/shrub produce high amounts of leafy biomass (4–5 t /ha) to supply soil nutrients required to sustain cereal/maize production for 3 consecutive growing seasons. Also, addition of green manure from tree pruning improved organic matter and increase availability of soil P in the soil by releasing organic acids during decomposition. It is generally accepted that tree legume intercropping may offset N fertilizer input by 50% as a results of improved soil fertility. Unlike atmospheric nitrogen which is added to the soil, the improvement of other soil nutrients by gliricidia intercropping is limited to the reserve in the soil. It therefore advised to characterize initial soil nutrient levels prior to understand the potential of this technology in improving soil fertility and adopt integrated approaches to supply a wide range of soil nutrients required to sustain crops production.

Figure 2: Maize-pigeonpea and maize-gliricidia intercropping at Molet Village(a), Sorghum-gliricidia intercropping at Mlali (b) and Ekilia Mjoweni, Africa RISING Champion Farmer, discussing on the fuelwood benefits of Maize-Gliricidia at her mother site plot at Laikala Village, Kongwa district, Dodoma, Tanzania. Photo credits: Anthony Kimaro/CIFOR-ICRAF.

- ***Increased crops yield:*** In research trials, Gliricidia intercropping increase maize yield up to three-fold over maize monoculture without any soil amendments. Crop yield benefits under farmer's field vary widely depending on crop management practices adopted. However, maize yield (1.2-3.2 t/ha) obtained in farmer managed Gliricidia plots is still higher than the yield (1.5 t/ha) obtained in continuous maize cultivation with little or no fertility inputs, a common practice in most smallholder maize-mixed farming systems in East and Southern Africa. The intercropping advantages of gliricidia intercropping is however, not limited to maize yield alone. On-farm fuelwood is another immediate benefit of to farmers, especially in areas with high arid and semiarid areas with high scarcity of woodfuel for cooking energy.
- ***Fuelwood supply:*** Fuelwood from gliricidia intercropping is a critical source of cooking energy for farmers in arid and semiarid areas where crop residues are used to mitigate the scarcity fuelwood. The wood is produced by multi-stems of gliricidia which are left to grow during the offseason (Fig. 2). Integrating gliricidia intercropping and efficient cook stove technologies improves household fuelwood consumption efficiency and reduce both frequency and time of fuelwood collection by 20%, saving both native forests and women productive time.
- ***Climate change adaptation and mitigation:*** Soil carbon is a critical soil health variable for climate change adaptation and mitigation in highly degraded soils. Application of green manure, not only improve organic matter, but also enhances soil nutrient and water retention capacities, contributing to higher resilience of cropping systems to drought. Trees/shrub legume intercropping also improve stable fractions (forms) of soil organic carbon, contributing to soil carbon sequestration. Fuelwood produced in gliricidia intercropping offset significant amount of carbon dioxide gas that would be released from burning fuelwood from native forests.

How to implement the technology

The main step to establish a gliricidia intercropping farm plot are provided below based on the interventions conducted under the Africa RIISNG program in Kongwa and Kiteto districts.

- A source of tree seeds or tree seedling is the first things to consider when planning to adopt any agroforestry technology. Unlike crops, there is no local agro-dealers who may supply tree seeds. However, in Malawi farmers collect and sale seeds of Tephrosia due to high demand for this species planted in one-year fallow arrangements to improve soil fertility and supply fuelwood. Gliricidia tree seedlings can either be produced in a nursery or purchased at a local price of 500 per seedling in Africa RISING villages in Kongwa district.
- Site is preparation should follow the normal practice for farmers in the target areas (Fig. 3). Then gliricidia seedlings are planted in a 60-cm diameter x 60-cm deep pit. Mulch of dry leave or livestock manure can be added to the put to improve initial soil nutrients and conserve moisture for newly planted seedlings. No irrigation is required, but seedlings leave can be pricked to reduce physiological stress and evapotranspiration before roots establishment.
- The recommended spacing for intercropping is 3m x 2m to provide space for site preparation (Fig. 3) and intercropping cereal and/or pigeonpea crops. Plant spacing of cereals (Maize or Sorghum) follows local recommendations by extension officers, but it is mostly 90-cmx60-cm or 75-cmx60-cm, leaving two plants per hole depending on the location. When pigeonpea is added in the mixture, it is planted between rows of maize or sorghum at the same planting spacing for cereals.
- The survival of gliricidia seedlings in semiarid areas is high (above 70-80%) when the seedlings are planted at the onset of rainy season along with food crops. Late planting in semi-arid areas may affect seedling establishment and growth.

