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Optimization of Water Allocation between Different Crops in Water Stress Conditions in Qazvin Irrigation Network

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Introduction: Evaluations show the necessity of using optimization models in order to determine optimal allocation of water in different water conditions. Its use can be proposed according to developed model abilities in this study in order to optimize water productivity and provide sustainable management and development of water resources over irrigation and drainage networks. Basic needs of the earth growing population and limitation of water and soil resources remindnecessity of optimal use of resources. World's more than 280 million hectare lands are covered by irrigation networks (Khalkhali et al., 2006). The efficiency of most projects is between 30-50 percent and studies show that performance of most irrigation and drainage networks is not desirable and they have not achieved their aims. Hirich et al. (2014) Used deficit irrigation to improve crop water productivity of sweet corn, chickpea, faba bean and quinoa. For all crops, the highest water productivity and yield were obtained when deficit irrigation was applied during the vegetative growth stage. During the second season 2011 two cultivars of quinoa, faba bean and sweet corn have been cultivated applying 6 deficit irrigation treatments (rainfed, 0, 25, 50, 75 and 100% of full irrigation) only during the vegetative growth stage, while in the rest of a crop cycle full irrigation was provided except for rainfed treatment. For quinoa and faba bean, treatment receiving 50% of the full irrigation during the vegetative growth stage recorded the highest yield and water productivity, while for sweet corn applying 75% of full irrigation was the optimal treatment in terms of yield and water productivity. Moghaddasi et al. (2010) worked examines and compares this approach with that based on the optimization method to manage agricultural water demand during drought to minimize damage. The results show that the optimization method resulted in 42% more income for the agricultural sector using the same amount of water allocated in the 1999 drought. This difference emphasizes the importance of water allocation with respect to growth stages rather than simply cutting allocations on an equitable basis to combat water scarcity. However, managing the system using the optimization method is more complex and requires a new framework and planning to make it operational.

Materials and Methods: Qazvin irrigation network in Qazvin province is located in 150 km West of Tehran, between 36˚ 20′ north latitude and 49˚ 40′ east longitude and 36˚ 00′ north latitude and 50˚ 35′ east longitude. Net water requirement of cultivated crops in the irrigation network is 109.798 million m3. According to the total efficiency of the irrigation network, an impure water requirement of cultivated crops will be 304.994 million m3. The inlet water from Taleghan dam into irrigation network is 274.8 million m3 that compared to impure water requirement decrease 10%. The current study was conducted in 5 options, including: option 1 (current conditions and supplied water volume of 274.8 million m3), option 2 (optimized current conditions using LINGO software and supplied water volume of 274.8 million m3), option 3 (30% water deficit and supplied water volume of 192.36 million m3), option 5 (40% water deficit and supplied water volume of 274.8 million m3). Water requirement of crops is determined using meteorological data with 30 years long term statistics and CROPWAT8 software.

Results and Discussion: Studying different scenarios of water deficit in network shows that products such as tomatoes, potatoes and alfalfa have the least changes in real production to potential production and yield ration in barely did not show significant difference in all options. In all of the options, tomatoes with water productivity indicator of 3029 rials/m3 have the maximum productivity index and sugar beets with water productivity indicator in options 2 to 5 as 479, 310, 307 and 268rials/m3, respectively has the minimum productivity index. Therefore, in water deficit conditions, the priority of water distribution in all options is for tomatoes and the last priority for sugar beets. In all of the options, wheat, barley and canola ascend in productivity index and corn and sugar beets descend in productivity index.

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Conclusion: Studying water- production index shows that considering instructions will result in optimal productivity that in turn will increase production and network total income. Optimal model results show that drought effects can be satisfied with optimal and targeted management in allocating water, so that network total income has not reduced in stress occurrences compared to network net income. Optimization method in model development has been selected according to aim of model and it is proposed that model results to be assessed by non- linear optimization methods. It is proposed that, different scenarios of climate are studied in region according to climate changes and optimal allocation of water is prepared according to the effect of these scenarios on temperature increase, raining decrease and products water need increase in present cultivation method. For model efficiency increase, it is proposed that using neural networks capabilities, intelligent prediction of the input discharge to the network is done and the possibility of comprehensive management and timely combining of network with water allocation optimal model is provided.

Keywords: Deficit irrigation, Optimum conditions, Qazvin Irrigation network, Water distribution