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The Role of Optimizing Agricultural Water Resource Management to livelihood Poverty abolition in Rural Iran

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Abstract: Most of the projected increase in global population will take place in third world countries that already suffer from water, food, and health problems. As a vital agricultural resource, irrigation water is important for the productivity of a society and the livelihood of its members. With a common belief in the important role of irrigation in agricultural development, many developing Asian countries have promoted irrigation development over recent decades. These efforts have sought to achieve such broad objectives as economic growth, rural and agricultural development, food security, and protection against adverse drought conditions, with all of these goals expected to contribute to improved social outcomes. Through these benefits, irrigation water is linked to poverty alleviation, both directly and indirectly. This study examines agricultural intensification through the practice of irrigation as a strategy for poverty reduction. In addition, this study aims to empower water users with information on agricultural wastewater.

Key words: Water management, Water Waste Management, Poverty alleviation, Rural livelihood, Agricultural water,

INTRODUCTION

Iran contains both arid and semiarid regions with an annual average precipitation of 250 mm, which is less than one-third of the global average. Also, evaporation in Iran is greater than the global average, ranging between 200 and 1500 mm; about 27% of rainfall evaporates directly. Approximately 50% of rainfall is concentrated in 21% of the country. During recent years, especially from 1999-2001, the level of rainfall in Iran dropped well below average. Currently, total water consumption is approximately 88.5 bm^3 per year, of which more than 92 -94% is used in agriculture and less than 7% is allocated to urban and industrial consumption. In total, 82.5 bm^3 of water is utilized for irrigation on 7.8 million hectares of cultivated land. The irrigation potential in Iran is estimated at 37 million ha, with only 7.8 million ha currently receiving irrigation water, representing 21% of the potential. Of the total arable land, about one-third is irrigated by traditional systems. For the 1.2 million ha under modern irrigation systems in Iran, regulators are seeking to improve water use and reduce water losses. Keshavarz, Heydari and Ashrafi (2003) observed that overall irrigation efficiency in Iran ranges from 33-37%, lower than the average for both developing countries (45%) and developed countries (60%). It is important to note that Iranian farmers use far more water per hectare than do other farmers around the globe. In 28% of Iran's 165 million hectare area, annual precipitation is 100 to 200 mm; about 37 million hectares are suitable for irrigated farming (Keshavarz *et al.,* 2003).

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FAO (2003) reported that in Iran, where 36% of arable land is cultivated, water constraints are the main limit on cultivated area expansion and yield improvement.

FAO (2003) stated that important efforts are currently underway to promote the use of pressurized irrigation systems; at present, 2,500,000 ha are equipped with drip and micro irrigation. The goal is to increase this area by 100,000 ha annually, in order to reach 1 million ha by the year 2030 (FAO, 2003).

Research has confirmed that irrigation development does reduce poverty (Carriger, 2005; Hussain *et al.,* 2004).

Irrigation development directly boosts yield and gives farmers the water security they need to take risks with new crops and to enhance inputs such as fertilizer and seeds. The World Bank (2005) pointed out that agricultural water management (AWM) is not a goal in itself but part of a process of resource management that provides critical input to agricultural production and farmer incomes (World Bank, 2005).

As stated by Malakmohammdi (2009-06-04), extension education is necessary for agricultural functional promotion and human capital development in the agricultural sector. Extension education seeks to convert human resources (HR) to human capital (HC) and to mobilize people with valuable knowledge and technology through the formation of partnerships. Agricultural extension is no longer simply focused on improving yields and producing food. Large numbers of subsistence farmers have to break out of poverty not just financial poverty but also information poverty, skill and competency poverty and cultural poverty (Malak Mohammadi, 2009).

Water, Agriculture and Food Supply:

Agriculture is now and will continue to be a key source of livelihood for low-income countries and the poor who live there. In these countries, 80% of export earnings come from the agricultural sector, which uses more water than any other enterprise UND, (2004).

As stated by Takashi (2001), agriculture is the major economic sector in most developing countries Takashi, (2001).

For many developing countries, agriculture is still the largest productive sector in the economy, the source of the most economic growth and employment, and a large contributor to export revenues. In Iran, agricultural development is one of the most important sectors and represents a high percentage of production and employment. According to various studies, the agricultural sector in Iran has not undergone significant development over recent decades. The most important challenges to production are inadequate resource management and the degradation of soil and water resources.

