Buhaya agroforestry system
Tanzania, United Republic of - Ekibanja (Kihaya)

Traditional agroforestry system comprising mixture of banana, coffee, fruit trees, biannual crops, annual crops and timber trees which together optimize the use of soil, moisture and space.

Buhaya agro forest system is a mix of annual and perennial crops together with trees and shrubs are densely planted on a restricted area usually 0.5 -2ha per household to increase crop yield, wood production and conserve soil and water. Buhaya agro forest system is applied on individual owned land specific at home steady. In this technology a plot of 1ha comprises of : 1. Perennial crops (coffee, banana,) on average (10,000/36 coffee plants can be planted in one hector randomly in the alternating manner with banana, 10,000/25 banana stools) can be planted in 1ha randomly in the alternating manner with coffee. 2. Annual and biannual crops (eg. Maize, beans, cassava, sweet potatoes, yams etc) are planted in the between spaces. Maize and beans are planted twice in the short (Masika) and long rains (Vuli) where tubers are planted at any time throughout the year. 3. Trees and shrubs (eg. Makkhamia spps, Maesopsis and migorora). Trees are planted along the boundaries spaced at an average of 15m to act as wind break and timber production. Shrubs are planted at closed distance in between trees to act as live fence. Buhaya agro forest system was practiced since early 1900. Application of farmyard manures and crop residue mulch are the supportive measures. The land owners keep small livestock/ few cattle under zero grazing to obtain manure for soil fertility improvem

The purposes for applying the technology is to control soil erosion and nutrient improvement. The establishment of Buhaya agro forest system is done on a virgin land starting in the dry season July to September and it normally takes 2-5years by doing the following activities. 1. To prepare the land by cutting, removing/burning shrubs and grasses followed by land tillage. This is the difficult job and sometimes it can force the farmer to plant annual crops before planting perennial crops due to inadequate preparation time. 2. To dig holes of different size according to what crop is meant for in the alternating manner. This activity is done after harvesting annual crops in shot rainfalls (March to June). 3. To plant banana in July and August followed by coffee in September to November and March to May next year. 4. To plant trees along the boundaries followed by planting shrubs between the trees spacing to create a live fence. 5. To plant cassava, yams, pawpaw, avocados and mangoes. These are planted randomly and in a few quantity. The maintenance of Buhaya agro forest system is the simple but tidies job requires all the year to be working in the garden. The required activities are 1. To weed the field as preparation for planting seasonal crops(i.e maize and beans) twice per year in dry seasons. 2. To remove unwanted banana suckers (desuckering) and harvested banana stems in order to maintain a required number of plants(mother, daughter and grand daughter) per stool. This requires a lot of time for assessing the plant health as well as spacing. 3. To plant and harvest maize and beans twice per year. 4. To prune coffee trees, harvest coffee cherry, dry, and market them once per year. 5. To replace harvested cassava and yams as required.

left: Mr. Habibu Hasssan spreding coffee berries one of the major source his income. (Photo: Godfrey Baraba)
right: Mr.Habibu Shabani prruning coffee as one of mantainance activities. (Photo: Godfrey Baraba)

Location: Tanzania
Region: Bukoba District (Kyema village)
Technology area: 1 - 10 km2
Conservation measure: vegetative, management
Stage of intervention: prevention of land degradation
Origin: Developed through land user`s initiative, traditional (>50 years ago)
Land use type:
Mixed: Agroforestry
Land use:
Cropland: Perennial (non-woody) cropping (before), Mixed: Agroforestry (after)
Climate: subhumid, tropics
WOCAT database reference: T_TAN015en
Related approach: Spontaneous transfer of indigenous knowledge (A_TAN004en)
Compiled by: Godfrey Baraba, bukoba district council
Date: 2012-05-22
Contact person: Fidelis Kaihura, National Project Manager, K-TAMP project, Agricultural Research and Development Institute Maruku P.O.Box 127 Bukoba, Tanzania. Tel: +255 754273849 E-mail: Fidelis.kaihura@fao.org
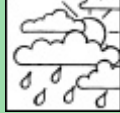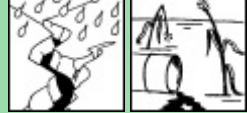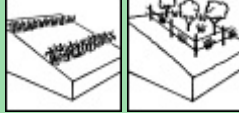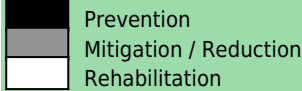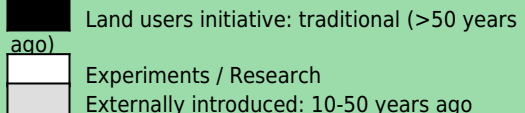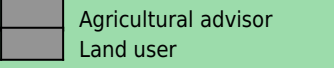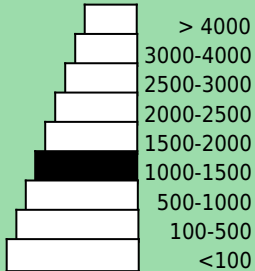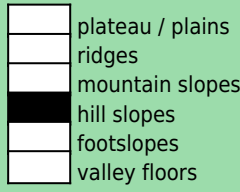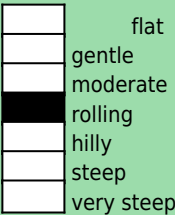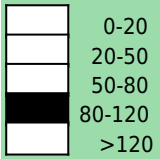
Classification
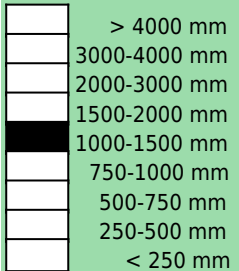
Land use problems:
- The major land use problem was soil erosion and excessive nutrient mining (expert's point of view)
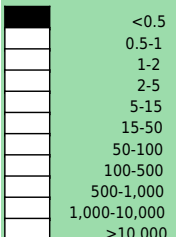Limited suitable land for cropping in the area (land user's point of view)

