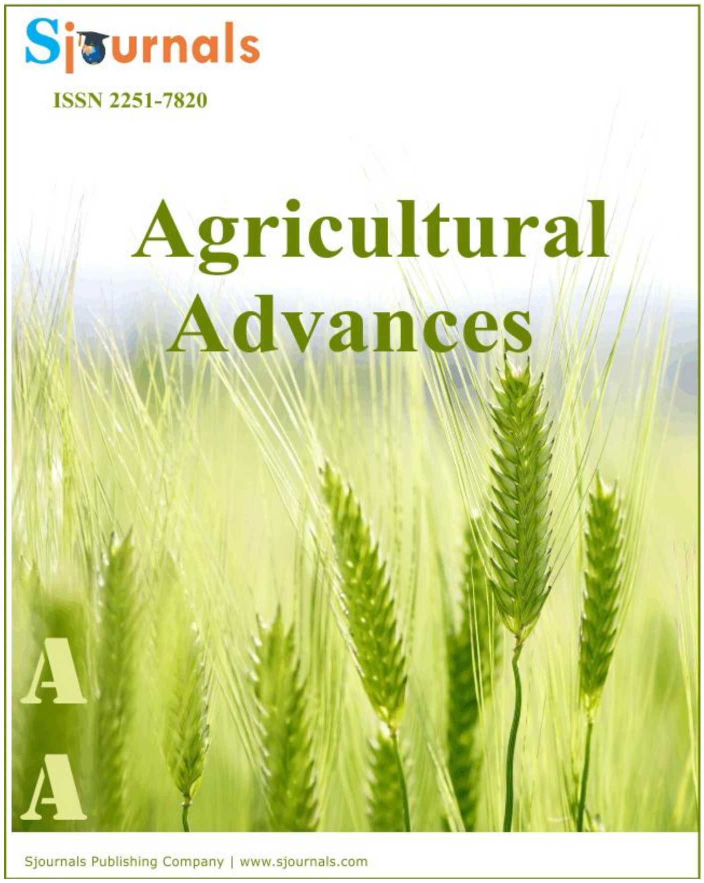
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ISSN 2251-7820
Agricultural Advances
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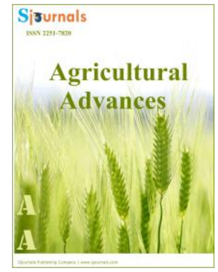
Scientific Journals
Agricultural Advances (2016) 5(3) 269-274
ISSN 2251-7820
doi: 10.14196/aa.v5i3.2154



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Review article

Investigation of crops cultivation systems: A review

Mohammad Hossein Haddadi*
Scientific member of Agronomic and Horticulture Crops Research Department, Mazandaran Agricultural and Natural Resources Research and Education Center, AREEO, Sari, Iran.

*Corresponding author; Scientific member of Agronomic and Horticulture Crops Research Department, Mazandaran Agricultural and Natural Resources Research and Education Center, AREEO, Sari, Iran.

A R T I C L E I N F O

Article history,
Received 19 February 2016
Accepted 18 March 2016
Available online 25 March 2016
iThenticate screening 22 February 2016
English editing 15 March 2016
Quality control 21 March 2016

Keywords,
Crop
Tilage systems
Hydroponics

A B S T R A C T

In order to optimize the use of moisture, nutrients and solar radiation, and to obtaine suitable yield, seeds must be planted under optimum cultivated systems. Intensive production of field crops practiced until recently to achieve high yields required intensive tillage and application of other high-technology inputs. This concept, however, implies a number of problems, among which relationship between product quality and quantity are in the foreground, along with increase crop production which shows an important ecological sustainability. Above all, farmers approach production in terms of the cost effectiveness of the applied system. In order to compact soil loss and preserve soil moisture, a more attention has been focused on conservative tillage involving soil management practices that minimize the disruption of the soil structure. In addition reduced cultivation is considered to be more environmentally friendly and sustainable than the conventional plough-based system. Cultivated systems specialize in the provision of food, feed, and fiber, often at the expense of other ecosystem. Conservation tillage after wheat and barly harvesting were extended in Iran. Hydroponics is a method of agriculture that grows plants without soil using a mixture of water and nutrient salts, commonly called a nutrient solution. The nutrient solution is fully controllable and can be delivered to plants on an as needed basis. This makes hydroponics capable of high yields while minimizing water and nutrient consumption.

