# Water Scarcity and Need for Sustainable Water Use

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**Abstract:** Availability of water is the most limiting factor for agricultural sector. More than 90% of the renewable water in the country is used for agriculture, but the sector still cannot provide enough production to meet the demand of the population. On the other hand, with the current conditions the total agricultural products from irrigated farming are 56 million ton and total water used for irrigated agriculture is 83 $bm^3$, therefore water productivity is 0.7 kg/ $m^3$. For the supply of food for the year 2020 the agricultural production should increase to 160 million ton. Therefore the water productivity should increase to 1.6 kg/ $m^3$. Therefore, focus on efficient use of water through irrigation efficiency and improvements in management of water use will be the major challenges in the coming years. [Ahmad Reza Ommani. **Water Scarcity and Need for Sustainable Water Use**. Journal of American Science 2011;7(5):98-105]. (ISSN: 1545-1003). http://www.americanscience.org.

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## Water and Agricultural Economy

The importance of agriculture in the economy is indicated by its significant contribution to the gross domestic product (one-forth of GDP) and the provision of job opportunities to 25% of the labour force (Keshavarz, Heydari & Ashrafi, 2003). Irrigation increases cropping intensity and contributes to expansion of areas suitable for farming. It increases yields, stabilizes output, enables crop diversification, reduces risk and increases farm incomes and employment. Through irrigation is influence on agricultural incomes, irrigation has a multiplier effect on non-farm incomes. Irrigation contributes to food security and poverty alleviation. By improving agricultural productivity, irrigation contributes significantly to overall growth and development.

The issue of water scarcity is further intensified by a high dependence on water. Growing population and its needs for food and drinking water, coupled with a short vision on regional water planning and management, have resulted in an unbalance between water supply and demand. Pollution, climate change and frequent severe droughts have been making the problem even more serious and make the future pretty uncertain. Water resource scarcity and unbalance between supply and demand are leading to high competition for water and consequently greater risks of food insecurity in the region (Ommani and Noorivandi, 2003).

In most countries such as Iran, the agriculture sector is the predominant consumer of water. Historically, large-scale water development projects have played a major role in poverty alleviation by providing food security, protection from flooding and drought, and expanded opportunities for employment. In many cases, irrigated agriculture has been a major engine for economic growth and poverty reduction. However, at the same time, poor communities have tended to suffer the greatest health burden from inadequate water supplies and, as result of poor health, have been unable to escape from the cycle of poverty and disease. Thus, growing scarcity and competition for water stand as a major threat to future advances in poverty alleviation, especially in rural areas. In semi-arid regions, increasing numbers of the rural poor are coming to see entitlement and access to water for food production, livestock and domestic purposes as more critical than access to primary health care and education. Ommani and Noorivandi (2003) pointed out, that scarcity of water resource is unintelligible process. This process is dependent to social, natural and economical factors (Figure 1).

## Water and Food Security

Utilization of new irrigation methods and optimum use of water is a vital element to access food security. Based on the research done by Ommani and Noorivandi (2003), both socio-economic characteristics and environmental conditions of the farm have increased the food insecurity for the Iranian farmers. They suggested that smallholder farmers with under-developed socio-economic and environmental conditions are relatively poor. They concluded that lack of sufficient farm management competencies make higher water and soil erosion, over-fertilization, inadequate application of manure, lack of fallow, overgrazing, burning of crop residue, and over-use of pesticides. Based on this research water is the resource

for food security. Water and food security interact together.

Many of the over 800 million people in the world who still go hungry live in water scarce regions. When FAO launched its Special Program for Food Security in 2003, it was well revealed that limited access to water was often a major constraint to increasing food production. A key question for the future is whether water shortage will act as a serious brake on food production during the coming decades (FAO, 2002).

FAO (2001) pointed out; that global population will continue to expand at a rate of 1.1 percent until 2015 and more slowly thereafter. Today's population of 6000 million will reach 8100 million by 2030, an increase of about 33 percent. As a result, demand for food will increase over this period but at a slowing rate. The nature of the demand will also change as incomes rise and urbanization continues. The urban population is expected to increase from 43 percent of the world population in 1990 to 61 percent by 2030.

