Intercropping with Maize in Sub-arid Regions

Definition and Benefits of Intercropping

Mixed cropping is the practice of growing more than one crop in a field at a given time. 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 monocropped and intercropped fields, the land equivalent ratio (LER) was developed. The LER can be calculated using any measure of units (Willey 1985). The LER is calculated by dividing the amount of the intercropped yield by the amount of the monocropped yield for each crop in the field. Add the partial LERs together to find the total LER. For example, intercropped beans may produce 0.67 the yield of monocropped beans and the intercropped maize may produce 0.58 the yield of monocropped 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 monocrop 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 monocrop. When nitrogen fertilizer is added to the field, intercropped legumes use the inorganic nitrogen instead of fixing nitrogen from the air and thus compete with maize for nitrogen. However, when nitrogen fertilizer is not applied, intercropped legumes will fix most of their nitrogen from the atmosphere and not compete with maize for nitrogen resources (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). This is important during times of water stress, as intercropped plants use a larger percentage of available water from the field than monocropped plants. Creating windbreaks may also modify the microclimate. Rows of maize in a field with a shorter crop will reduce the wind speed above the shorter crops and thus reduce desiccation (Beets 1990).

Increased plant diversity in intercropped fields may reduce the impact of pest and disease outbreaks by providing more habitat for predatory insects and increasing the distance between plants of the same crop. Other ecological benefits of intercropping include less land needed for crop production, reduction of pesticide and herbicide use, and a reduction in soil erosion.

Intercropping has several benefits to the farmer including a reduction in farm inputs, diversification of diet, addition of cash crops, increased labor utilization efficiency, and reduced risk of crop failure. When planting more than one crop in the same field, it will take the same
amount of time to plant the multiple varieties of seeds as it would one, thus increasing labor utilization efficiency. Peak labor requirements that occur during harvest are spread out when two or more crops are harvested at different times allowing the smallholder to complete the harvest with family labor.

Intercropping presents a large level of risk reduction for the smallholder. If one crop is entirely lost to pest or drought damage, the farmer may still harvest the other crop in the field. Given the unpredictable rainy season and the different water requirements of each crop, planting many varieties of the same crop in an intercropped field gives the farmer a better chance that some crops will survive.

Examples of Maize Intercrops

Maize and Sesame

Intercropping maize (*Zea mays* L.) and sesame (*Sesamum indicum* L.) was found to maintain maize yields while producing an important cash crop to supplement smallholder income in southeast Tanzania (Mkamilo 2004). It is unproductive for farmers to grow sesame as a sole crop due to the high risk of seedling mortality from water-logging, snails, or the sesame flea beetle (*Alocypha bimaculata* Jacoby). The farmers’ objective of the maize-sesame intercropping system is to grow the normal amount of maize while receiving the added bonus of a sesame cash crop from the same fields.

For his trials, Mkamilo (2004) used the *Staha* maize variety and the improved *Nal-92* sesame variety, which is recommended for its high yield and white seed color. The white seed color is demanded in the international sesame market and may increase the value of the sesame. Local varieties of sesame may have more vigor and produce a higher yield.

Mkamilo (2004) determined the best time to sow the sesame in order to meet the farmers’ objectives is two weeks after the maize has been planted. Although concurrent planting of maize and sesame result in the greatest LER and greatest yield, the inter-plant competition from the sesame greatly reduces the maize yield. Planting sesame two weeks after maize also reduces the risk of loss from water-logging in the soil. Planting sesame a little later ensures it will come to full maturity at the beginning of the dry season, instead of during the rainy season, allowing the seeds to dry in the field, saving much labor.

There is no significant difference in sesame yields when it is hand broadcast or planted in rows. However, hand broadcasting of sesame reduced the maize yield 53% to 69% as compared to monocropped maize, whereas sesame planted in rows only reduced the maize yield 19% to 55% (Mkamilo 2004). Although planting sesame in rows may be more labor intensive than hand broadcasting, it will significantly increase maize yield and reduce the amount of labor needed for future weeding.

