INCREASING WATER PRODUCTIVITY BY USING LOW PRESSURE IRRIGATION SYSTEM

AUGMENTATION DE LA PRODUCTIVITE DE L'EAU EN UTILISANT LE SYSTEME D'IRRIGATION A BASSE PRESSION

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ABSTRACT

Increasing the productivity of water used in agriculture is essential to meet the goals of food and environment security. Water productivity is generally defined as crop yield per cubic meter of water consumption (WP). WP depends on several factors, such as crop, climate, irrigation technology, field water management, land and infrastructure, and input (including labor, fertilizer and machinery). Low pressure irrigation system with Hydroflume increases efficiency of surface irrigation by saving water (or energy) and fertilizer consumption. It permits easy movement of machinery and tractors, reduces labor cost and increases production of all crops. Using this system, the water use efficiency increases to 70% or more. Canals are eliminated and as a result, more area can be cultivated. Isfahan province, central Iran, has great potentials in agriculture. About 6% of thr crops in the country are produced in Isfahan. The province is located mostly in semi-arid region and the average annual rainfall is 125 mm, which is less than the average annual rainfall in Iran. So it is essential that farmers preserve water for overcoming the limitation of rainfall. The study indicates that water productivity has been increased by using of Hydroflume pipe in the Isfahan farms.

Key word: *water productivity, low pressure irrigation system, hydroflume, Isfahan.*

RESUME

Il est nécessaire d'augmenter la productivité de l'eau agricole pour atteindre les objectifs de la sécurité alimentaire et environnementale. La productivité de l'eau est généralement définie par le rendement agricole par mètre cube d'eau consommée (WP). La WP dépend de plusieurs facteurs, tels que la culture, le climat, la technologie d'irrigation, la gestion

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d'eau sur le terrain, les terrains et les infrastructures, et les contributions (y compris la main d'oeuvre, les engrais et les machines). Le système d'irrigation à basse pression par le tuyau souple augmente l'efficience de l'irrigation de surface en conservant l'eau (ou l'énergie) et les engrais. Il donne lieu au mouvement facile des machines et des tracteurs à la réduction des coûts de main d'oeuvre et à l'augmentation de la production agricole. Grâce à ce système, l'efficience d'utilisation de l'eau augmente de 70% ou plus.

Les canaux sont éliminés, donc une plus grande superficie peut être cultivée. La province d'Isfahan, située au centre de l'Iran, possède de grands potentiels de l'agriculture. La province est située principalement dans la région semi-aride et la pluviométrie moyenne annuelle de cette région est de 125 mm, ce qui est inférieure à la précipitation annuelle moyenne de l'Iran. Il est donc essentiel que les agriculteurs conservent l'eau pour surmonter le problème de la disponibilité limitée des précipitations. L'étude indique que la productivité de l'eau a été augmentée en utilisant les tuyaux souples dans les fermes d'Isfahan.

Mots clés: *Productivité de l'eau, système d'irrigation à basse pression, tuyau souple, Isfahan.*

1. INTRODUCTION

Water use in agriculture has been rated the highest among other water users (Ines, 2001). At the same time, competition for water between agricultural and urban sectors will also increase. Hence, it would be necessary to develop improved water use methods (Bossio, 2009). A promising approach is to determine the potential of water considering its inter-relationships with the soil, plant and the atmosphere. Water use analysis based on the productivity of water consumed instead of on yield, has been advocated as an indicator to analyze water use (Ines, 2001). Water productivity indicators express the benefit derived from the consumption of water and can be used for assessing the impact of on-farm strategies under water scarce conditions (Vazifedoust, 2007). Water scarcity in West Asia and North Africa is a well-known and alarming problem because water in this region is the scarcest in the world and water-related issues have become extremely acute and even critical. Today, this problem is of increasing concern to national governments and research institutions (Oweis, 2005). Therefore, it is important to find new ways to use water resources beneficially.

