INCREASING WATER PRODUCTIVITY IN AGRICULTURE BY CHANGING ENERGY PRICE IN IRAN

AUGMENTER LA PRODUCTIVITÉ DE L'EAU EN AGRICULTURE PAR L'ÉVOLUTION DU PRIX D'ÉNERGIE EN IRAN

Mehrzad Ehsani[1], Houman Khaledi[2]

ABSTRACT

Iran with inadequate and erratic precipitation in space and time is among the arid & semi-arid countries of the world. Groundwater plays an important role in sustainable development of human society in Iran. Therefore, rational management for water supply and demand, besides optimum use of the water resources is necessary. At present, a total of around 786,000 structures (springs, qanats and wells) provide about 79,000 MCM of groundwater through 620,000 wells. But due to excess water extraction from wells, 270 planes face negative balance of groundwater aquifers.

Studies show that there are around 150,000 wells in Iran run by electricity and rest by fossil fuels for pumping water for irrigation. Government policy to subsidize energy (electricity and fossil fuels for diesel systems) in agricultural water sector until 2010 causes low productivity not only of energy but also of water. The Iranian government reformed the policy and removed subsidies in all sectors, including agriculture from the beginning of 2011. This policy, called "subsidy reform" withdraws part subsides from energy and water price. It is expected to promote enhancement in irrigation efficiency, and water and energy productivity in agriculture.

In this article theoretical concept of agricultural water productivity will be introduced, and then actual condition of groundwater, wells characteristic, as well as, water withdrawal from groundwater and energy consumption shall be reviewed. It also demonstrates the basic role of planning and management in promoting agricultural water productivity and

1 Director General on Operation of Irrigation Structures (Iran Water Resources Management Company), as well as, Hon. Secretary of IRNCID; Tel: +9821 88906597, Fax: +9821 88893648, E-mail: ehsani2@gmail.com.

2 - Irrigation and Drainage Expert, Mahab Ghodss Consulting Engineering Co., IRNCID/ICID Young Professional Forum Member, Iran; E-mail: homankhaledi@yahoo.com.

reducing energy usage. The paper includes recommendation for increasing water and energy productivity.

Key words: *Water productivity, Energy price, Water withdrawal, Subsidy reform, Iran.*

RÉSUMÉ ET CONCLUSIONS

L'Iran avec l'insuffisance et une mauvaise localisation, ainsi que, les précipitations périodiques est parmi les pays arides et semi-arides du monde. Dans l'exercice normal de l'eau le total des ressources en eau renouvelables atteint 130 milliards de mètres cubes en Iran, dont environ 97 milliards mètre cube de l'ensemble des ressources en eau renouvelables sont utilisées pour les secteurs agricoles, industriels et domestiques. Le manque d'eau en Iran causé agriculteurs iraniens essayé de prélèvements d'eau dans les eaux souterraines par les qanats et creuser des puits à partir de 3000 ans et irriguer leurs fermes et les jardins avec méthode efficace par la compréhension de la valeur de l'eau dans un tel état.

Les eaux souterraines jouent un rôle important dans le développement durable de la société humaine. Par conséquent, la gestion rationnelle de l'approvisionnement en eau et de la demande, ainsi que, l'utilisation optimale des ressources en eau existantes est nécessaire. À l'heure actuelle, un total d'environ 786.000 structures (ressorts, les qanats et les puits) fournissent environ 79.000 MCM d'eau souterraines qui 620.000 d'entre eux sont des puits. rejet annuel de puits tubulaires est d'environ 50 milliards de mètres cubes, environ 90% d'utilisation pour le secteur agricole. D'autre part, à cause du retrait de l'excès d'eau des puits, 270 avions face à un solde négatif de nappes souterraines.

Avec l'expansion de la technique moderne d'approvisionnement en eau et la distribution en tant que réservoirs d'eau, puits tubulaires, et système d'irrigation dans les décennies précédentes, il a été prévu pour répondre à l'augmentation de la productivité de l'eau mais ce n'est pas comme prévu. D'autre part, la technologie a permis le forage de puits de pompage de l'eau plus rapide et plus facile que par le passé. Toutes ces conditions ont une force négative sur les nappes souterraines.