- Gliricidia is coppiced in the second year to stimulate coppicing and production of foliage for application as a green manure.
- At the age of 3 years or above, prune gliricidia regularly at least 2-3 times per season to supply green manure and minimize aboveground competition for growing resources (space and light). The recommended pruning height is 60-cm above the ground.
- Pruning gliricidia after the maximum growth stage of maize (6-8 weeks after planting) is not recommended as the maize crops will not benefit from nutrient released. It is recommended to allow the stems sprouting at this stage to grow and accumulate foliage and wood biomass for the next cropping season since there is little or no risk for competition for aboveground growth resources. Gliricidia withstand grazing pressure and hence remain green and cover the soil during offseason when livestock graze freely in the fields. In this way it contribute to reduce wind erosion, recycle nutrient via litter falls and contribute to land rehabilitation.
- At the onset of the new cropping season, gliricidia stems are pruned to supply fuelwood and green manure prior to site preparation and planting. The green manure is incorporated into the soil during site preparation and the management cycle of gliricidia intercropping technology begins again.

Figure 3: Site preparation using power tiller in Gliricidia-maize intercropping farm (a) and Maize sowing in Mlali village (b). Pruning gliricidia stems to supply green manure during the cropping season in Laikala village(c), Kongwa District, Dodoma. Photo credits: Anthony Kimaro/CIFOR, 2022(a & b) and Abdala Liingilie.

Chapter 3: Contour farming with fodder crops

Introduction

Inadequate supply and poor-quality fodder during off-season largely affect livestock productivity in semiarid areas. Livestock keepers in semi-arid areas often graze in farmlands soon after crop harvest to access high quality crops residues. Extensive grazing on farmlands accelerates land degradation through reduced vegetation cover and animal trampling. Also, the use of crop residues and/or livestock manure for cooking energy is a common practice to cope with high scarcity of fuelwood in semiarid areas. This approach however accelerates land degradation mainly through nutrients depletion due to the disruptions of the nutrient cycling processes. Integration of agroforestry in soil and water conservation technologies such as contours provide a technology package to address multiple challenges of limited fodder and land degradation reflected in soil erosion and nutrient depletion. Gliricidia is a deciduous tree but coppices retain leaves during dry season thereby enhancing its value as dry season forage and a soil cover.

Description of the technology

Contour farming is a technology mostly practiced on gentle sloping areas (a maximum slope of 5%-7%.) to control soil erosion and rehabilitates land for crop production. It involves construction of ridges (also known as contour bunds) along points of equal elevation across a sloping field (Fig. 4). The first ridge on the upper side of the farm is called Fanya chini (banks below ditches) and its main function is to capture water entering the field. Fanya juu (banks above ditches) are ridges constructed within the farm to capture runoff. 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. Vegetation, especially fodder crops (grass or leguminous tree/shrubs), can be planted on the ridges to stabilize the bunds and to produce additional products (fodder and fuelwood) to improve and diversify livelihood strategies of farmers. 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. This variant contour farming integrating fodder crops is named as contour farming with fodder crops. This technology is appropriate to address to address the challenges of land degradation, sustainable food crops production and fodder scarcity in soil erosion-prone and livestock keeping areas with inadequate rainfall.