Water has been predicted to be the oil of the twenty-first century, meaning that successful water management will be the key to future economic growth and social wealth in both developed and developing countries Clothier, (2000). Smith (2008) referred to Beddington as he said: by 2030, rising world populations will require a 50% increase in food production; [in a way] that by 2080, food production must double (adapted from Malakmohammdi, 2009). Population increases and improved living standards brought about by development will result in a sharp increase in food demand over the coming decades. Most of this increase will be met by the products of irrigated agriculture (Bouwer, 2000; Playan and Mateos, 2006). Rahaman *et al* (2004) pointed out that from a global perspective, the agricultural sector is the world's largest user of water, accounting for almost 90% or water usage. This intensive use of water is expected, since water is the essential requirement for all forms of food production. The traditional concept of agricultural productivity (yield per unit of land) will be supplanted by a new paradigm of systemic productivity, dependent on adequate water resources (Rahaman *et al.,* 2007).

Irrigated agriculture accounts for 80% of water consumption worldwide (Peter, 2004). Irrigation provides 40% of the world's food from only 17% of the cropped areas (UND, 2004). According to recent reports, over 60% of the world's irrigation is in Asia. Since 1965, the irrigated area has almost doubled in Asia so that irrigated agriculture is now a main source of food security, higher farm incomes and improved welfare among rural populations (Barker, 2002).

Agriculture, food and water are the basics which are essential for the day-to-day well-being and survival of mankind the world over. This is particularly true in the developing world, where poverty, famine and diseases frequently threaten the livelihood of most communities. Within the agricultural sector, irrigation is often the dominant contributor to value added, employment, and exports. Thus, agricultural policy issues affecting the irrigated sector form an important part of overall agricultural policy particularly those related to trade and incentives, input and output marketing and prices, investment, and food security.

Agricultural water use raises significant issues for water resource management, including issues related to water scarcity, competing demands from other sectors, irrigation service delivery and system management, and water use efficiencies. Unfortunately, 60% of water designated for agricultural use is lost because of leakage and inefficient irrigation systems. The primary objective in coming years will be to balance water supply and demand among users to ensure adequate water for agriculture and sustainable irrigation system management while satisfying other needs. Limited and unreliable access to water negatively impact agricultural productivity in many regions since rainfall is variable, an issue that is likely to increase with climate change.

The key objective over the next decades will be to ensure that irrigated agriculture enhances the sector's value added, farmers' incomes, and food security at the global, national, and household levels by rapidly meeting the rising demand for food at affordable prices. Today, huge losses in irrigation systems and poor water management practices have worsened the water crises that already exist in many countries. Notably, irrigation and poor drainage lead to waterlogging and salinization (Schultz, n.d).

The world's population is expected to increase from 6 billion to 10 billion by mid-century, which will lead to greatly increased demand for food, primarily from developing countries (Malak Mohammadi, 2009; Rahaman *et al.,* 2004). Much of the projected increased demand for food will have to be addressed by improved and expanded irrigation. However, this represents only a partial solution. Most irrigation systems are financially out of reach for poor landholders. While agricultural water management and development play an important part in poverty reduction, they are not sufficient to banish poverty.

According to the world development report published in 2006, the challenges facing agricultural water management include: (1) policy and institutional challenges, (2) economic and financial challenges, (3) declining investment, (4) the inability of technology and water resources to supply growing demand, (5) poverty and rural income challenges and (6) environmental factors and the sustainability imperative. The main problems facing agricultural water management in Iran include: water scarcity, ground water depletion, pollution, water logging and salinity. These are symptoms of a comprehensive water supply problem embedded in policy, institution and market failures related to the development of water resources (FAO, 2003).

The Relationship between Water for Agriculture and GDP:

Ward *et al* (2005) show that agriculture in most locations generates the lowest value added per unit of water compared to other water-using sectors. Within the agricultural sector, however, there are numerous ways to improve the return on investments in water. Higher return on water investments will boost incomes for farmer (Ward *et al.,* 2005). Beaumont (2002) and Shetty (2007) reported the region including the Middle East and North Africa (MNA) is one of the most water-scarce regions in the world. A regional annual average of 1,200 cubic meters per person, roughly sevenfold below the world average of 7,000'. By 2025, population increases are projected to drive regional average water availability down to just over 500 cubic meters per person per year (Beaumont, 2002; Shett, 2007).