1. Introduction

Intensive production of field crops practiced until recently to achieve high yields required intensive tillage and application of other high-technology inputs. This concept, however, implies a number of problems, among which relationship between product quality and quantity are in the foreground, along with increase crop production which shows an important ecological sustainability. Above all, farmers approach production in terms of the cost effectiveness of the applied system.

2. Tillage system

Use of Agricultural mechanization is considered the main factor contributing to the total energy inputs in agricultural system. Tillage represents half of the operations carried out annually in the field consequently, there is a potential to reduce energy inputs and production costs by reducing tillage. Tillage practices are needed to increase agronomic stability and productivity while enhancing the environment.

Since land preparation for double cropping systems requires timeliness, especially when a moldboard plow is used, reduced tillage, mainly NT systems, are becoming widespread. Beneficial effects of the crop residue maintenance on the soil surface include a reduction of soil erosion and runoff, an increase soil water conservation and soil aggregation, and a less use of fossil fuel is not direct effect of crop residue management. Benefits of residue cover include improved soil water storage, enhanced soil organic matter content, nutrient recycling and protection against water and wind erosion. Approximately 24% of Earth's terrestrial surface is occupied by cultivated systems. Cultivated areas continue to expand in some areas but are shrinking in others. As the demand for food, feed, and fiber has increased, farmers have responded by expanding the cultivated area, intensifying production (for example, higher yields per unit land-time), or both. Globally, over the past 40 years intensification of cultivated systems has been the primary source (almost 80%) of increased output. In countries with high levels of productivity and low population growth rates, the extent and distribution of land under cultivation is stabilizing or even contracting (for example, Australia, Japan, the United States, and Italy). The area in agricultural production has also stabilized and begun to contract in China. But some countries, predominantly found in sub-Saharan Africa, have had persistently low levels of productivity and continue to rely mainly on the expansion of cultivated area.

Cultivated systems specialize in the provision of food, feed, and fiber, often at the expense of other ecosystem services. Cultivation has affected the provision of other services in three ways: by conversion of biologically diverse natural grasslands, wetlands, and native forests into less diverse agroecosystems; by the choice of crop species grown and the pattern of cropping in time and space; and by the manner in which crops, soil, and water resources are managed at both plot and landscape levels. For many ecosystem services, significant losses arise as a direct consequence of conversion to agriculture. Subsequent impacts are conditioned primarily by the intensity of cultivation in time and space, by the type and amount of applied inputs, including water, nitrogen, and pesticides, and by the effectiveness with which production inputs and residues are managed.

Soil biodiversity is responsive to the management of cultivated systems (Giller et al., 1997). Cultivation drastically affects the soil environment and hence the number and kinds of organisms present (Karg and Ryszkowski, 1996; Ryszkowski et al., 2002).

In general, tillage, monoculture, pesticide use, erosion, and soil contamination or pollution have negative effects on soil biodiversity. In contrast, no-till or minimal tillage, the application of organic materials such as livestock manures and compost, balanced fertilizer applications, and crop rotations generally have positive impacts on soil organism densities, diversity, and activity. Soil condition can thus be improved by farm practices and, indeed, some soils are in effect created by farmers (Brookfield, 2001).

The magnitude of the human well-being benefits derived from an adequate and nutritious food supply are so large that they are often taken for granted, especially in wealthy countries in which food costs represent a small proportion of disposable income. Likewise, it is very difficult to protect against environmental degradation and loss of ecological services in regions where people experience chronic food shortages. Unless chronic hunger and food insecurity are reduced, the poor will continue to exploit natural resources in the short run, thereby undermining the sustainability of natural ecosystems and consequent food security in the long run (Webb, 2002).

A number of effective soil and crop/vegetation management systems have been developed to minimize soil erosion. They include conservation tillage along with use of crop residue mulch and incorporation of cover crops in the rotation cycle on cropland; controlled grazing with appropriate stocking rates and use of Improved pasture species on grazing lands; and adoption of methods of timber harvesting and logging operations that cause the least amount of soil disturbance (shear blade, tree extractors) on forestland (Lal, 2003). Conservation tillage after wheat and barly harvesting were extended in Iran (Haddadi, 2016).