The growing population and changes in food priorities will result in a strong demand for additional food production, though the types of grains demanded for food and feed, and the mix of grains and animal products in the diet, will change. Although net food imports into the developing countries are expected to increase, most of the increasing demand in developing countries will be met by increased local production. According to FAO (2002), increases in demand can be met in three ways:

- increasing agricultural yield;
- increasing the area of arable land; and
- increasing cropping intensity (number of crops per year).

Over the past 30 years, most of the increase came from yield, mainly as a result of the Green Revolution. This is expected to be case in developing countries over the next 30 years, with 69 percent of the increase in was resulted from yield, 12 percent increases in cropping intensity and the rest from increase in the area of cultivated land. Much of increase in crop production will come from irrigated land, three-quarters of which is in the developing countries. Currently, some 20 percent of agricultural land in the developing countries is irrigated and it provides about 40 percent of crop production in these countries (FAO, 2001).

FAO (2002) pointed out, that over the past 30 years, the irrigated area expanded at about 2 percent a year, giving a total increase of some 100 million hectares during 1962–98. Irrigated area in developing countries in 2000 was nearly doubled than, what it was in 1962. FAO (2002) expects that irrigated areas in 93 developing countries could grow by 0.6 percent yearly between 1998 and 2030. Such a rate of growth would lead to only a 23 percent increase in irrigated area over the period. However, when coupled with increase in cropping intensity, the effective harvested irrigated area is expected to increase by much more: from 241 to 323 million hectares, a 34 percent increase. Will there be enough freshwater to satisfy the growing needs of agriculture and other water uses. Agriculture already accounts for about 70 percent of the freshwater consumption in the world and is seen as the main factor behind increasing global freshwater scarcity.

Analysis of 93 developing countries by FAO shows comparatively encouraging conclusions on this question. During the period 1998–2030, irrigation water consumption in these countries is expected to grow by a total of only about 14 percent, from the current 2 128 km3/year to 2 420 km3/year in 2030. This increase is low compared to the increase projected in the harvested irrigated area. Much of this difference is explained by an expected improvement in irrigation efficiency, leading to a reduction in the withdrawals needed for irrigation water per irrigated hectare. Another reason for this reduction is due to a change in cropping pattern for some countries, such as China, where a substantial shift from rice to wheat production is expected: irrigation water requirements for rice are usually twice those of wheat.

**Water Quantity**

**1. Renewable Fresh Water Resource**

The main source of water in Iran is precipitation both rainfall and snow, estimated the mean range of 1995 to 2000 to be 415 billion cubic meters ($bm^3$). About 72% of the total rainfall directly evaporates and by taking in to account 13 $bm^3$ of water entering from the borders, the total potential renewable water resource are estimated to be 130 $bm^3$. Currently, the total water consumption is approximately 88.5 $bm^3$, out of which more than 93% is used in agriculture, while less than 7% is allocated to urban and industrial consumption. Under the present situation 82.5 $bm^3$ of water is utilized for irrigation on 7.5 million hectares of land under irrigated agriculture (Ommani and Noorivandi, 2003).

**2. Non Renewable Groundwater Resource**

Groundwater continues to be one of the dominant sources of bulk water in Iran. Its use has been essential for meeting water demands and household food security. In addition to being a regular source of water under normal climatic conditions, it plays a critical role in food supply and livelihood security during dry periods, in view of its ability to act as a buffer against drought and precipitation variability. Increased access to groundwater reduces risk substantially enabling many formers make out of poverty. From the environment perspective, groundwater plays another role of no less importance (Keshavarz, Heydari & Ashrafi, 2003).

