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Important of applying intercropping for sustainable crop production: A Review

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Abstract
Intercropping is the cultivation of two or more crops at the same time in the same field. Its advantages are risk minimization, increased income and food security, reduction of soil erosion and pest and disease control. Because of these advantages intercropping is practiced in many parts of the world, especially in the developing countries. Therefore, this paper is aimed to review the advantages of intercropping for sustainable agriculture. In Ethiopia fruit trees are intercropped with all types of short-term crops such as beans, peas, potatoes, maize, millet, exotic and indigenous vegetables when they are still young as a way of attaining food security and income before the trees mature. Besides this intercropping provides high insurance against crop failure, especially in areas subject to extreme weather conditions such as frost, drought, flood, and overall provides greater financial stability for farmers, making the system particularly suitable for labor-intensive small farms. Furthermore, because of some favorable exudates from the component legumes, greater land-use efficiency, greater yield stability and increased competitive ability towards weed, intercropping is advantageous over mono-cropping.

Keywords: Intercropping, food security, disease, yield stability, soil erosion

1. Introduction

Intercropping is a type of mixed cropping and defined as the agricultural practice of cultivating two or more crops in the same space at the same time (Hugger and Palled, 1979). The important reason to grow two or more crops together is the increase in productivity per unit area of land in intercropping system (Longer *et al.*, 2006). Intercropping with cereal crop such as maize in tropical regions is a way to grow a staple crop while obtaining several benefits from the additional crop. It is the most appropriate cropping system for maintenance of soil productivity in the tropics (Jonah and Dozer, 1979), and ensures good soil cover throughout the year (Beets, 1990). These practices have been so interwoven in the socio-economic lives of peasant farmers (Sadashiv, 2004). The reason for the persistence of this practice is not only that gross returns per unit area of land are usually higher under intercropping than in sole cropping (Bernita and Sera, 2009) [10]. The system also offers the farmers insurance against crop failure, helps control erosion, weeds and insect infestation and brings about a more distribution of farm lab our than sole cropping (Ali *et al.*, 2000) [2]. There are also some socio economic, biological and ecological advantages in intercropping over mono-cropping (Maleeka *et al.*, 2005) [28].

The practices which promote diversity and stability on the farm are enterprise diversification, crop rotation, use of wind breaks, provision of more habitats for microorganisms, intercropping and integration of crop farming with livestock production (Reddy *et al.*, 1992). When two or more crops are growing together, each should have adequate space to maximize cooperation and reduce competition between them. This is accomplished by the following factors namely: spatial arrangement, plant density, maturity dates of the crops grown, plant architecture. The spatial arrangements are row intercropping: growing two or more crops together at the same time with at least one crop planted in rows; strip intercropping: growing two or more crops together in strips wide enough to separate crop production using machines but close enough to interact; mixed cropping: growing two or more crops together in no distinct row arrangement; relay intercropping: plant a second crop into a standing crop at a time when the standing crop is at its reproductive stage but before harvesting (Okigbo, 2003). To optimize plant density, the seedling rate of each crop on the mixture is adjusted below the full rate to reduce competition from overcrowding. The crops will yield well in the mixture (Magaguda *et al.*, 2001).

Planning intercrop with staggered maturity dates or developmental periods utilize variations in peak resource demands for nutrients, water and sunlight. This facilitates harvesting and separation of grain and reduce competition (Akyempong *et al.*, 1999). Plant architecture allows one intercrop to capture sunlight that would not otherwise be available to others. This is important to growth and yield of cereal and legume crops (Reddy *et al.*, 1981).

Various types of intercropping were known and presumably employed in ancient Greece about 300 B.C. Theophrastus, among the greatest early Greek philosophers and natural scientists, notes that wheat, barley, and certain pulses could be planted at various times during the growing season often integrated with vines and olives, indicating knowledge of the use of intercropping (Papanastasis *et al.*, 2004). Today, intercropping is commonly used in many tropical parts of the world particularly by small scale traditional farmers (Altieri, 1991). Traditional multiple cropping systems are estimated to still provide as much as 15-20% of the world's food supply (Altieri, 1999) [5].