3. Hydroponics system

Hydroponics is a method of agriculture that grows plants without soil using a mixture of water and nutrient salts, commonly called a nutrient solution. Hydroponics is the science of growing plants in a soil-less medium. The roots feed on a nutrient rich solution that contains all the essential elements necessary for the normal plant growth and development. Plants grown hydroponically are not physiologically different than plants grown in soil. Both inorganic and organic components need to be decomposed into inorganic elements in order to become available for plant uptake (Carpenter, 1994).

In hydroponic culture, dissolved nutrients are delivered to the plant in a solution rather than a soil solution. Therefore, hydroponics allow a gowe: to maintain the plant in an ideal nutrient condition. However, the margin of error is great due to the lack of buffering capacity, which can result in plant starvation or nutritional stress. Hydroponics is an efficient, profitable, and sanitary technology for growing plants. Hydroponics is a valuable means of growing plants in regions with little arable land or regions with large, dense populations (Schoenstein, 1996).

Hydroponic culture allows for increases in density spacing and yields due to minimal competition among roots. For example, hydroponic organic basil production in California spaced their plants at 12.7 cm centers (Schoenstein, 1996). Herbs have the potential to grow up to 25 percent faster in a hydroponic solution compared to soil (Skagg, 1996).

Plants grown hydroponically have a threefold increase in vitamins and minerals compared to plants grown in soil (Skagg, 1996). By the year 2000, Dutch growers will more than likely be totally free of soil (Carpenter, 1994). The significance of hydroponics is in providing a way for the average person to grow their own food without the need of soil, for example, for people living in flats and inner city areas. Correct pH, EC and temperature levels of the water are critically important in hydroponics. Therefore, the help of a controller that monitors these factors is invaluable and will ensure higher success and efficiency rates of the grower. According to Wikipedia (2014), the advantages of hydroponics are the following:

1-No soil is needed for hydroponics. 2-The water stays in the system and can be reused - thus, a lower water requirement. 3-It is possible to control the nutrition levels in their entirety - thus, lower nutrition requirements. 4-No nutrition pollution is released into the environment because of the controlled system. 5-Stable and high yields. 6-Pests and diseases are easier to get rid of than in soil because of the container's mobility. 7-Ease of harvesting. 8-No pesticide damage. 9-Plants grow healthier. 10-It is better for consumption. 11-Soil is usually the most available growing medium for plants. 12-It provides anchorage, nutrients, air, water, etc. for successful plant growth.

However, soils do pose serious limitations for plant growth too, at times. Presence of disease causing organisms and nematodes, unsuitable soil reaction, unfavorable soil compaction, poor drainage, degradation due to erosion etc. are some of them (Ellis et al., 1974). In addition, conventional crop growing in soil (Open Field Agriculture) is somewhat difficult as it involves large space, lot of labour and large volume of water (Beibel, 1960).

Soil-less culture mainly refers to the techniques of Hydroponics‗ and Aeroponics‗. The term Hydroponics‗ was derived from the Greek words hydro' means water and ponos' means labour. It is a method of growing plants using mineral nutrient solutions, without soil (Butler and Oebker, 2006). Terrestrial plants may be grown with their roots in the mineral nutrient solution only or in an inert medium, such as perlite, gravel, or mineral wool. Hydroponics is the technique of growing plants in soil-less condition with their roots immersed in nutrient solution. This system helps to face the challenges of climate change and also helps in production system management for efficient utilization of natural resources and mitigating malnutrition (Maharana et al., 2011). Aeroponics‗ is another technique, more or less similar to hydroponics with only difference that under aeroponics plants are grown with fine drops (a mist or aerosol) of nutrient solution (Ellis et al., 1974). In India, Hydroponics was introduced in year 1946 by an English scientist, W. J. Shalto Duglas and he established a laboratory in Kalimpong area, West Bengal.

He has also written a book on Hydroponics, named as Hydroponics the Bengal System‗. Later on during 1960s and 70s, commercial hydroponics farms were developed in Abu Dhabi, Arizona, Belgium, California, Denmark, German, Holland, Iran, Italy, Japan, Russian Federation and other countries. During 1980s, many automated and computerized hydroponics farms were established around the world. Home hydroponics kits became popular during 1990s. The word hydroponics has been derived from two Greek words hydro means 'water' and ponic means 'working'. Thus, fodder produced by growing plants in water or nutrient rich solution but without using any soil is known as hydroponics fodder or sprouted grains or sprouted fodder (Dung et al., 2010a).