Rural economic activities are related to three sectors: agriculture, industry and services. The total rural population in Iran is 23 million, the majority of whom are poor. About 50% of active rural populations are employed in agriculture. While agriculture and the rural economy are important elements in MNA countries, the relative contribution of agriculture to overall GDP in most countries is low and has been declining. Iran uses 92% and 2% of its water in agriculture and industry, respectively, but these sectors contribute19 % and 22 % of GDP, respectively. Thus, 1 % of water consumption contributes to 0.21% and 11% of GDP in agriculture and industry, respectively (Table1). The wide gap between water use and GDP contribution for agriculture is even more apparent when contrasted with similar parameters in the industrial sector. From a narrow macroeconomic perspective, the rationale for justifying the allocation of water to agriculture as opposed to the industrial and other sectors is weak Shett, (2007).Thus, as Iran confronts the water crisis, there will be increasing pressure to allocate water away from agricultural to industrial and municipal uses, as well as to increase water efficiency within the agricultural sector.

Beaumont (2002) and Shetty (2007) believed that Economic theory argues that only when the price paid for a commodity reasonably reflects the true price can market forces work for efficient distribution. Thus, water subsidies lead to waste in agricultural practices and limit the incentives for research and development related to conservation techniques. Empirical evidence shows that farmers are price-responsive in their use of irrigation. The four main types of responses to higher water prices are to use less water for a given crop, to adopt water-conserving irrigation technology, to shift water applications to more water-efficient crops, and to change the crop mix to include higher-value crops. However, these responses have to be balanced against the fact that for most countries in the world, the water price has elastic ties to a low in agriculture, and Iran is no exception (Beaumont, 2002; Shett, 2007).

Table 1: Water Consumption and GDP Contribution.

Agricultural Sector		%GDP contribution per unit water	Industrial Sector		%GDP contribution per unit water
Consumption	GDP%		Consumption	GDP%	
92	19	.21	2	22	11

Extension and Human-Oriented Management:

As stated by Shen and Varis (2000), the water resource management crisis is the result of poor management rather than of modern technologies. Technology-oriented management should be balanced with human-oriented management Shen and Varis (2000). Akpabio *et al* (2007) pointed out that equitable resource allocation, efficient and balanced resource use, participation of stakeholders in decision making and recognition of linkages and interactions among human and physical systems are key principles in integrated water resource management (Akpabio *et al.,* 2007). Rahaman *et al* (2004 (believed that to be effective, water management must take a holistic approach, linking social and economic development with the protection of natural ecosystems. Moreover, technological innovation is important for water resource development. However, efficient and effective water resource management should not rely only on technology (Rahaman *et al.,* 2004). FAO (2003) reveal that for improving irrigation management, efforts are focused on the empowerment of water users associations and their involvement in resource management (FAO, 2003). Iranian agriculture has suffered from inefficient resource management by actors within the sector, rather than by limited natural resources. Thus, it is essential to give more consideration to human resources in the agricultural sector. Since farmers and water users are the primary active human resources in the agricultural sector, it is necessary to increase their competence in order to improve the efficiency and productivity of farming. Today, this is becoming increasingly important because of the competitiveness within the sector.

Evenson (1997) believes that agricultural extension and education will impact the economics and sustainability of agriculture by providing information to induce farmers' awareness and knowledge through testing and experimentation, farmers' adoption of new technology or practices, and changes in farmers' productivity (Evenson, 1997). Van den Ban and Hawkins (1996) assert that agricultural extension is a public service for human resource development (HRD) in the agricultural sector (Van *et al.,* 1996). MalakMohammdi (2009) pointed out, although, it should be contemplated that extension is not the magic wand that will change agriculture overnight. Nonetheless, extension will impact human capital development through agricultural literacy, thus enhancing economic growth (Malak Mohammadi, 2009). Ravnborg *et al*., (2007) point that that achieving this goal will also require complementary investments in education, health, rural infrastructure, capacity building, and supportive institutions, in combination with pro-poor, pro-gender equity research on low-cost and gender-suited technologies, crop research advances, improved agronomic and water management practices, and related dimensions of social exclusion, equity, and empowerment. This process requires a host of actors, including nongovernmental organizations (NGOs), research organizations, governments, the private sector, and donors. Holistic and integrated assessment of needs, possible interventions, and their interactions will be the keys to achieving sustained improvements in water use for poverty reduction (Ravnborg *et al.,* 2007).