Land use	Climate	Degradation	Conservation measure
Agroforestry Cropland: Perennial (non-woody) cropping (before) Mixed: Agroforestry (after) rainfed	subhumid	Soil erosion by water: loss of topsoil / surface erosion, Chemical soil deterioration: fertility decline and reduced organic matter content	vegetative: Tree and shrub cover vegetative: Grasses and perennial herbaceous plants management: Change of land use type

Stage of intervention

- Prevention
- Mitigation / Reduction
- Rehabilitation

Origin

- Land users initiative: traditional (>50 years ago)
- Experiments / Research
- Externally introduced: 10-50 years ago

Level of technical knowledge

- Agricultural advisor
- Land user

Main causes of land degradation:
Direct causes - Human induced: soil management, crop management (annual, perennial, tree/shrub)
Direct causes - Natural: Heavy / extreme rainfall (intensity/amounts), other natural causes, Sandstone parent material
Indirect causes: education, access to knowledge and support services

Main technical functions:
- improvement of ground cover
- increase in organic matter
- increase in nutrient availability (supply, recycling,...)

Secondary technical functions:
- control of raindrop splash
- control of concentrated runoff: retain / trap
- stabilisation of soil (eg by tree roots against land slides)
- reduction in wind speed

Environment

Natural Environment

Average annual rainfall (mm)

- > 4000 mm
- 3000-4000 mm
- 2000-3000 mm
- 1500-2000 mm
- **1000-1500 mm**
- 750-1000 mm
- 500-750 mm
- 250-500 mm
- < 250 mm

Altitude (m a.s.l.)

- > 4000
- 3000-4000
- 2500-3000
- 2000-2500
- 1500-2000
- **1000-1500**
- 500-1000
- 100-500
- <100

Landform

- plateau / plains
- ridges
- mountain slopes
- **hill slopes**
- footslopes
- valley floors

Slope (%)

- flat
- gentle
- moderate
- **rolling**
- hilly
- steep
- very steep

Soil depth (cm)

- 0-20
- 20-50
- 50-80
- **80-120**
- >120

Growing season(s): 120 days (September to December), 65 days (March to May)
Soil texture: medium (loam)
Soil fertility: medium
Topsoil organic matter: medium (1-3%)
Soil drainage/infiltration: good

Soil water storage capacity: medium
Ground water table: 5 - 50 m
Availability of surface water: good
Water quality: poor drinking water
Biodiversity: medium

Tolerant of climatic extremes: temperature increase, seasonal rainfall increase, seasonal rainfall decrease, wind storms / dust storms, droughts / dry spells, decreasing length of growing period
Sensitive to climatic extremes: heavy rainfall events (intensities and amount), floods
If sensitive, what modifications were made / are possible: use of new adapted varieties.

Human Environment

Mixed per household (ha)

- **<0.5**
- 0.5-1
- 1-2
- 2-5
- 5-15
- 15-50
- 50-100
- 100-500
- 500-1,000
- 1,000-10,000
- >10,000

Land user: Individual / household, Small scale land users, common / average land users, men and women
Population density: 200-500 persons/km2
Annual population growth: 1% - 2%
Land ownership: individual, not titled
Land use rights: individual
Water use rights: open access (unorganised) (Water sources are mainly permanent streams found in different land ownership, but water uses are free.)
Relative level of wealth: average, which represents 75% of the land users; 60% of the total area is owned by average land users