In the tropical regions, intercropping is mostly associated with food grain production, whereas in the temperate regions it is receiving much attention as a means of efficient forage production (Lithourgidis *et al.*, 2006) [26]. Although intensive mono cropping is much easier for large scale farmers who plant and harvest one crop on the same piece of land using machinery and inorganic fertilizers, small scale farmers who often do not have readily access to markets and grow enough food only to sustain themselves and their families, recognize that intercropping is one good way of ensuring their livelihood.

Objective

To review intercropping as an alternative mechanism for sustainable agriculture

2. Literature Review

2.1. Efficient resource utilization and yield advantage

Mucheru Muna *et al.* (2010) explained the main advantage of intercropping is the more efficient utilization of the available resources and the increased productivity compared with each sole crop of the mixture Using units such monetary or nutritional value can be considered as an alternative to yield for assessing the advantages of intercropping (Willey, 1985). Yield advantage occurs because growth resources such as light, water, and nutrients are more completely absorbed and converted to crop biomass by the intercrop over time and space as a result of differences in competitive ability for growth resources between the component crops, which exploit the variation of the mixed crops in characteristics such as rates of canopy development, final canopy size (width and height), photosynthetic adaptation of canopies to irradiance conditions, and rooting depth (Tsubo *et al.*, 2001).

Resource complementarity minimizes the niche overlap and the competition between crop species, and permits crops to capture a greater range and quantity of resources than the sole crops. According to Midmore *et al.* (1993), advantage of improved resource is increasing the uptake of other nutrients such as P, K, and micronutrients, and provides better rooting ability and better ground cover as well as higher water use efficiency.

2.2. Insurance against crop failure

Due to its stability, Intercropping became more popular than mono-cropping (Horwith, 2002). The stability under intercropping can be attributed to the partial restoration of diversity that is lost under mono-cropping (Clawson, 2000) [2]. As a result of this, intercropping provides high insurance against crop failure, especially in areas subject to extreme weather conditions such as frost, drought, flood, and overall provides greater financial stability for farmers, making the system particularly suitable for labor-intensive small farms. Thus, if a single crop may often fail because of adverse conditions such as frost, drought, flood, or even pest attack, farmers reduce their risk for total crop failure by growing more than one crop in their field. Consequently, if one crop of a mixture fails, the component crop may still be harvested in intercropping which is advantageous than monocropping. Moreover, farmers may be better able to cope with seasonal price variability of commodities which often can destabilize their income (Clawson, 2000) [2].

2.3. Soil conservation

EL-Swaify *et al.* (1998) [12] explain that intercropping with legumes is an excellent practice for controlling soil erosion and sustaining crop production. Where rainfall amount is excessive, cropping management systems that leave the soil bare for great part of the season may permit excessive soil erosion and runoff, eventually resulting in infertile soils with poor characteristics for crop production. Moreover, deep roots penetrate far into the soil breaking up hardpans and use moisture and nutrients from deeper down in the soil. Shallow roots bind the soil at the surface and thereby help to reduce erosion. Also, shallow roots help to aerate the soil. Reduced runoff and soil loss were observed in intercrops of legumes with cassava (El-Swaify *et al.*, 1999).

2.4. Improvement of soil fertility

One important reason for intercropping is the improvement and maintenance of fertility. An example of this is when a cereal crop or tuber crop is intercropped with legumes (beans, peas, ground nuts. After the intercrop is harvested, decaying roots and fallen leaves provide nitrogen and other nutrients for the next crop, legumes also fix nitrogen. The crop residues of the legumes can also be used as fodder, by cutting and carrying them to the animals, or by letting the animals graze the residues in the field. The nutrients in the crop residues can then be recycled when manure is used to fertilize crops. Legumes in an intercrop system also provide humus in the soil, due to decaying crop remains resulting in improved soil structure, reducing the need for soil tillage. Water losses, soil erosion and leaching of nutrients are also reduced in intercropping systems due to the improved structure and better soil cover. In intercropping, nitrogen fixation by the legume is not sufficient to maintain soil fertility. If chemical fertilizers are applied, it is not necessary to use nitrogen fertilizer on the cereal crop. Fertilizers are more efficiently used in an intercropping system, due to the increased amount of humus and the different rooting systems of the crops as well as differences in the amount of nutrients taken up (Rahman *et al.*, 2006).