Focus on Poverty:

At its most extreme, poverty threatens human survival, but for people living in poverty, it is a multi-dimensional experience that encompasses a range of factors including, but not limited to, survival (UND, 2004). The World Bank as well as many other international organizations have asserted that reducing poverty and eliminating hunger are among the most fundamental challenges we face. Today, more than 1.3 billion people are compelled to live on less than one dollar a day. More than 800 million people go hungry because they cannot afford to buy the food that their families need. Moreover, the numbers of poor and hungry people will surely continue to grow unless action is taken now. In order to reduce poverty and end hunger, it is necessary to focus attention on the rural economy. Nearly three out of four of the world's poor and hungry people live in rural areas. Although the absolute number and the proportion of poor people living in cities are both sure to grow rapidly, the majority of the poor will continue to live in the countryside well into the next century (Ward *et al.,* 2005).

World Bank, as well as many other international organizations, has revealed well that reducing poverty and eliminating hunger are among the most fundamental challenges we face, especially, as Malakmohammadi (2009) stated, in the most vulnerable areas of the world such as Asia and Pacific Region that accounts for 57% of the world's population (nearly 3.2 billion), about half of that population will be younger than 25 in 2010, more than 80% of the world's smallholder farmers and 73% of the total farming households live in, two-thirds

of the world's hungry and poor are found here, 800 million people who are poor and 500 million of them who are malnourished (Mala Mohammadi, 2009).

The ICARDA Medium-Term Plan (2006- 2008) showed that poverty is widespread in dry areas, demonstrating that lack of water affects economic and nutritional wellbeing as well as the availability of natural resources. The rural population is largely dependent on agriculture, and the agricultural sector faces a number of converging environmental trends that reduce options, drive migration and threaten the future sustainability of livelihoods, particularly in the most marginalized areas (e.g., mountains and desert margins) (ICARDA, 2006). Ward *et al* (2005) indicated that rural development is holistic and multi- sector. It is necessary to focus on improving the well-being of rural people by helping them to build productive social and environmental assets for the 21st century. Importantly, agriculture continues to be a fundamental instrument for sustainable development and poverty reduction (Ward *et al.,* 2005).

Iran's population is approximately 70.495 million, of whom 31.36% live in rural regions, 23.4% of the total population is classified as active in the agricultural sector. This percentage is equivalent to 3.611 million people of the 23.469 million active in the economic sector. In 2004, the poverty line rose to 29% in rural states and to 28% in urban areas. Thus, the proportion of people classified as poor has increased since 2004 Sci, (2007). Water is an important livelihood asset, particularly for the rural poor who depend on agriculture. Better water management is a promising pathway to fight poverty, improve equity, and empower poor men and women. Livelihood activities depend on water availability to varying degrees. For example, rain-fed farming and extractive activities like forest gathering depend on green water. Intense agriculture and hence at least a part of the farm wage component depend on blue water Phansalkar, (2005). Rahaman *et al.,* (2004) maintain that a lack of access to adequate water for household use and food production and the lack of a clean environment are among the basic determinants of poverty. Poor water management hurts the poor most drastically. The Boone conference focused on water as a key to sustainable development and urged that policies for all aspects of water management should be intimately linked to poverty reduction and economic growth (Rahaman *et al.,* 2004).

Impacts of Irrigated Water:

As a vital resource in agriculture, irrigation water contributes to many livelihood activities Hussain, (2004). Irrigation contributes to agricultural growth by raising the productivity of land and labor (and augmenting input such as seeds and fertilizer) (Akpabio *et al.,* 2007). Inappropriate irrigation management has contributed to environmental problems including excessive water depletion, falling water tables due to excessive mining and water quality reduction, water logging, salinization, and poor irrigation practices accompanied by inadequate drainage that has often damaged the soil. Due to the important role of irrigation in agricultural growth, developing countries such as Iran need to promote irrigation development in order to achieve such broad objectives as economic growth, rural and agricultural development, food security and protection against adverse drought conditions.