Contrary to an old study by the Tanzanian Agricultural Research Organization, which recommended planting one maize plant per station throughout Tanzania, Mkamilo (2004), found a density of two to three maize plants per station to increase maize yield in both sole cropping and intercropping with sesame. This configuration also increased sesame yield in intercropping.

Although the majority of farmers in this region do not use organic or inorganic fertilizers, fertilizers may be beneficial depending on soil fertility. On the low-fertility site, the addition of 45 kg/ha of nitrogen fertilizer resulted in a 2.5 to 3.5 fold increase in maize and sesame sole cropped yields respectively (Mkamilo 2004). However, the medium-high fertility site showed no
benefit from fertilization. Phosphorous fertilizer at an application rate of 40 kg P₂O₅/ha had no significant effect on either soil type, as it was not a limiting factor in the soil. When nitrogen fertilizer was added to the intercrop, it increased the maize yield, but significantly reduced the sesame yield due to increased inter-crop competition, making the benefits of fertilizer negligible (Mkamilo 2004). Soil nutrient mining may become a problem if other practices such as crop rotation or fallowing are not employed. Moderate levels of inorganic fertilizer may be beneficial in the long run.

Adding sesame to maize is a technique to add extra income on top of a farmer’s staple crop. By intercropping sesame with maize, farmers reduce their risk of total crop failure from water logging, snail, and sesame flea beetle. If these problems persist, they usually destroy the sesame crop when it is young, reducing inter-species competition with maize, so a close to normal maize yield may still be harvested from the field. As maize is often harvested before the sesame in an intercrop, it allows for a more even distribution of labor requirements throughout the harvest season.

Recommendations for Maize-sesame intercropping:

- Plant maize at the beginning of the rainy season
- Plant maize in rows with 75 cm between rows, with 2-3 stalks per station
- In-row distance should be 40 cm for 2 stalks/station and 60 cm for 3 stalks/station
- Plant sesame 2 weeks after maize
- Sesame rows should be midway between each maize row with in-row spacing of 6 cm
- Weed at 2, 4, and 6 weeks after planting maize
- Low levels of fertilization or crop rotation with legumes may be necessary to maintain soil fertility

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.

The simulations show that initial soil water content has the greatest influence on intercropping productivity. Bean plant density had no influence on maize or bean yields, indicating that maize yield is not affected by bean intercropping, although bean yields were decreased in the intercropped system (Tsubo et al. 2005). High densities of maize maximized maize yield and calorie production, but high densities of beans maximized financial return.

Recommendations for Maize-bean intercropping:

- Plant at the beginning of the rainy season (November or December in South Africa)
- Plant when the soil is saturated (irrigation at planting is beneficial to returns)
- Plant higher densities of maize (40,000 plants/ha) to maximize the yield and calorie production
Maize and Sweetpotato

Maize and sweetpotato (*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 sweetpotato does not significantly decrease maize grain yields, where late planting of sweetpotato negatively affects maize yield, especially in dry years. Using an early maturing variety of maize will increase total yield over several years as compared to a mid-late maturing variety (Amede et al. 2001). Amede et al. (2001) used *Katamani* as an early variety and *A511* as a mid-late variety. Although the mid-late variety provided higher yields in wet years, it severely out-competed the sweetpotato, reducing total LER. The early maize variety produced a higher yield of maize in the dry years, as it matured before the high water stress at the end of the growing season (Amede et al. 2001). Amede et al. (2001) consistently received an LER of 1.5 or greater when using the early maturing *Katamani* variety of maize.

Sweetpotato yield was significantly reduced in dry years due to an inability to tuberise. However, intercropping did not reduce sweetpotato vine production. Sweetpotato vines are commonly used as fodder for livestock. Since the vines are not included in the LER calculations, their use significantly increases the benefits of intercropping maize and sweetpotato (Amede et al. 2001). When planted simultaneously with maize, sweetpotato does not affect maize yield.