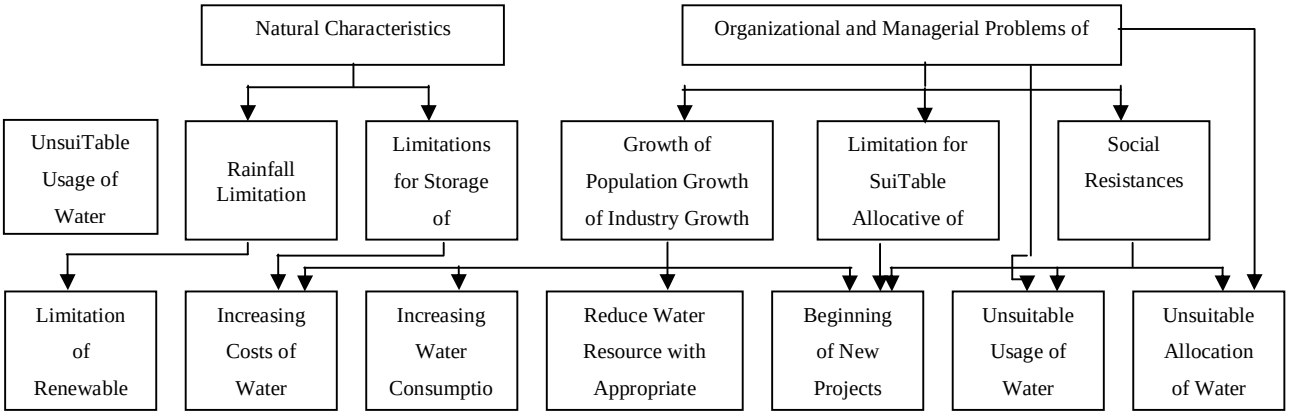


Figure 1. Factors Affected On Water Scarcity Source: (Ommani and Noorivandi, 2003)

Shortages of groundwater in areas of excessive abstraction and groundwater pollution by various sources are now common in the region and emphasize the importance of correct estimates and proper development, regulation and protection of supplies, in order to ensure the continued availability of this key natural resource (Ommani and Noorivandi, 2003). However, the management of groundwater has not always met the required standards and there are clear indications of major problems with over-abstraction and its consequences in many parts of the region. The available information clearly indicates that groundwater over-abstraction and quality degradation are among the major emerging problems in the Iran. In several parts of the region, over-abstraction is severe and water levels are declining at rates that range from 1-3 meters per year. Water level changes and fluctuations are the most important factors influencing access to groundwater for the environment and human uses. Even small drops in groundwater level can have substantial impacts on surface water availability because of the close link between surface and groundwater (Keshavarz, Heydari & Ashrafi, 2003).

**3. Water Scarcity**

The demand for water in Iran continues to grow due to population growth and the push for economic development. Population growth at high rates has steadily reduced the per capita share of water resource over the past half century, offsetting socio-economic plans and putting high pressure on the limited water resource (Najafi, 2006). The international costs of strategic food security crops are highly sensitive to variations in water supply, which directly or indirectly depend on rainfall. Under the prevailing arid and semi-arid climatic conditions in the Iran, reliable food production depends heavily on water resource (Saxena, 2006).

In today's world, water continues to be central to food security, environmental health, recreation, energy production, transportation, etc., and thus to the overall well being of the people (Keshavarz, Heydari & Ashrafi, 2003). Although most of the surface of planet earth is covered with water, only about 2.5 % of it is fresh water and less than 1% is available for human use. Saxena (2006) pointed out, that many countries of the West Asia and North Africa region are already facing severe water poverty and the situation here is likely to worsen in the years to come because of the demographic pressures and climatic change.

**4. Water Quality**

In Iran intensification of agricultural and industrial activities has led to the contamination of surface and ground water by fertilizers and other chemicals, a rapid rise in the level of groundwater, which leads to water logging and soil salinity, and high loads of the most common water pollutant (organic matter from domestic sewage, municipal waste and agro-industrial effluents). Similar situations exist in many other countries of the region (FAO, 2003a).

Sewage water is a source of pollution of both surface and ground water resource. It is produced mostly from large cities in urban areas. Sewage water is treated and released for agricultural use in many

countries. Industrial liquid waste is hazardous and contaminates large quantities of freshwater with small volumes produced from industrial plants. The industrial plants should be built far from watercourses and groundwater basins and should not e allowed to dump their wastes in hazardous areas without prior treatment. Pesticides, insecticides and fertilizers, which are used intensively in agriculture, might cause serious contamination to freshwater resource, and pose a threat to both human health and the environment (FAO, 2003a,b).

**5. Agricultural Water and Poverty**

Based on Asian Development Bank (1999) poverty is multi-dimensionally complicated, and is the result of myriad interactions between resource, technologies, institutions, strategies, and actions. The multidimensional character of poverty has been reflected in a wide array of papers, poverty reduction strategies, and policies (Asian Development Bank. 1999). World Commission on Dams (2000) pointed out, that although water provides only a single element in the poverty equation, it plays a disproportionately powerful role through its wide impact on such factors as food production, hygiene, sanitation and food security, and the environment. Indeed, development agencies, groups, and experts worldwide are increasingly recognizing the important role that water can have on poverty (World Commission on Dams, 2000). Within the water and poverty debate, agricultural water holds a unique place. While solutions to other dimensions of the water and poverty problem such as sanitation, hygiene, and potable supplies, generally call for increased expansion of services, the agricultural water problem requires drastic improvements in existing services. Furthermore, agriculture is now the world's largest user of water, consuming 80–90% of annual utilized supplies and providing livelihood for most of the world's poor.

