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Cropping Systems of East Africa: A review

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Abstract
Agriculture is the most important economic activity in sub-Saharan Africa (SSA) supporting over 67 percent of the population. Annual rainfall in East Africa range from about 150 mm in the arid and semi-arid areas to over 2,000 mm in the wet, mostly highland regions. East Africa is a geographic region covering 10 countries. Mono cropping**,** Crop rotation**,** Mixed cropping**,** inter cropping**,** Sequential cropping**,** Terracing are some the well adapted cropping systems in east Africa. Now a day innovative and indigenous technologies are applying to achieve improved yields in east Africa. These have involved a wide diversity of interventions, ranging from integrated soil fertility management, soil and water conservation, rainwater and runoff harvesting systems, integrated pest management, tillage and soil management systems, and innovative agronomic practices.

1. INTRODUCTION

Agriculture is the most important economic activity in sub-Saharan Africa (SSA) supporting over 67 percent of the population, but 60 percent of these depends on rain-based rural economies, generating in the range of 30-40 percent of the countries' GDP (World Bank, 1997). Moreover, food insecurity and poverty are the greatest threats to sustainable development in the region. About one-third of the people of SSA are malnourished, with more than 60 percent of these in East Africa; in West Africa the number of malnourished people has fallen dramatically (Inter Academy Council, 2004). East Africa is a geographic region covering 10 countries, that include Kenya, Tanzania and Uganda (these three form the East African Community), plus Djibouti, Ethiopia, Eritrea, Somalia, Rwanda, Burundi and Sudan. Sometimes the region is described as the "Greater Horn of Africa" (IGAD 2001).

With the exception of Uganda, Rwanda and Burundi, the region is characterized by semi-humid to semi-arid climate, where 73 percent of the land is classified as dry land. Drought is a common phenomenon, affecting about 100 percent of the land in Somalia, Eritrea and Djibouti, and 61-87 percent of the land in Ethiopia, Kenya and Sudan (Sanders and McMillan 2001).

Annual rainfall in East Africa range from about 150 mm in the arid and semi-arid areas to over 2,000 mm in the wet, mostly highland regions. This amount of rainfall might capable of ensuring sustainable agricultural production. but there is low productivity usually associated with prolonged and recurrent drought and dry spells. Yet only about 5 percent of the irrigation potential has been exploited. Moreover, more than two-thirds of the irrigation potential is located in humid regions. There is, therefore, an urgent need to make rain-fed agriculture more productive.

Recent studies (Rientjes, et al.,2011, Tesemma, 2010, *Makungu*, et al., 1998 and Hatibu and Mahoo 2000) have shown the emergence of success cases of rain-fed agriculture in East Africa, which are transforming the lives of many poor farmers. Innovative and indigenous technologies have been applied to achieve improved yields. These have involved a wide diversity of interventions, ranging from integrated soil fertility management (Rientjes, et al.,2011), soil and water conservation, rainwater and runoff harvesting systems, integrated pest management, tillage and soil management systems, improved seeds, and innovative agronomic practices.

In addition, developing participatory methodologies in research, extension and training have enabled faster out-scaling of successful interventions. Appropriate extension tools have been developed that allow farmer participation in research and development. However, these success cases are few and far between, and there is a need to have continuous collation of information, building on knowledge gained from the successful practices, so as to reach as many farmers as possible, and thereby enhance agricultural development in the region. The most known cropping systems of east Africa are discussed below.

2. Cropping Systems

2.1 Mixed cropping

Mixed cropping is the practice of growing more than one crop in a field at a given time. The system is characterized by a typical farm type or household livelihood pattern, and significant sub-types are described where appropriate.

2.1.1 Strip cropping

This involves planting broad strips of several crops in the field. Each strip is 3–9 m wide. On slopes, the strip is laid out along the contour to prevent erosion. The next year, the farmer can rotate crops by planting each strip with a different crop.

Strip cropping has many of the advantages of intercropping: it produces a variety of crops, the legume improves the soil fertility, and rotation helps re-duce pest and weed problems. The residues from one strip can be

used as soil cover for neighboring strips. At the same time, strip cropping avoids some of the disadvantages of intercropping: managing the single crop within the strip is easy, and competition between the crops is reduced.
Example: Planting alternating strips of maize, soybean and finger millet.

2.1.2 Relay cropping

This is growing one crop, and then planting another crop (usually a cover crop) in the same field before harvesting the first. This helps avoid competition between the main crop and the intercrop. It also uses the field for a longer time, since the cover crop usually continues to grow after the main crop is harvested.
Example: *Planting maize, then sowing beans between the maize rows four* weeks later.

2.1.3 Intercropping

Intercropping is the practice of growing more than one crop simultaneously in alternating rows of the same field (Beets 1990).

Intercropping is therefore a type of mixed cropping. Intercropping with maize in sub arid regions is a way to grow a staple crop while obtaining several benefits from the additional crop. One of the main benefits of intercropping is an increase in yield per area of land. To compare yields of mono cropped and intercropped fields, the land equivalent ratio (LER) was developed. The LER is calculated by dividing the amount of the intercropped yield by the amount of the mono cropped yield for each crop in the field (Willey 1985). Add the partial LERs together to find the total LER. For example, intercropped beans may produce 0.67 the yield of mono cropped beans and the intercropped maize may produce 0.58 the yield of mono cropped maize. When added together, the partial LERs create a total LER of 1.25. Willey (1985) indicates that an LER of 1.25 can be interpreted as 25% greater yield for intercropping or as a 25% greater area requirement for the mono crop system.