2.5. Lodging resistance to prone crops

Intercropping can provide better lodging resistance for some crops highly susceptible to lodging (Assefa and Ledin, 2001) [3, 6]. Lodging reduces plant growth severely. Some of the damage is often attributable to subsequent disease infections and mechanical damage, whereas loss of plant height reduces efficiency of light interception. The ability of forage crops to remain standing is particularly important because lodged forage crops may not be able to photosynthesize and translocate nutrients and water efficiently, which can result in loss of yield. In addition, lodged crops may slow harvest operations or may cause harvest loss. Improved stand ability commonly results in increased harvestable yield, improved crop quality, and increased efficiency of harvest. Lodging -prone plants. e.g., those are prone to tip over in the wind or heavy rain, may be given structural support by their companion crop (Trenbath, 2004).

2.6. Reduction of pest and disease incidence

There is reduction of insect/mite pest populations due to the diversity of crops grown and reduction of plant diseases because the distance between plants of the same species is increased due to the planting of other crops between them, alteration of more beneficial insects especially when flowering crops are included in the cropping system, increase of total farm production and profitability and reduction of weed population through allelopathy and efficient crop production (Magaguda *et al.*, 2003).

2.7. Promotion of biodiversity

Intercropping is one way of introducing more biodiversity into agro ecosystems and results from intercropping studies indicate that increased crop diversity may increase the number of ecosystem services provided. Higher species richness may be associated with nutrient cycling characteristics that often can regulate soil fertility (Russell, 2002), limit nutrient leaching losses (Hauggaard *et al.*, 2003) [15], and significantly reduce the negative impacts of pests (Bannon et., al, 1998) [7] also including that of weeds (Hauggaard *et al.*, 2001) [14]. Biodiversity is promoted by intercropping by providing a habitat for a variety of insects and soil organisms that would not be present in a single crop environment.

2.8. Other advantages

- Efficient use of labor
- It also provides a microclimate that can be favorable for associated crops.
- In a maize-bean intercrop, for example climbing beans can use the maize stalks for support (Magaguda *et al.*,1999)
- Provides a good soil cover, soil temperature will stay relatively low. This prevents burning of the organic matter in the soil and loss of nutrients.

3. Summary and Conclusion

Intercropping offers greater financial returns for a farmer. Even if you are growing some produce for your own family or just as part of a hobby, you will have multiple types of produce, which is always a nice outcome. Intercropping will help farmers use the same land as available and yield more as well as diverse produce. This generates more income for the farmer without really taking up any major expenditure.

The infrastructure available or the land used remains the same. Intercropping can be the insurance that farmers need, especially when the region is vulnerable to weather extremes. Drought, torrential rain, hurricanes or cyclones and various other weather elements can affect the yield of a given year or season. Having diverse yields allows the farmer to have some income even if the primary crop gets damaged or doesn't yield as much as expected. Intercropping makes the most of the available soil. When anything is grown on a farmland, the crop tends to absorb as much water and nutrients as it needs.

There could be more nutrients in the soil under the crops and around. This soil and more specifically the nutrients can be used, by the different varieties of crops. Intercropping also averts soil runoff and can prevent the growth of weeds. Intercropping is good for the primary crops. The secondary crops can provide shelter and even protect the primary crops. Intercropping also allows you to grow cash crops or any crop that will actually supplement the primary crop in some way. Most crops can now be intercropped including fruit trees and therefore, farmers with small pieces of land should no longer worry.

4. Recommendation

To get the maximum profit from intercropping as alternative for annual crop production,

- Research still needs to be carried particularly with respect to row orientations and light interception and the economic benefits as more if horticultural crops are intercropped.
- Intercropping is depending on crop mixed competition for light, water and nutrients or allopathic effects that may reduce yield, in order to reduce this problem, we should select appropriate crop planting rate and changes in the spatial arrangement of the crop can reduce competition.
- Intercropping is difficult with practical management, especially where there is high degree of mechanization or when the component crop has different requirement for fertilizers, herbicide and pesticide, in order to reduce this problem. We must use machinery used for sowing, weeding, fertilizing and harvesting are made for uniform field.

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