Biltonen et al (2002) pointed out, that within agriculture, water is a vital resource for many productive and livelihood activities and many developing countries have promoted water resource development over the last 5 decades to improve social outcomes. Huge investments have been made in water resource to achieve such broad objectives as economic growth, rural and agricultural development, national food security, famine protection, and land use intensification. Hussain et al (2004) also claims that irrigation development has been regarded as a powerful factor for providing food security, protection against adverse drought conditions, increased prospects for employment and stable income, and greater opportunity for multiple cropping and crop diversification. Access to reliable irrigation can enable farmers to adopt new technologies and intensify cultivation, leading to increased productivity, overall higher production, and greater returns from farming (Hussain et al, 2004)

Hussain et al (2004) pointed out, that there are five key interrelated dimensions of the relationship between access to good agricultural water, socioeconomic uplifting in rural communities, and poverty reduction. The dimensions are production, income/consumption, employment, vulnerability/food security, and overall welfare (Figure 2). In addition, Rezaei-Moghadam and Karami (2006) described relationship between poverty and sustainability of agricultural systems. The linkage between sustainable agriculture, poverty and agricultural extension efforts and their impacts on rural centers has been discussed in this study. The findings of path analysis in three different causal models provide the complexity of relationships between variables and environmental degradation so that there is a causal relationship between poverty and sustainability. Lack of direct causal effect of use of technology and extension efforts on sustainability in three models indicated the structural and institutional limitations of extension in diffusion of appropriate technologies. Finally, recommendations regarding regional planning with respect to socio-economic characteristics and changing from transfer of technology approach to other alternatives and revising the education programs of extension agents are provided.

Based of Figure 3 negative direct causal effect of poverty on sustainability indicated the relationships between poverty and environmental degradation lack of direct causal effect of use of technology and extension efforts on sustainability indicated the structural and institutional limitations of extension in diffusion of appropriate technologies.

**6. Water Scarcity and Need for Sustainable Water Use**

Water scarcity, defined in terms of access to water, is a critical constraint to agriculture in many areas of the world. A fifth of the world's people, more than 1.2 billion, live in areas of physical water scarcity, lacking enough water for everyone's demands. About 1.6 billion people live in water-scarce basins, where human capacity or financial resource are likely to be insufficient to develop adequate water resource. Behind today's water scarcity lie factors likely to multiply and gain in complexity over the coming years (Molden, 2007).