Hydroponics is produced in greenhouses under controlled environment within a short period (Sneath and McIntosh, 2003). A greenhouse is a framed or inflated structure covered with a transparent or translucent material in which the crops could be grown under the conditions of at least partially controlled environment. However, the structure should be large enough to permit a person to carry out cultural operations (Chandra and Gupta, 2003).

The greenhouse for the production of hydroponics fodder can be of hi-tech greenhouse type or low cost greenhouse type as per the financial status of the farmer and availability of building material. Different types of fodder crops viz. barley (Reddy et al., 1988), oats, wheat (Snow et al., 2008); sorghum, alfalfa, cowpea (AI-Karaki and AI-Hashimi, 2012) and maize (Naik et al., 2011; Naik et al., 2012a) can be produced by hydroponics technology.

However, the choice of the hydroponics fodder to be produced depends on the geographical and agro-climatic conditions and easy availability of seeds. In India, maize grain should be the choice as the grain for production of hydroponics fodder due to its easy availability, lower cost, good biomass production and quick growing habit. The grain should be clean, sound, undamaged or free from insect infestation, untreated, viable and of good quality for better biomass production.

3.1. Seed preparation

Soaking of seeds and the rapid uptake of water for facilitating the metabolism and utilization of reserve materials of the seeds for growth and development of the plants is a very important step for production of hydroponics forage. In case of barley (Morgan et al., 1992) and maize (Naik, 2012b) seeds, 4 hours soaking in water is beneficial. Under field conditions, farmers producing hydroponics maize forage have the practice of putting the seeds in a gunny bag tightly and then make it wet and keep for 1-2 days. Nutrient solution and water the use of nutrient solution for production of hydroponics forage is not mandatory as it can also be produced by tap water. There are reports of non-significant improvement in the nutrient content of the sprouts which do not justify the added expense of using nutrient solution rather than fresh water (Sneath and McIntosh, 2003; Dung et al., 2010a).

However, a positive response to added nutrient solution has been reported. The nutrient solution (Dung et al., 2010a) for hydroponics fodder production contained Ca, K, N, Fe, Mg, S, P, Zn, Mn, Cu, Bo and Na at a level of 89.20, 81.90, 75.10, 1.80, 20.80, 43.20, 3.20, 0.40, 0.50, 0.01, 0.10 and 0.10 ppm, respectively. It is quite interesting to note that the hydroponics forage production requires only about 3-5% of water needed to produce same amount of forage produced under field condition (AI-Karaki et al., 2012). For producing one kg of maize fodder, about 1.50 litres (if water is recycled) to 3.0 litres (if water is not recycled and drained out) of water is required (Naik et al., 2013c).

3.2. Yield of hydroponics fodder

For successful hydroponics fodder production, fresh yield and DM content of the crops are important. During sprouting of the seeds, there is an increase in the fresh weight and a consequent decrease in the DM content which is mainly attributed to the imbibition of water (leaching) and enzymatic activities (oxidation) that depletes the food reserves of the seed endosperm without any adequate replenishment from photo-synthesis by the young plant during short growing cycle (Sneath and McIntosh, 2003). In a 7-day sprout, photosynthesis commences around day-5 when the chloroplasts are activated and this does not provide enough time for any significant DM accumulation (Dung et al., 2010b).

4. Results and discussion

In order to compact soil loss and preserve soil moisture, a more attention has been focused on conservative tillage involving soil management practices that minimize the disruption of the soil structure.

Cultivated systems contribute to human health and nutrition primarily by providing food either through subsistence agriculture or through commercial agriculture and food markets.

There seems to be a great potential for developing hydroponics technology for fodder production. Hydroponics fodder can be produced and fed in situations where cultivated fodder cannot be grown successfully. The technology can also be adopted by progressive modern dairy farmers with elite dairy herd and produce hydroponics fodder for feeding their dairy animals. However, further research is needed to develop low cost devices for the fodder production through this technology using locally available materials.

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How to cite this article: Haddadi, M.H., 2016. Investigation of crops cultivation systems: A review. Agricultural Advances, 5(3), 269-274.