Systems that intercrop maize with a legume are able to reduce the amount of nutrients taken from the soil as compared to a maize mono crop (Mongi etal., 1976 and Adu-Gyamfi et al. 2007).

Increased diversity of the physical structure of plants in an intercropping system produces many benefits. Increased leaf cover in intercropping systems helps to reduce weed populations once the crops are established (Beets 1990). Having a variety of root systems in the soil reduces water loss, increases water uptake and increases transpiration. The increased transpiration may make the microclimate cooler, which, along with increased leaf cover, helps to cool the soil and reduce evaporation (Innis 1997).
Ex. Of crops for intercropping in East Africa

- **Maize vs. sesame**

Intercropping maize (Zea maysL.) and sesame (Sesamum indicumL.) was found to maintain maize yields while producing an important cash crop to supplement smallholder income in southeast Tanzania (Mkamilo 2004).

- **Maize and Beans**

Tsubo et al. (2005) produced a simulation model to determine the best planting methods for maize and bean intercrops in sub-arid South Africa. Based on 52 years of weather data, they compared the best planting time, optimal water saturation at planting, maize plant density, and bean plant density to receive the highest LER, energy value (EV), and monetary value (MV) from the intercropped field. For every combination of factors, a LER greater than 1.0 was found, indicating that intercropping of maize and beans increases total yield.

- **Maize and Sweet potato**

Maize and sweet potato (Ipomoea batatas) are a common intercropping combination in the semi-arid Rift Valley of East Africa. Amede et al. (2001) show that simultaneously planting maize and sweet potato does not significantly decrease maize grain yields, where late planting of Sweet potato negatively affects maize yield, especially in dry years.

- **Maize and Cowpea**

Intercropping of maize and cowpeas (Vigna unguiculata) is especially beneficial on nitrogen poor soils (Vesterager et al. 2008).
As cowpeas obtain the majority of their nitrogen from the atmosphere, they do not compete with maize for nitrogen in the soil. Maize yields were not significantly affected by intercropping with cowpeas (Vesterager et al. 2008).

2.2 Crop rotation

According to Helmers, et al (2001) the risk benefits of crop diversification are generally well understood, but the additional effect of rotational cropping on risk is less understood. In this regard they demonstrated that in the diversification from maize to a maize-soya bean rotation system, 71% of the reduction in risk was due to the rotational effect and 29% due to diversification.
Example: Planting maize one year, and beans the next.

2.3 Mono-cropping

This is where the field is used to grow only one crop season after season. This has several disadvantages: it is difficult to maintain cover on the soil; it encourages pests, diseases and weeds; and it can reduce the soil fertility

and damage the soil structure. So avoid mono cropping if you can. It is much better to rotate crops, or use intercropping or strip cropping
Example Planting maize year after year in the same field.

2.4 Sequential cropping

This involves growing two crops in the same field, one after the other in the same year. In some places, the rainy season is long enough to grow two crops: either two main crops, or one main crop followed by a cover crop. Growing two crops may also be possible if there are two rainy seasons, or if there is enough moisture left in the soil to grow a second crop.
Example Planting maize in the long rains, then beans during the short rains.

2.5 WATER AND SOIL CONSERVATION PRACTICE

Reducing slope steepness and/or length is referred to as terracing. A terrace has been described (Critchley 2000) "as a unit consisting of a relatively steeply faced structure across the slope (referred to as a riser, bank, dyke, ridge, wall or embankment), that supports above it a relatively flat terrace bed (which may be either flat, or sloping backwards or forwards and may slope laterally)."

On sloping lands, terracing is necessary for reducing overland flow rates thereby, contributing to water and nutrient conservation. Although terracing steep lands in East Africa has been an indigenous technology among some communities, new methods have been evolving over the years as the need to be innovative with ever-decreasing space for cultivation grows with the population, especially in the densely populated and erosion-prone highlands (Critchley 2000).

In particular, from the 1970s, SIDA-supported soil conservation activities targeting high-potential steep lands of Ethiopia, Kenya and Tanzania (Lundgren and Taylor 1993; Wenner 1981; Thomas 1997), along with other programs and projects have generated not only tangible benefits to farmers, but also a large body of knowledge.

Some of the more common terracing technologies used by smallholder farmers include contour bunds, "fanya juu" terraces, bench terraces, stone lines and vegetative barriers.

2.6 Challenges in cropping systems

Here are some problems that encountered with cropping systems,

- **Pests and diseases**

Certain insect pests and diseases may spread easily from one crop to the next through the crop residues.

- **Market**

Markets do not always exist for new crops that they planted as part of a rotation.

- **Soil fertility problem**

Continuous growing of crops in a given land without the required inputs leads to soil fertility declination especially on mono cropping.

- **Knowledge, skills and labor**

Managing rotations properly requires more skills than a single crop. It also needs work at different times of a year. People may be reluctant to try out new crops because they are not used to growing or eating them.

3. Conclusion

Annual rainfall in East Africa range from about 150 mm in the arid and semi-arid areas to over 2,000 mm in the wet, mostly highland regions. This amount of rainfall in itself should be capable of ensuring sustainable agricultural production. However, the real situation is that agricultural production is below potential land capabilities in nearly all the countries, and crop failures are a common occurrence. Cropping systems in east Africa are: Mono cropping**,** Crop rotation**,** Mixed cropping**,** Inter cropping**,** Sequential cropping**,** Terracing… and in east Africa integrated crop production system have been practiced like that of intercropping and crop rotation with full application of required inputs (improved seeds, fertilizers, ipm).

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