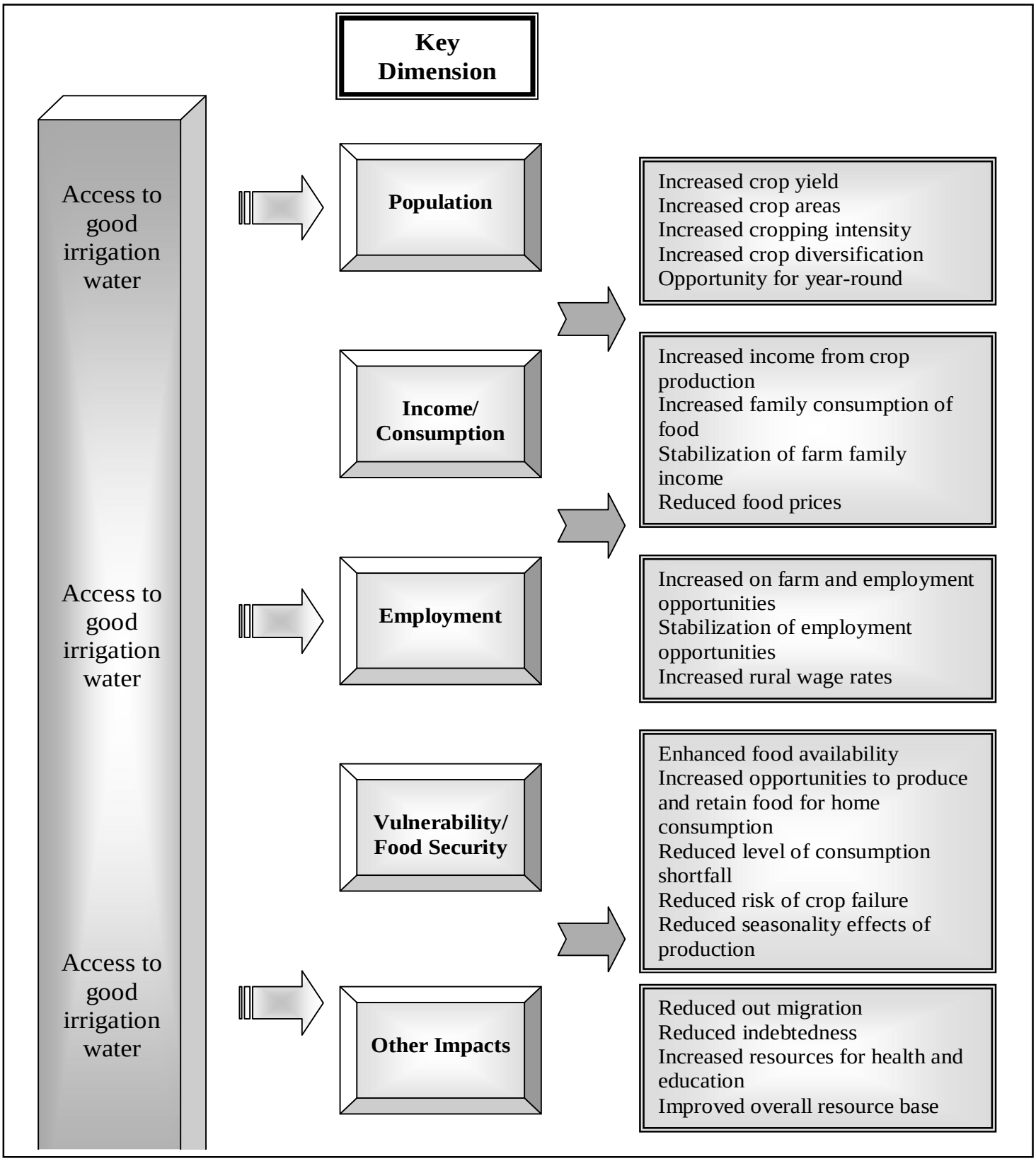


**Figure 2.** Agricultural Water and Poverty Reduction: Key Dimensions Source: (Hussain et al, 2004)

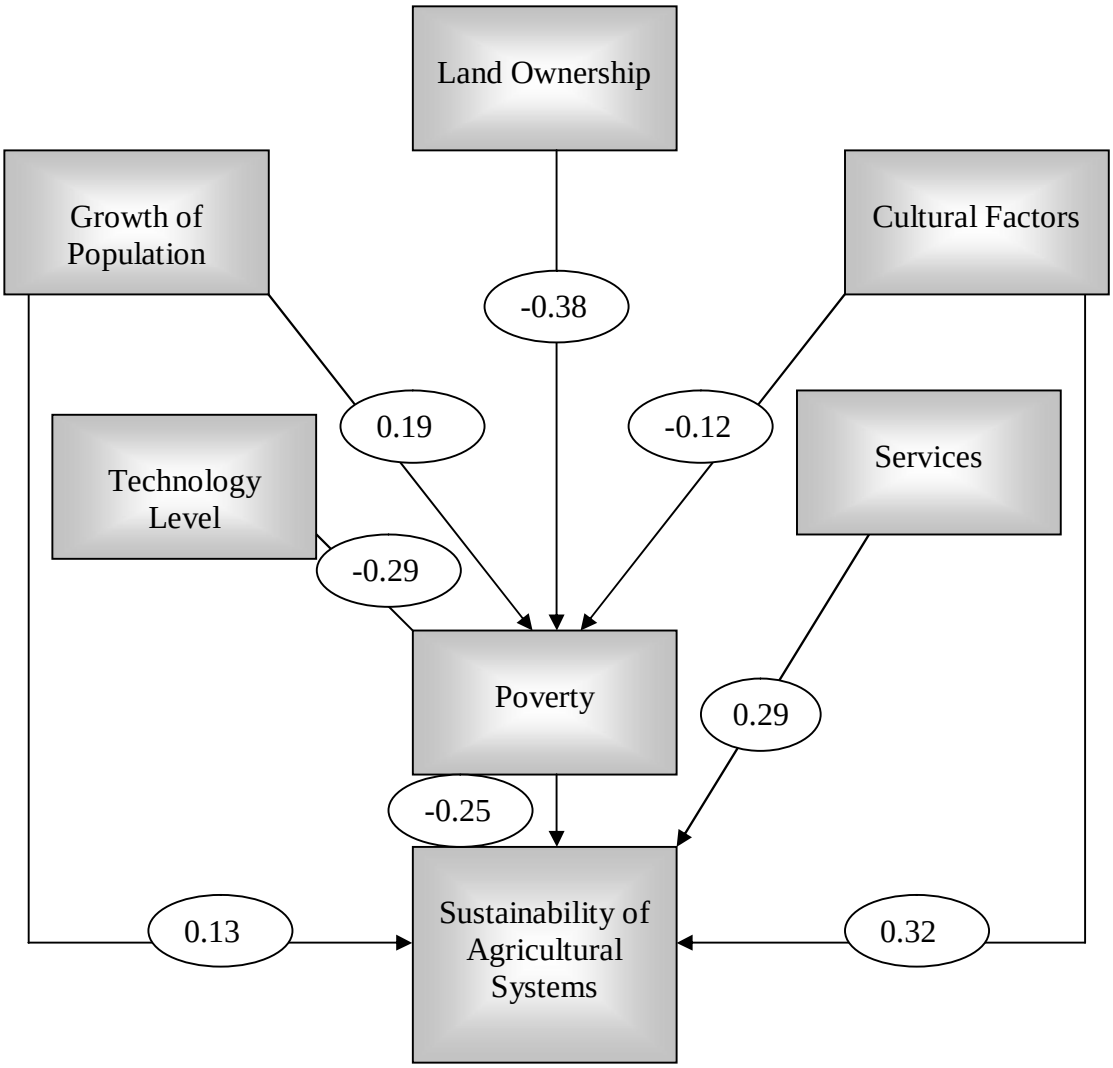


**Figure 3.** Relationship between poverty and sustainability of agricultural systems.
Reference : (Rezaei-Moghadam and Karami, 2006)

A growing population is a major factor, but the main reasons for water problems lie elsewhere—lack of commitment to water and poverty, inadequate and inadequately targeted investment, insufficient human capacity, ineffective institutions, and poor governance. Water and food security are strongly connected. Many of the nearly 800 million chronically undernourished people live in water-scare regions. In these areas, limited access to water often plays a major constraint to improving food production. Global population will continue to expand. The increase in population and changes in food preferences will result in a strong demand for additional food production (FAO, 2001). It is expected that much of the increase in crop production will come from irrigated lands, as irrigated agriculture is much more productive than rain-fed agriculture - irrigated agriculture contributes nearly 40 percent of world's food production on 17 percent of cultivated land. However, agriculture already counts for 70 percent of the freshwater withdrawals in the world - for developing countries this figure is even as high as 85 percent - and is seen as the main factor behind increasing global water crisis (FAO, 2003a).