2. THE CONCEPT OF WATER PRODUCTIVITY

Crop water productivity is defined as crop yield per cubic meter of water consumption, including 'green' water (effective rainfall) for rain-fed areas and both 'green' water and 'blue' water (diverted water from water systems) for irrigated areas. Water productivity defined as above varies from region to region and from field to field, depending on many factors, such as crop patterns and climate patterns (if rainfall fits crop growth), irrigation technology and field water management, land and infrastructure, and input, including labor, fertilizer and machinery (Cai, 2003). According to Dang et al. (2001) the water productivity is defined in three different ways. The water productivity per unit of evapotranspiration is the mass of crop production divided by the total mass of water transpired by the crop and lost from the soil. The water productivity per unit of irrigation is the crop production divided by irrigation flow. The water productivity per unit of gross inflow is the crop production divided by the rain plus irrigation flow. In contrast to other indicators, Water productivity is a good index in analyzing

the potential of water in a point in space (Ines, 2001). Before the 1990s the term water use efficiency (WUE) was commonly used (Zoebl, 2006) which is defined as the ratio between the amount of water that is used for an intended purpose and the total amount of water supplied within a spatial domain of interest. Using hydroflume can improve both water productivity and water use efficiency, but this paper focuses on the effects of hydroflume on WP.

3. HYDROFLUME: LOW PRESSURE IRRIGATION METHOD

Selecting appropriate methods of irrigation and improved irrigation management is obviously a suitable solution to have sustainable WP. Furthermore, on a wide scale, it can save the amount of water energy and other agricultural inputs. Hydroflume system is a supplement for surface irrigation that can save 30 to 35 percent of water in 1950. This system was used in the United States to increase water use efficiency and uniformity of surface irrigation. In Iran, the first time agro-industry company used it in pilot scale in 1980.

This method has been considered in Isfahan for three years now. Farmers who couldn't use drip or sprinkler irrigation because of soil and water condition are eager to use this method. This method can be used for different crops, such as potato, beet, tomato, corn, alfalfa and rice.

Hydroflume method compared with other irrigation method has more advantages that include:

- Low cost compared with the drip or sprinkler irrigation.
- Preventing the accumulation of salts in soil and root zone in contrast to other systems.
- Full control on the flow of water input to furrows.
- Minimum labor requirement.
- Less farm area are occupied with this method equipment.
- Decreasing in care and maintenance costs compared with other methods.
- The possibility of collecting tubes during usage of farm machinery and field preparation.

In the traditional irrigation methods, a large amount of water is lost due to evaporation and seepage and deep percolation in canals and ditches path. By using hydroflume pipe, it can be possible to increase water efficiency more than 70 percent; therefore, the hydroflume method is a simple solution and cost effective way to improve surface irrigation method.

On the other hand, about 30% of water, 50% of labor, 40% fertilizers, and 10% of land are saved in hydroflume method compared with traditional methods. Hydroflume pipes are made of low density polyethylene. Its diameter ranges from 50 to 450 mm. The pipe is simply placed on land and easily connects to any water source, such as pond, well or water channels. It can work with low pressure. There is no impact on applications even if water contains insoluble materials. Hydroflume pipes can also convey muddy water for irrigation. According to the high hydroflume resistance against chemicals, it is possible to use fertilizer.

In most projects implemented in Isfahan, water is conveyed by high density polyethylene pipes which are buried in the soil. Then, water is directed in to a polyethylene or metal barrel which has 1.5 m height. Hydroflume pipes are connected to these barrels and water flows by 0.15 atm pressure during these pipes. Hydroflume length is determined based on land steep and

allowed head loss in pipe (maximum 20 % of working pressure). Hydroflume pipes after filling of water are punched in desired locations and valves with maximum 2.5 lit/s flow will be installed on the pipe. In figures 1 and 2, it is shown that how this method is set in one case study field.