Smith (2004) points out that many poor people in the rural areas of developing countries depend largely on their own productive activities for subsistence and have very little cash income Smith, (2004). Akpabio *et al* (2007), Smith (2004), Hussain (2004), Hussain *et al* (2004), Hussain and Hanjra (2004) and Chambers (1988) report that irrigation can increase the yields of most crops. Furthermore, irrigation leads to less risky and more continuous levels of rural employment and income. Irrigated as compared to rain-fed agriculture is conducive to higher cropping intensities that improve yields, allowing the cultivation of higher-value crops and the use of sophisticated cultivation techniques (Akpabio *et al*., 2007; Chambers, 1988; Hussain, 2004.a.b.c; Smith, 2004).

One such intervention is micro-irrigation technologies, commonly in use in water-scarce areas of developed countries. These technologies provide the ability to use water more efficiently in irrigated agriculture. Micro-irrigation technologies can also improve productivity, raise incomes by improving crop yields and outputs, and enhance household food security. Numerous studies have established the benefits of micro-irrigation; several government and non-government organizations are engaged in actively promoting these technologies. The main constraints contributing to the low rate of irrigation development in Iran have been identified as:

- Lack of a comprehensive national irrigation policy and comprehensive legal framework for irrigation development
- Inadequate coordination within the irrigation sector that has led to duplication of efforts, conflicts of interest and inefficiency in the utilization of water resources
- Inadequate funding for irrigation development
- Uneven distribution of water resources in terms of seasons and regions

- Lack of adequate infrastructure
- Lack of adequate credit facilities

According to research performed by the International Water Management Institute (IWMI), one-third of the world's population will face absolute water scarcity by the year 2025. Among the worst hit will be regions in Asia, the Middle- East and sub-Saharan Africa, home to some of the largest concentrations of rural poverty in the world. Policymakers, researchers, NGOs, and farmers are pursuing various technical, institutional and policy interventions to meet this challenge (Varma *et al.,* 2006). Smith (2004) reveals that there are four major inter-related mechanisms through which irrigated agriculture can reduce poverty:

(1) Improvements in the levels and security of productivity, employment and incomes for irrigating farm households and farm labor;

(2) Linkages in the rural economy;

(3) Increased opportunities for rural livelihood diversification; and

(4) Multiple uses of water supplied by irrigation infrastructure (Smith, 2004).

Hussain *et al* (2004) assert that there are five key dimensions of the relationship between access to good agricultural water and socioeconomic improvement in rural areas: production, income, consumption, employment, vulnerability, food security and overall welfare (Hussain *et al.,* 2004). Hussain (2004) maintains that irrigation can influence poverty through three pathways:

a) Micro-pathway: through increasing returns and enhanced social capital for poor households (productivity pathway); b) Meso-pathway: by integrating the poor into factor-product and knowledge/information markets (market participation pathway); and c) Macro-pathway: through improving growth rates and creating second-generation positive externalities (growth pathway). Briefly, in order to eradicate poverty, water policies must focus on the agricultural sector Hussain, (2004).

MATERIALS AND METHODS

This qualitative research was conducted through a literature review to develop a new strategy to abolish poverty by designing models to explain the nature of optimizing agricultural water resource management in the context of extension and education.

RESULTS AND DISCUSSION

As Malakmohammadi (2009) reported in June 2008, the world population was 6,659,111,122 which will exceed 7,600,486,063 including 3,819,803,284 male and 3,780,682,779 female by 2020 which means 941374941 more than what we already have. Therefore, increase in food demands, as well as the other nature based products, puts increasing pressure on most of the natural resources, if not all, and consequences land degradation, land fragmentation, lower productivity, deforestation, Shortage of water and other scarce resources (Malak Mohammadi, 2009).