The key to increase world's food production without deepening the global water scarcity is improving the efficiency in the use of irrigation water. At irrigation scheme and farm level, irrigation efficiency can be sometimes as low as 30 percent. The gains from introducing effective water management and improved irrigation and water-control techniques and technology can be tremendous both in terms of water saving as well as in increase in productivity and stabilization of erratic food production (FAO, 2003a).

**7. Recommendation:**

Therefore, focus on efficient use of water through irrigation efficiency and improvements in management of water use will be the major challenges in the coming years. Recent events of drought in the country have resulted in the reduction of water productivity in farming. In recent years Khuzestan Province encountered with shortage of water resource (Organization of Agricultural-Jihad of Khuzestan, 2004). Sustainable water resources management in agriculture and increasing the water use efficiency in Khuzestan Province has a vital role for conservation of water resources.

Allahyari and Chizari (2008) Indicated that Iran's extension system dos not pay enough attention to necessity characteristics of extension organization to accomplish environmentally sound agriculture and these attributes are not favorable situation. These conditions necessitate reorganizing of extension institutions to accomplish sustainability.

Considering unsustainable agricultural conditions of Iran (Ommani and Chizari, 2008), organizational recession and inability of current extension organizations (Allahyari and Chizari, 2008) to accomplish of sustainability, it seems that extension systems require a new structure and contents to achieve sustainability objectives.

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