Basé sur des études montrent qu'il ya environ 150.000 puits en Iran qui traitent avec l'électricité et du reste de gérer par les combustibles fossiles afin de pomper l'eau pour l'irrigation. La politique du gouvernement de subventionner l'énergie (électricité et de combustibles fossiles pour les systèmes diesel) dans le secteur de l'eau en agriculture jusqu'en 2010 répond à une faible productivité, non seulement dans l'énergie mais aussi la consommation d'eau. Le prix de l'électricité et du gazole dans le secteur agricole ont été d'environ 0,2 cent par kWh et 0,16 cent le litre. Soit dit en passant, les agriculteurs ne sont pas s'inquiéter du prix et causé vigueur sur les eaux souterraines par le retrait de l'excès d'eau.

Le gouvernement iranien a réformé la politique et a supprimé les subventions dans tous les secteurs ainsi que l'agriculture depuis le début de 2011. Cette politique appelée «réforme subventionnée" qui disparaît libération de l'énergie et des prix de l'eau. Dans la première étape, le prix de l'électricité dans le secteur agricole a augmenté de 7 fois plus que une perméables à 1,4 cent par kWh et le gazole a augmenté de 9 fois plus que perméable à 15 cents par portée. Il est prévu de satisfaire une amélioration de l'efficacité d'irrigation, l'eau et la productivité de l'énergie dans l'agriculture.

Dans cette condition concept article théorique de la productivité agricole de l'eau sera mis en place, puis effective des eaux souterraines, les puits caractéristique, ainsi que, le retrait de l'eau de consommation d'eau souterraine et de l'énergie doit être réexaminée. Selon la consommation d'énergie dans l'agriculture, les frais d'eau par mètre cube d'analyser et de comparer avec la politique de subventionnement avant la réforme. L'étude a conclu que les prix du carburant et de l'énergie pourrait avoir un impact positif sur l'efficacité de l'utilisation des eaux souterraines, de carburant et la consommation d'énergie et les modes de culture en Iran. En outre, l'élimination des subventions pourrait fournir aux agriculteurs les incitant à adopter des activités avec des bénéfices plus élevés pour atteindre plus deux par unité d'énergie et de productivité de l'eau. Il démontre également le rôle fondamental de planification et de gestion dans la promotion de la productivité de l'eau agricole et réduit la consommation d'énergie. Afin d'améliorer la productivité de l'eau agricole, il est nécessaire d'appliquer des méthodes logiques en ce qui concerne la culture traditionnelle et des lignes directrices codifiées, y compris toutes les mesures techniques, administratives, agricoles, institutionnels, financiers, les questions d'éducation et de les appliquer avec précision une motivation suffisante. Le document comprend la recommandation sur l'eau et la productivité de l'énergie augmente à mesure que mentionné ci-dessus.

Mots clés: *Productivité de l'eau, prix d'énergie, prélèvements d'eau, réforme subventionnée, Iran.*

(Traduction française telle que fournie par les auteurs)

1. INTRODUCTION

Scarcity of water resources in the world in dry and semi-dry regions has inconvenienced the production sectors, which are dependent on water supply.

Because of the lack of precipitation and its erratic occurrence in space and time, Iran has been listed among dry & semi dry countries in the world. In view of the present condition of water resources in the world and especially in Iran, one of the most potential approaches to circumvent water crisis is to pay serious attention to agricultural water productivity and improve it judicious and efficient use of water.

High population growth during the past decades has caused increase in water demand from limited water resources. About 75% of renewable water is in use at the present time in Iran that is very high in comparison to other countries in the world.

Iran's agriculture intensively depends on irrigation water, as about 90% of agriculture crops are produced in the irrigated lands. It can be said that irrigation water is the most important input in agricultural production in Iran (Figure 1). It is thus, necessary to think about essential policies with sound approaches to pass through the probable crises from now on. One of the important approaches is to promote agricultural water productivity. Water allocation should make to product with higher economical benefits per cubic meter. Of course, this issue doesn't mean to ignore the other principal and long-term objectives such as food security and employment.

Fig. 1. Irrigation network in south of Iran -Khuzestan (Réseau d'irrigation dans le sud de l'Iran –Khuzestan)

2. PRODUCTIVITY CONCEPT

Productivity from general and quality point of view is defined as:

Productivity = effectiveness + efficiency

Productivity, that is, the ratio of output to input, focuses on the maximum utilization of time and capability to fulfill the pre-determined objectives. In most of the countries in the world, as well as, in Iran, because of the erratic rainfall, fresh water availability is the primary constraint for the agricultural production.

Considering the present situation of water resources in the world, especially in Iran, we should rationally pay serious attention to the agricultural water productivity to confront water crisis, to increase the quantity and to enhance the quality of the agricultural products by effective strategies.

