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A General Overview on Intercropping and Its Advantages in Sustainable Agriculture

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ABSTRACT

Agricultural sector as important economic activities in various communities requires coherent planning in order to achieve development and confront with crises. Sustainable agriculture is more efficient in use of resources such as soil and water, and is in balance with the environment conditions. Conventional farming and monocropping systems In addition to depletion the natural resource, is caused environmental pollution. Intercropping can be defined as a multiple cropping system that two or more crops planted in a field during a growing season. Intercropping is a ways to increase diversity in an agricultural ecosystem. Ecological balance, more utilization of resources, increases the quantity and quality of products and reduction damage by pests, diseases and weeds will increases with use of intercropping systems. Row-intercropping, mixed- intercropping, strip-intercropping and relay-intercropping are most important types of intercropping. Crops yield increases with intercropping due to higher growth rate, reduction of weeds, pests and diseases and more effective use of resources. Pest and disease damage in intercropping is less than pure cropping, due to pest or pathogen attract by the second crop species, Also weeds will be control, when crops in intercropping system have a complementary effect together. Soil fertility increases by using plants of leguminosae family in intercropping, due to the increasing amount of biological nitrogen fixation.

Keywords: Agriculture, intercrop, monocropping, sustainable.

INTRODUCTION

Agricultural to concept of ways and methods of the operation of water resources, soil and energy in order to provide food and clothing needs of human, constantly throughout history has been the foundation of economic, social, political and cultural development in over the world. One of the main needs of each dynamic activity is planning within the general objectives on it activity; agricultural sector also as one of the most important economic activities in various communities requires coherent planning in order to achieve development and confront with crises. Sustainable agriculture is a type of agriculture that is more efficient in use of resources, for the benefit of human, and is in balance with the environment. In other words, sustainable agriculture must be ecologically appropriate, economically justified and socially desirable. Objectives of sustainable agriculture have a closely associated with its definitions; objectives of the successful sustainable agriculture program are the following: provide food security along with increased quality and quantity, with considering the needs of future generations; conservation of water, soil and natural resources; conservation of energy resources inside and outside the farm; maintain and improving farmers profitability; maintain the vitality of rural communities; conservation of biodiversity (Eskandari, 2012a; Earles, 2005; Gruhn et al., 2000).

In conventional farming and monocropping systems, although high yield per unit area is been able to provide the nutritional needs of growing populations in some areas, but these systems requires direct and indirect to abundant costs and energy that arise from fossil fuels. In terms of ecology and environment, monocropping has been caused a series of serious problems. Human by excessive use of resources such as water, soil, forests, pastures and natural resources not only put them at risk of extinction, but also with the creation of pollution caused by industrial activities, chemical fertilizers and pesticides, threatens the earth (Reganold, 1992). If farming activities be conducted based on ecological principles, in addition to preventing the destruction of natural ecosystems, the result is stable condition (Mazaheri *et al*., 2006). Also agricultural systems must provide needs of people today and future generations; therefore it seems that is essential achieving to sustainable agriculture. One of the key strategies in sustainable agriculture is restoration diversity to agricultural ecosystems, and its effective management. Intercropping is a ways to increase diversity in an agricultural ecosystem. Intercropping as an example of sustainable agricultural systems following objectives such as: ecological balance, more utilization of resources, increasing the

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quantity and quality and reduce yield damage to pests, diseases and weeds. Success of intercrops in comparison with a pure cropping can be determined by a series of agronomic operations that interactions between the species will be affected by them. These operations are including ultimate density, planting date, resources availability and intercropping models (Mazaheri *et al*., 2006; Gliessman, 1997; Hatfield and Karlen, 1993).

Perspectives and define Intercropping

Although there is no recorded history for intercropping and multiple cropping, however, considering the available evidence planting crops as a combined has a long history. Intercropping is as a multiple cropping system, in which two or more crops species planted simultaneously in a field during a growing season. Of course this does not mean that in the intercropping, plants can be planting at a time together, but is the purpose that two or more crops are together in one place, during their growing season or at least in a timeframe. Therefore is possible that the plants are different in terms of planting time, and a plant is planted after the first plant (Mazaheri *et al*., 2006; Ofori and Stern, 1987).

Types of intercropping

Compared with pure cropping in which one species is planted, intercropping is consisting planting of two or more crops. Intercropping can be included: annual plants with annual plants intercrop; annual plants with perennial plants intercrop; and perennial plants with perennial plants intercrop (Eskandari et al., 2009a; Ghanbari and Lee, 2003)

The intercropping is divided into the following four groups (Vandermeer, 1992; Ofori and Stern, 1987):

1- **Row-intercropping:** Growing two or more crops simultaneously where one or more crops are planted in regular rows, and crop or other crops may be grown simultaneously in row or randomly with the first crop.
2- **Mixed- intercropping:** Growing two or more crops simultaneously with no distinct row arrangement. This type of can be suitable for grass-legume intercropping in pastures.
3- **Strip-intercropping:** Growing two or more crops simultaneously in different strips wide enough to permit independent cultivation but narrow enough for the crops to interact ergonomically.
4- **Relay- intercropping:** Growing two or more crops simultaneously during part of the life cycle of each. A second crop is planted after the first crop has reached its reproductive stage but before it is ready for harvest.