It has been estimated that Iran's population will reach 90 million by the year 2020 (DESA, 2006). Such an increase would require 172 million tons of agricultural production from irrigated land (Keshavarz *et al.,*2003). The availability of water is the most limiting factor in the agricultural sector. More than 90% of the renewable water in the country is used for agriculture, but the sector still cannot produce enough to meet the demands of the population. Currently, agricultural products from irrigated farming total 56 million tons. The amount of water used for irrigated agriculture is $83bm^3$, so water productivity is 0.7 kg/m^3. To supply adequate food in 2020, agricultural production will have to increase to 160 million tons. So by the year 2020, water productivity will have to increase to 1.6 kg/m^3. Therefore, it is important to focus on using water efficiently through improved irrigation and water management.

Recent drought events in Iran have limited the amount of water available for farming. The future challenge will involve increasing water use efficiency and productivity by implementing far-reaching changes in the agricultural and water sectors. The most viable option for coping with water scarcity will be to substantially increase water productivity in the agricultural sector.

In Iran, it is now water, not land that limits improvements in agricultural production. Maximizing water productivity rather than yield per unit of land is therefore a better strategy for on-farm water management under such conditions. Changing the focus from land to water requires not only new technologies and policies for water management but also changes in land use and cropping systems. This accord with MalekMohammadi (2009-06-04) who argued that, climate changes pose serious challenges to social and economical development. Developing countries are more vulnerable because their economies depend on climate-sensitive natural resources

and because they are less able to cope with the impact of climate changes. In addition, many natural resources (such as soil, water and minerals) are diversing. Agricultural water resources have remained largely unmanaged, despite the fact that hunger and malnutrition are rising faster and threatening the world's health and stability (Malak Mohammadi, 2009). Bouwer (2000) pointed out, although, increasing population and uncertain climate changes will pose heavy demands on water resources in the future (Bouwer, 2000).

The FAO (2003) reported that the agricultural sector plays a primary role in the economy and also that irrigation efficiency in the Middle East is low. Based on this report, Iran ranked second after Iraq FAO, (2033). The FAO also reported that water loss in Iran is very high. In this regard, Iran (45 billion m^3) is ranked second after Pakistan. In recent years, Iran has experienced a water shortage. Optimizing water resource management in agriculture and increasing the water use efficiency in Iran has a vital role for water resource conservation.

Pioneering approaches may increase the success of sustainable agriculture and poverty alleviation. Success will depend on the motivation, skills and knowledge of farmers. Extension programs have vital roles to play in this context. Extension can demonstrate the resource management skills necessary to satisfy pressing human needs while maintaining or enhancing the quality of the environment and conserving natural resources. Extension acknowledges that water is an essential component in agriculture.

From a broader development standpoint, it is important to note that agriculture claims the largest share of the work force in Iran. A large proportion of the poor depend on the agricultural sector for their livelihoods. Despite its small contribution to GDP, agriculture is still the key to development in many developing countries, including Iran. Smith argued that agriculture is not necessarily a low-priority or low-value use for water.

Broadly conceived, poverty reduction strategies will entail four elements:

- Ensuring the right to secure access to water for the poor;
- Empowering people to use water more efficiently (increasing water productivity);
- Improving the governance of water resources;
- Supporting the diversification of livelihoods.

Based on a review of the literature, we propose broad areas of focus for investment in the development and management of agricultural water resources. These investments need to be informed by a thorough understanding of the constraints and aspirations of poor people themselves. Some of these proposed strategies are:

1- Developing new appropriate water systems;
2- Increasing the productivity and equity of existing water systems;
3- Recognizing and managing water rights;
4- Facilitating irrigation extension education project to develop water management literacy;
5- Providing policy and technical support to improve traditional irrigation systems;
6- Reducing subsidies for groundwater pumping;
7- Motivating and encouraging water catchment and watershed development by sufficient subsides;
8- Preventing water waste and water erosion to enhance water efficiency;
9- Designing and developing water resources infrastructure;
10- Increasing emphasis on drainage.

Conclusion:

In general, access to good irrigation allows poor people to increase their production and incomes and provides them with employment opportunities to diversify their income base. Such access also reduces the vulnerability caused by the seasonality of agricultural production or external shocks. Thus, access to good irrigation has the potential to reduce poverty. We do not recommend blueprint strategies to reduce poverty and inequity, since strategies have to be context-specific and must begin with the recognition that water should be an integral part achieving sustainable livelihood for poor men and women.

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