In case of agricultural water productivity there are different views to be considered. The most common views are “agricultural water productivity in terms of physical and financial output”. The concepts of these two views briefly are as follows:

– Productivity from the viewpoint of physical output: in accordance with this view, the highest productivity of agricultural water means more production per unit of water volume.
– Productivity from the viewpoint of financial return: in accordance with this view, the highest productivity of agricultural water means more benefit per unit volume of water.

3. GROUND WATER SITUATION IN IRAN

Groundwater plays an important role in sustainable development of human society. Therefore, rational management for water supply and demand, as well as, optimum use of the existing water resources is necessary. At present, a total of around 786,000 structures (springs, qanats and wells), of which, 620,000 are wells provide about 79,000 MCM of groundwater (Figure 2).

Fig. 2: Sample of digging well and withdraw water from groundwater, Iran (Exemple de forage de puits et de retirer l'eau de la nappe phréatique, de l'Iran)

Annual discharge of tube wells is around 50 billion cubic meters of which, about 90% is use for agricultural. On the other hand, due to excess water withdrawal from wells, 270 planes faced with negative balance of groundwater aquifers (Figure 3).

Subsidized energy prices encourage farmer for over-pumping. Groundwater overdraft occurs when water removal exceeds water recharge. The slow natural recharge rate of most aquifers and high rate of pumping has led to groundwater overdrafts in most irrigated areas of Iran over the past century. The most important adverse impacts associated with groundwater overdraft is declining water table.

Fig. 3. Drought in the south-east of Iran –Kerman (La sécheresse dans le sud-est de l'Iran-Kerman)

4. WATER PRICING IN PAST TIME

Irrigation water price in Iran, compared with the other agricultural inputs, is very low and is one of the reasons for high usage of water and low irrigation productivity. Any procedure to match the administered and the real price of water may be the best course of action to be taken for saving water.

5. ENERGY FOR WELLS

Studies show that there are around 150,000 wells in Iran that are pumped using electricity and rest by fossil fuels. Government policy to subsidize energy in agricultural water sector until 2010 had resulted in low productivity of both energy and water. The price of electricity and fuel in agriculture sector were about 0.2 cent/KWh and 0.16 cent/liter, respectively. The farmers were not worried about the cost and pumped groundwater indiscriminately. Iranian government reformed the policy and removed subsidies in all sectors as well as agriculture from the beginning of 2011. This policy is called “Subsidy Reform”. In the first stage, the price of electricity in agricultural sector increased 7 times, to 1.4 cent per KWh and fuel price increased 9 times, to 15 cent per litter. This measure is expected to avoid misuse of water and enhance irrigation efficiency and water and energy productivity in agriculture.

6. PREDICTION OF SUBSIDY REFORM EFFECT ON ENERGY, WATER AND AGRICULTURAL WATER PRODUCTIVITY

Low cost energy before the subsidy reform caused negative effect on groundwater balance due to over pumping from wells, much in excess of the actual demand of water. By applying new policy in subsidies reform, simultaneous with the gradual removal of energy subsidies from beginning of 2011 on electricity and diesel energy, the costs of ground water extraction has increased. The high price of energy caused self-control on consumption of water usage (Figure 4). The energy-groundwater nexus has created a curious political economy paradox: soaring energy prices may help save the aquifers but threaten groundwater-based livelihood systems. Improving the energy efficiency of groundwater irrigation may help save aquifers and livelihoods.

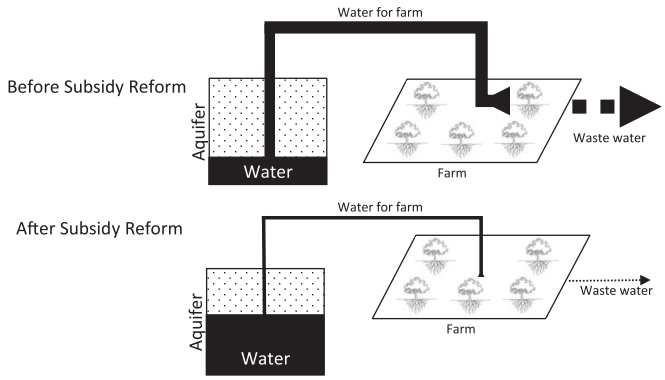

Fig. 4: Schematic comparison of extracted underground water before and after subsidy reform (Comparaison schématique des eaux souterraines extraites avant et après la réforme subventionnés)