Importance of off-farm income: less than 10% of all income: The one who did not apply the technology depends on more than 85% of his income from off farm activities.
Access to service and infrastructure: low: technical assistance, employment (eg off-farm), energy, drinking water and sanitation, financial services; moderate: health, education, market; high: roads & transport
Market orientation: mixed (subsistence and commercial)
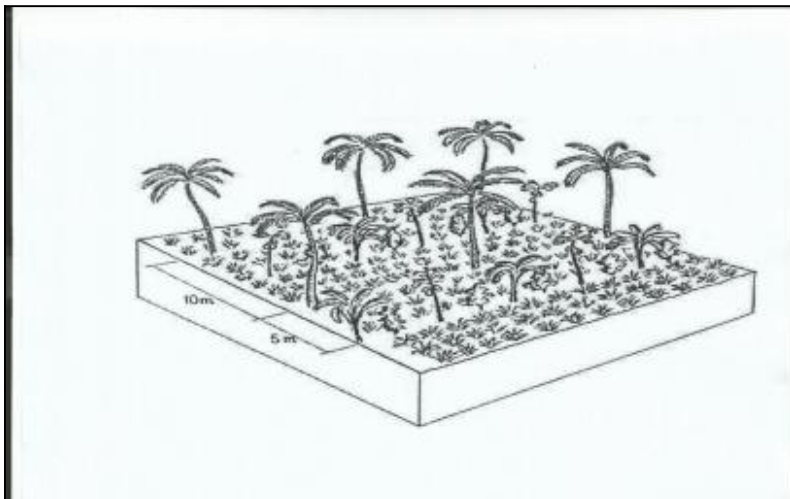
Technical drawing

Overview of the Buhaya agroforestry system. Average of 5m spacing between banana plants then alternate with coffee after two stools. Cassava and yams scattered at the space after 6 to 10 stools. beans and maize are planted in the left space to make sure all soil surface is covered. Long trees (Maesopsis spps) spaced at 10m. (Godfrey Baraba)

Implementation activities, inputs and costs

Establishment activities

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- Land preparation
- Digging holes
- Planting banana and coffee
- Planting trees and shrubs
- Planting biannual crops

Establishment inputs and costs per ha

Inputs	Costs (US$)	% met by land user
Labour	747.87	100%
Equipment		
- Hand hoes	17.36	100%
- Axes	17.36	100%
- Matchet	10.42	100%
- spides	8.50	100%
Agricultural		
- seedlings	107.06	100%
- Cassava	1.49	100%
- yams	0.81	100%
Other		
- caffea spps	111.56	100%
- mangoes	15.63	100%
- Percia americana	34.38	100%
TOTAL	**1072.44**	**100.00%**

Maintenance/recurrent activities

- Weeding
- Desuckering
- Planting annual crops
- Punning, harvesting and drying coffee
- Cassava and yams harvesting.

Maintenance/recurrent inputs and costs per ha per year

Inputs	Costs (US$)	% met by land user
Labour	641.00	100%
Agricultural		
- seeds	25.00	100%
- Maize	25.00	100%
- Cassava	1.49	100%
- yams	0.81	100%
TOTAL	**693.30**	**100.00%**

Remarks:
The most determinate factor affecting the cost is labour. This is because the technology is labour intensive, while labour force is inadequate.
The above cost was calculated as 1manday equivalent to 8 working hours with the following performances; ploughing 30m2, weeding 400m2, land clearing 10m2, de suckering 30 stools, Harvesting and pruning 3 coffee trees.

Assessment

Impacts of the Technology

Production and socio-economic benefits	Production and socio-economic disadvantages
+ + + simplified farm operations	
+ + increased crop yield	
+ + increased farm income	
+ + diversification of income sources	
+ increased wood production	

Socio-cultural benefits	Socio-cultural disadvantages
+ + + improved food security / self sufficiency	
+ + improved cultural opportunities	
+ + improved conservation / erosion knowledge	
+ + improved health	

Ecological benefits	Ecological disadvantages
+ + + reduced evaporation	
+ + + improved soil cover	
+ + + increased nutrient cycling recharge	
+ + increased soil moisture	
+ + reduced surface runoff	
+ + increased biomass above ground C	
+ + increased plant diversity	
+ reduced wind velocity	

Off-site benefits	Off-site disadvantages
+ reduced wind transported sediments	
+ reduced damage on neighbours fields	
+ reduced damage on public / private infrastructure	

Contribution to human well-being / livelihoods

+ + + This technology supports high quality and quantity coffee and other crops production and as a results improves farmers income.

Benefits /costs according to land user

Benefits compared with costs	short-term:	long-term:
Establishment	slightly positive	positive
Maintenance / recurrent	slightly positive	positive

Acceptance / adoption:

100% of land user families (387 families; 75% of area) have implemented the technology voluntary. Almost 75% of the area is under agroforestry practices.
There is strong trend towards (growing) spontaneous adoption of the technology. The technique has been in place for centuries

Concluding statements

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
The technology is not complicated in terms of input requirements and application → Improved farmer linkage to sources of improved materials e.g. research	Some tree species host pests → Improve farmers knowledge on tree pests prevention and cleaning
Inputs are locally and readily available → Facilitation of farmer own produced improved inputs	Limits farm mechanization → Improved farmers knowledge and skills on improved maintenance without mechanization
Maintenance costs decreases with increasing production period → Ditto	High competition of nutrients among different species → Improved farmers knowledge and skills in agroforestry systems management
Markets are readily available → Feeder road maintenance should be given higher priority	
Diversification of production → Improved farmers knowledge and skills in agroforestry systems management	
Reliable income from multiple crops. → Knowledge in farming as a business	
Technology is traditional and widely accepted → Strengthen linkages to sources of improved technologies	
Reduced workload → Ditto	
Complimentarity of produced diverse crops → Ditto	

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