Recommendations for Maize-sweetpotato intercropping:

- Use an early maturing variety of maize and a shade tolerant variety of sweetpotato
- Plant maize and sweetpotato simultaneously
- Plant at the beginning of the rainy season, as locally practiced
- Plant maize in rows 75 cm apart with in-row spacing of 25 cm
- Plant sweetpotato midway between maize rows with an in-row spacing of 30 cm
- Weeding is especially important at the beginning of the season
- In addition to harvesting maize and sweetpotato, sweetpotato vines may be used as fodder

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). Mongi et al. (1976) found that cowpeas planted 3 weeks after maize had significantly reduced yields and therefore recommends planting cowpeas simultaneously with maize.

Intercropping of maize and cowpeas is more economical than maize monocropping when phosphorous fertilizer is not applied as compared to applications of 30 or 60 kg P/ha (Mongi et al. 1976). Mongi et al. (1976) found alternate row intercropping to give 34% more monetary return than monocropped maize, while maize and cowpea planted in the same hills had an increase of 29% in monetary return. As many small farmers value their leisure time, they may prefer to plant one maize and one cowpea seed in each hole rather than planting alternate rows of maize and cowpeas. This will save them time, but slightly reduce potential yield and monetary return. The addition of cowpeas to the maize field provides an important protein supply for human and livestock consumption, improves soil fertility and structure, suppresses weeds, and insures against total crop failure when one crop fails (Mongi et al. 1976).
Recommendations for Maize-cowpea intercropping:
- Plant maize and cowpea simultaneously
- For highest yields, plant maize rows 75 cm apart with in-row spacing of 30 cm
- Plant cowpea in rows midway between maize rows with in-row spacing of 15 cm
- Weeding is important at the beginning of the growing season

Choosing an Appropriate Intercropping System

Each intercropping system described has shown to increase total yield from maize fields without a significant reduction in the yield of maize. The intercropping technology is thus suitable for the smallholder who depends on maize as their staple crop. Table 1 summarizes the main benefits of each intercropping system. The best system to implement will ultimately depend on the location, the cultural practices, and the objectives of the farmer. It will needlessly be easier to implement improved intercropping techniques to an intercropping system that already exists (Beets 1990). If intercropping is not practiced, introducing intercropping with a plant that is already known to the farmer reduces the amount of education needed to introduce a new crop species. Before introducing a new crop to farmers, it is important to determine if the crop will be utilized to its full potential in the local cultural and market settings.

Table 1. Main benefits of each intercropping system.

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<tr>
<th>Intercropping System</th>
<th>Yield Increase</th>
<th>Soil Nutrient Stabilization</th>
<th>Reduced Pest &amp; Disease</th>
<th>Increased Labor Utilization Efficiency</th>
<th>Reduced Risk</th>
<th>Increased Crop Diversity</th>
<th>Additional Fodder</th>
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If soil nutrient depletion is a problem, it is strongly encouraged to choose an intercropping system including legumes (beans or cowpeas) that obtain nitrogen from the atmosphere rather than taking it from the soil. If farmers prefer to use a non-leguminous intercrop, crop rotation with a legume or application of fertilizers may be necessary to prevent nutrient mining from the soil. However, remember that application of fertilizer has the benefit of increasing maize yield and vigor, thus decreasing the productivity of the intercrop.

Introducing or improving an intercropping system with maize can significantly benefit the smallholder by increasing yield on a limited amount of land, reducing risk of total crop failure, and maximizing the efficiency of labor utilization. In addition, some systems help to stabilize soil nutrient levels, which will keep yields sustainable into the future. Pests and weeds may also be controlled, which lead to higher yields. Intercropping with maize may be a return to more traditional techniques, but using current knowledge and improved technologies will help smallholders to ensure sustainable yields into the future.
Works Cited