7. EFFECT OF SUBSIDIES REFORM ON WATER AND ENERGY CONSUMPTION IN AGRICULTURE

According to available data, the average energy consumption in each agricultural well is about 34 kilowatt hour (kWh), and total amount of agricultural usage of energy is more than 5000 megawatt hour (MWh). Due to the average annual working hours of agricultural wells in Iran which is around 3500 hours per year and the number of active agricultural wells which use electricity for water pumpage are about 150,000, therefore the annual electricity consumption in agricultural sector meet to over 17 Giga-watt hour (GWh). In spite of increasing in cost of energy, the policy of agricultural sector focused on controlling of ground water discharge by using electricity for water pumpage. By the way the trend show the share of agricultural sector in electricity consumption is enhanced. The studies reveal that the average working hours of some wells are 7 time as others.

Research indicated that majority of pump-station were over-designed with higher than needed power for electric motors. Also, their maintenance was poor. Both these factors caused low efficiency in water and energy usage.

At present time, the average energy and water efficiency in irrigated farm which use groundwater is nearly 45 and 50 percent. In other words, energy efficiency for crop production calculated 16 percent, hereupon by removal of subsidies, the utilization of a significant number of agricultural tube wells are uneconomical justification.

In such circumstances applying new technology and adjusting crop patterns and irrigation methods, should be the basic strategies for agricultural activities. In fact energy policy reform would affect positively on balance of ground water.

It is expected that subsidy reform in agricultural sector will lead to reduce working hours of pumpage by more than 50 percent of current situation. On the other hand, Iran Water Resources Management Company urges the farmers to use gated wells by installing and fixing intelligent counter in order to supervising water withdrawal and control the volume of water extracted from wells.

Researchers believe that by implementation of subsidy reform in agriculture the difference between actual performances with average working hours of permitted deep wells would reduce to 2000 hours (60%) in comparison with the current situation. In other words, the amount of electrical energy consumed, which currently is over 5800 GWh, will be reduced to about 2400 GWh. The reduced working hour will save water and energy.

Reduction of current utilization hours (actual) in order to achieve standard level with simultaneous utilization of modern irrigation methods, without decreasing agricultural productions will have significant positive effects on groundwater water table.

8. CONCLUSIONS

In the last two decades, Iran irrigation scenario has been dominated by groundwater irrigation. Based on studies show there are around 150,000 wells in Iran that handle with electricity and rest manage by fossil fuels in order to pump water for irrigation. Government policy to subsidize energy (electricity and fossil fuels for diesel systems) in agricultural water sector until 2010 meets low productivity not only in energy but also in water consumption.

Given the current economic situation in Iran and the financial burden which has always been on the part of the government for the development of irrigation and drainage project, it is unrealistic to continue with the current pricing and subsidy policies. In order to economize the use of the country's subsidies and encourage economic use of water, it is vital to reform pricing and subsidy policies. Government irrigation tariff policies do not provide any incentives to farmers to optimize water use and invest in modernized on-farm irrigation systems. For the public surface water irrigation schemes in particular, farmers do not have any incentives to save water since the operation and maintenance charge is a flat fee unrelated to water consumption and determined by the field production. For the individual groundwater irrigation systems, farmers have access to cheap credit to finance their initial capital investments and pay subsidized energy with no charge for water.

One of the methods to improve water productivity might be removing agricultural subsidies in both energy and water. This recommendation applies mainly in countries that government subsidies shall pay for energy and water. With water and energy subsidized reform in arid countries expecting to apply better on-farm water management and also agricultural production shall be based on economic and marketing. Higher groundwater productivity is also largely attributed by the economic reasons. The extraction cost of groundwater is much higher than that of the canal irrigation, the farmers efficiently use the scarce water and optimally manage the timing of irrigation.

Introducing marginal cost for electricity motivates farmers to use water more efficiently at the farm level through careful use of irrigation water; use of better agronomic inputs; optimize costly inputs; optimize livestock composition and carefully select crops and cropping patterns, which give higher return from every unit of water and grow low water consuming crops. The investigations prove that marginal productivity of groundwater irrigation on yield is much higher than that of canal irrigation.

More efficient irrigation technology generally increases the "effectiveness" of a unit of water, but the water "saved" can be used to increase yields, shift to more water intensive crops, or expand irrigated acreage. More income can be produced per unit of water in all types of farming systems, with livestock systems deserving attention. But this optimism should be met with caution because in areas of high productivity only small gains are possible. Larger potential exists in getting more value per unit of water, especially through integrated systems and higher value production systems and through reductions in social and environmental costs.

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