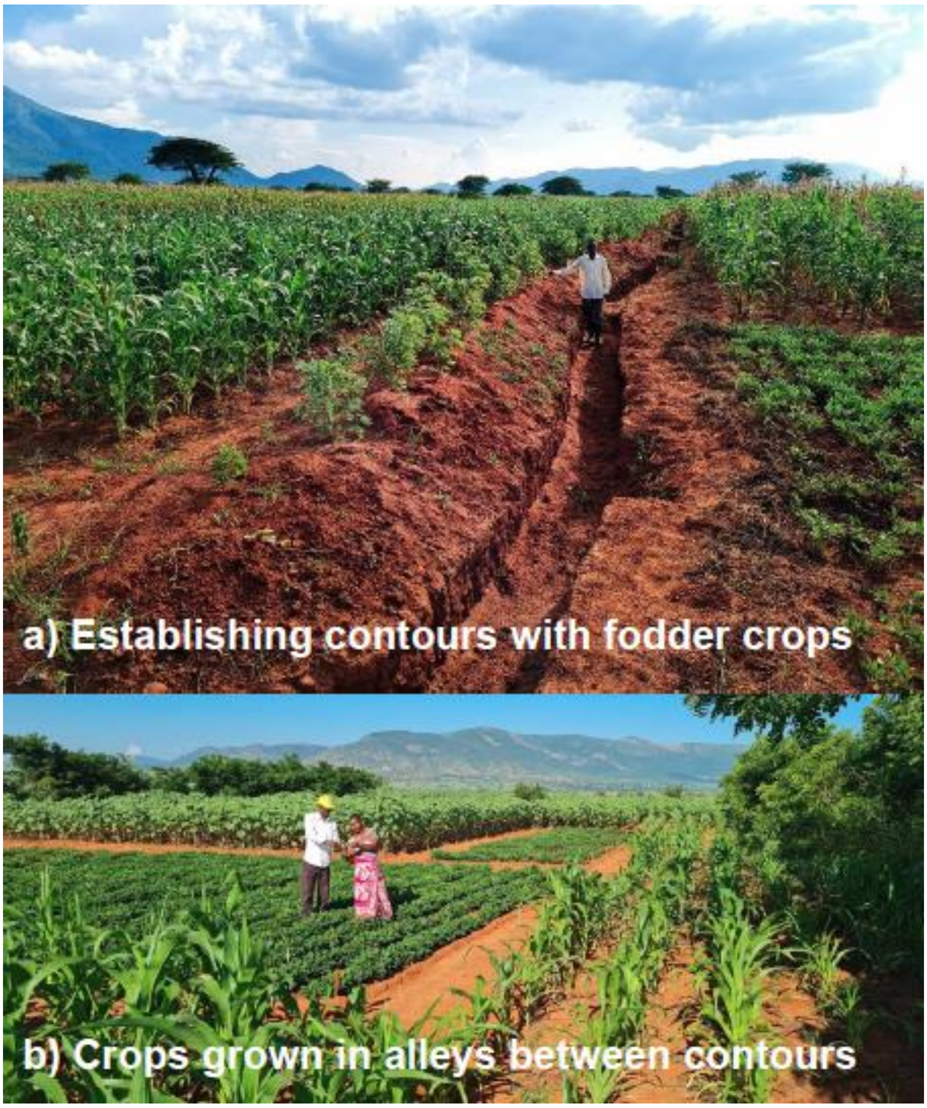

Figure 4: Establishing contours with fodder crops at Mlali village (a) and food crops (sunflower, groundnuts, and maize) planted in the protected area between contours at Ng'umbi village (b) Kongwa, Tanzania. Photo credits: Anthony Kimaro/CIFOR-ICRAF.

Benefits of the technology

Intercropping gliricidia with cereals and/or pigeonpea take the advantage of differential growth rate and root utilization zone (niche separation) for these crop components to produce multiple benefits. Pigeonpea has slow initial growth rates compared to cereals and this gives advantage for annual crops to reach maximum growth rate while pigeonpea is at the vegetative growth stage. Deep roots of gliricidia and pruning regime employed allows the tree/shrub species minimize.

- ***Land rehabilitation:*** Contour farming with fodder crops improves land production mainly by reducing soil loss and capturing water runoff in ditches to increase soil moisture to crops grown in the alleyways. The technology has the potential to reduce reduces soil loss by 94% and runoff by 78% under semiarid conditions. In addition soil fertility is improved as a results of retaining the fertile top soil eroded from unprotected open fields. Soil nitrogen (75%), phosphorus (81%), and organic carbon (28%) were improved significantly after six years of contour farming with fodder crops at Mlali village, Kongwa District.

- ***Increased crops yield:*** Yields of food crops grown in contour protected lands is usually higher compared to yields in unprotected fields due to improved land productivity under this technology. After six years of continuous practicing contour with fodder crops at Kongwa village, farmers increased their maize yields by 120%, in addition, to producing biomass (fuelwood and fodder) from the ridges. These additional crops provided a safety net for farmers during years of adverse weather when food crop productivity may fall.
- ***Fodder supply:*** Grass fodder and fodder trees/shrubs integrated in contour farming produce large amount of fodder and fuelwood which can be used at home or sold (exchanged) locally to meet immediate family needs. These contour-stabilizing crops produced 13.5t/ha/year of foliage, which can be used to feed livestock and/or as a leaf meal for making poultry feeds. Farmers who do not own livestock can sale or exchange fodder with manure for applying in their contour protected fields to improve soil fertility. The 3-year analysis (2018-2020) of contour farming at Mlali village, estimates the value of fodder sold and exchanged was 392.81 USD/ha/year (32.73 USD/ha/month). This steady income is critical in improving access to food, especially during the lean period when food supply is minimal and the grass fodder demand is high during the offseason. Integrating food production on contour diversity production and income sources of farmers which used to meet other immediate family needs and contribute to coping mechanisms when food crops production is affected by adverse weather conditions.
- ***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 in Mlali village for 2 years, reducing labour and time women spend on firewood collection by 50%. Fuelwood produced contribute to alleviating harvesting pressure on native forests and offsetting offset 1.58 tCO_2/ha/year of carbon dioxide emission per year.

How to implement the technology

The main step to establish a gliricidia intercropping farm plot are provided below based on the interventions conducted under the Africa RIISNG program in Kongwa and Kiteto districts.

- Establish contour lines using an A-frame. Extension staff can help with this. The distance between successive contour lines is determined by the slope length and gradient. This distance can also be estimated using the formula W=200/S, where W is the inter-hedgerow spacing (m) and S is slope in percentage (%).
- Plant fodder trees and grass on the contour bunds. The recommended intra-row spacing on the *fanya juu* bank is 3 m for fodder trees and 1 m for forage grass.
- No weeding is conducted on the *fanya juu* banks to encourage the stability of the banks. Fodder trees/shrubs can be pruned to minimize any shading effects on crops, with the cuttings providing fuelwood, but it must be done care to avoid reducing bank stability.
- The choice of plant types and species, and their combinations for bank re-enforcing is guided by the priority needs of the farmer (fodder or fuelwood) to ensure the products generated will be relevant and attractive.
- Tree and shrub species with multiple stems and good coppicing ability are preferred for an annual supply of fodder and wood. Also locally adapted grass species provide strong bank stability because of their extensive root system.