Advantages of intercropping

There are many reports concerning the positive effects and also superiority of intercrop than the pure cropping. Most important advantages of intercropping are the following:

1- Increasing production

One of the main reasons for the use of intercropping around the world is produced more than a pure cropping of same land amount (Caballero and Goicoechea, 1995). Ghanbari and Lee, (2002) reported that dry matter production in wheat and beans intercrops had been more than their pure cropping. Also Martin and Snaydon, (1982) in their study reported that grain and dry matter yield in bean and barley intercrops was more than their pure cropping. Odhiambo and Ariga, (2001) with maize and beans intercrops in different ratios found that production increased due to reduced competition between species compared competition within species. Wiley, (1990) considers intercropping as an economic method for higher production with lower levels of external inputs. This increasing use efficiency is important, especially for small-scale farmers and also in areas where growing season is short (Altieri, 1995). Production more in intercropping can be attributed to the higher growth rate, reduction of weeds, reducing the pests and diseases and more effective use of resources due to differences in resource consumption (Eskandari, 2012b; Eskandari et al., 2009b;Watiki et al., 1993; Willey, 1990; Willey, 1985). In addition, if there are "complementary effects" between the components of intercropping, production increases due to reducing the competition between them (Mahapatra, 2011; Zhang and Li, 2003; Willey, 1979).

2- Greater use of environmental resources

Advantages of intercropping in the crop production in comparison with pure cropping are due to the interaction between components in intercrops and the difference in competition for the use of environmental resources (Mahapatra, 2011; Valdez and Fransen, 1986). If the intercrops components have a difference together in use of environmental resources, so that are complementary in use of this resources, thus use of the resources is more effective than a pure cropping, and the result increased yield (Jensen, 1996). In terms of competitive this means that, intercrops components are not competition for same nich (ecological nest) due to differences morphological and

physiological, and competition between species is less than competition within species (Vandermeer, 1992). Francis and Decoteau, (1993) reported that sweet corn yield increase by planted with pea as intercrops due to better use of environmental resources. It also noted that competition between species in maize and peas' intercrop was less than the competition within species. Wahua, (1983) found that nutrient uptake by intercropped maize and cow pea as one of the environmental resources, was higher than pure cropping, and intercrops components were complementary in the use of resources (Eskandari and Kazemi, 2011; Eskandari et al., 2009b).

3- Reduction of pests, diseases and weeds damage

One important advantage of intercropping is its ability to reduce pest and disease damage. In general strategies involved in reducing pest infestation and damage in intercropping can be divided into three groups: First: delimiter crop hypothesis: this way that second species, breaks down the ability of a pest in attack to its host, and is used more in proprietary pests. Second: trap crop hypothesis: means that second species, attracted towards their, pest or pathogen that normally does damage to the main species, and is used more in general pests and pathogenic agents. Third natural enemies' hypothesis: this way that predators and parasites are more attracted in intercropping, than the monocropping, and thereby diminishes parasitized and prey (Danso *et al*., 1987). Although intercropping does not always reduce pest or pathogen, but most reports have pointed to reduced populations of pests and diseases in the intercropping (Fujita *et al*., 1992). In a review by Francis, (1989) on intercropping, in 53% of the experiments intercropping reduced the pest, and in 18% increased the pest than the pure cropping. Increasing pests can be due to several reasons, such as the second crop is a host for pests in intercropping, or increasing the shade in canopy, provides favorable conditions for pests and pathogens activity. In addition plant residues can be as a source for pathogens inoculated (Anil *et al*., 1998; Watiki *et al*., 1993). More species diversity in agricultural ecosystems can limit the plant pathogenic spread. Intercropping systems increases biodiversity like the natural ecosystems. This increase in diversity reduces pest damage and diseases (Anil *et al*., 1998).

It is well known that the weeds interfere with crops causing serious impacts through either competition (for light, water, nutrients and space) or allelopathy. Intercropping patterns are more effective than monocropping in suppression of weeds, but their effectiveness varies greatly (Girjesh and Patil, 1991). Intercrops may demonstrate weed control advantages over pure cropping in two ways. First, greater crop yield and less weed growth may be achieved if intercrops are more effective than pure cropping in usurping resources from weeds or suppressing weed growth through allelopathy. Alternatively, intercrops may provide yield advantages without suppressing weed growth below levels observed in component pure cropping if intercrops use resources that are not exploitable by weeds or convert resources to harvestable material more efficiently than pure cropping. Because of the difficulty of monitoring the use of multiple resources by intercrop/weed mixtures throughout the growing season, identification of specific mechanisms of weed suppression and yield enhancement in intercrop systems has so far proven elusive (Matt and Dyck, 1993). In monocropping systems rarely, all available natural source such as moisture, nutrients and light are used by plant, consequently released nich are captured by the weeds. If used plants in the intercropping, in the use of resources are complementary, in this case intercropping system with more and effective use of ecological resources, and filling the empty nich, leads to weed control are better and effective than the monocropping system (Saudy and El-Metwally, 2009; Altieri, 1995). Soria *et al*., (1975) with corn- cassava and beans- cassava intercrops announced that intercropping is effective in weed control.

4- Stability and uniformity Yield

For farmers who have limited sources, income and stability yield of agricultural systems is very important. When several crops can be grown together, fail to produce a product, could be compensated by other crop, and thereby reduces the risk. Risk of agronomy failure in multi cropping systems is lower than pure cropping systems. It may be an appropriate growth condition for a species and inappropriate for other species (Eskandari et al., 2009a).

5- Improve soil fertility and increase in nitrogen

Conservation of soil fertility in intercropping is a form of rotation that each season is done on land. Rhizobium bacteria are able to have a symbiotic relationship with plants of leguminosae family, and thereby can fixation of atmospheric nitrogen into available nitrogen for plants uptake. And the result nitrogen (as an essential element for soil fertility and plant growth) is added to the soil. There are several reports indicating that increasing the nitrogen content in non-legume plants, due to the intercrops of these plants with plants of leguminosae family (Eskandari et al., 2009a; Anil et al., 1998; Fujita et al., 1992).

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