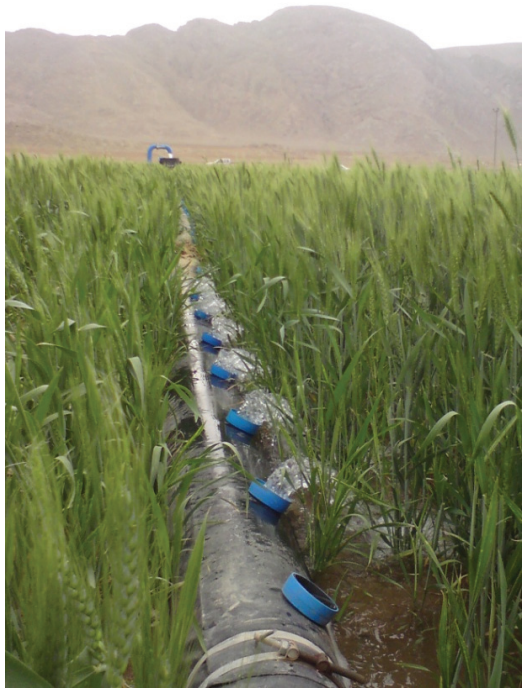

Fig. 1. Hydroflume pipe in wheat field

Fig. 2. Hydroflume intake from polyethylene barrel

4. THE EFFECTS OF HYDROFLUME METHOD ON WP

In this paper, the possibility of increasing water productivity is studied by using hydroflume irrigation method. For this purpose, six felids in Isfahan province, where hydroflume irrigation method was installed recently were selected. Information, such as field area and the amount of crops before and after using this method and also other field characteristics such as soil texture and the shape of field.

Water conveyance with the traditional method using ditch has a low efficiency. This kind of conveyance causes a significant decrease in water amount during the path. Implementation of hydroflume method on farms can prevent wasting water. Although existence of suitable agricultural land in case study fields, before installing this system, farmers had to put fallow same parts due to water shortage.

This method is more effective in fields far from water source, because it can improve water conveyance efficiency. So farmers are able to cultivate more lands. In this case study, the lands under cultivation increased about 20% to 200% more than before (Table 1). Increase in land under cultivation means increase in crop production. More crop production can be increased WP. So that WP is increased about 6.7% to 80% more than before in this study (Table 2). Also, it is considered that the shape of the fields and soil texture can affect on WP by using hydroflume method. WP is considerably increased in light texture soil. Overall, the use of hydroflume in all case study fields increased, but it was more noticeable in land with long water conveynced path because of saving water from evaporation.

Table 1. Increase field area by using hydroflume

Increase Field area By Hydroflume (%)	Field Location
102.0	jey va Ghohab
20.0	Monshiyan
200.0	Kaj
33.3	Esfina
20.0	Mahyar

Table 2. Increase WP by use hydroflume

Increase WP By Use Hydroflume (%)	Yield	Field Location
25.3	Wheat	Jey Va Ghohab
33.3	Barley	
6.7	Wheat	Monshiyan
20.0	Barley	
75.0	Wheat	Kaj
62.5	Alfalfa	Esfina
80.0	Barley	
24.0	Zea Mays	Mahyar

5. CONCLUSIONS

In light soil texture in traditional irrigation method, because of water loss in the conveyand path, water velocity in the entrance of the farm decreases and leads to a decrease in efficiency and also efficiency causes decreasing in yield, But in hydroflume irrigation, it is possible to use longer furrow because of increasing Water velocity so the advanced time decrease and using agricultural machinery becomes easier. By using a fertilizer injection system in the water resource place, it is possible to distribute fertilizer uniformly. It should be noted that if the hydroflume system designs well, WP will significantly increase.

The agriculture sector as a major consume water resources is facing water shortage due to limited water resources. One of the important challenges in this situation is finding a way to increase WP which is caused producing more corp. Since surface irrigation method is the most common irrigation method in the world, the goal of this paper is finding a way to increase WP in traditional irrigation method. Hydroflume irrigation method can improve surface irrigation system and increase WP and water use efficiency. As it was mentioned, using the hydroflume method in case study flied not only cause an increase in cultivated area, but also cause an increase in yield, especially in light texture solid and the farms that has long water conveyed path to get water.

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