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Optimum Water Allocation for Supplementary Irrigation in Wheat and Barley Farms in the Sub-Basins of KamyaranRegion

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Introduction: Rainfed agriculture plays an important role in food production. In Iran, 6 million hectares of cultivated landsare rainfed. Moreover, about10% of raw agricultural products are being produced by rainfed agriculture. Yields of rainfed fields are decreased due to drought in recent years in Iran. Supplementary irrigation is a suitable management to improve and enhance the yield of rainfed agriculture. Determination of appropriate time of supplementary irrigation is necessary in each region. But water allocation for this practice is the main challenge, because water resources are restricted. Therefore, water allocation management between irrigated and rainfedfields could be a viable strategy. Water resources for supplementary irrigation in rainfed fields are saved through deficit irrigation in irrigated lands or from rivers. The purpose of this study is optimum water allocation for supplementary irrigation in wheat and barley farms from rivers to around rainfed fields in Kamyaran region. In this study, supplementary irrigation is considered in three management methods of autumn irrigation, spring irrigation and both of them.

Materials and Methods: Kamyaran is located in Kurdistan province in west of Iran. The area of rainfed field is very vast in this region. Usually, rainfed fields are located in high slop lands and far from water resources in Kamyaran region. Supplementary irrigation is possible in rainfed fields around to water resources and with slope of less than 8%. The area of sub-basins with appropriate situations in Kamyaran region was calculated by geographic information system (GIS). Ratio of wheat to barley in rainfed fields is 3 to 1. Rivers in each sub-basin is the only water resources for supplementary irrigation in Kamyarn region. In this study, the objective function is maximizing net benefit. Also, constraints are total available water volumes in rivers at supplementary irrigations times and rainfed fields with appropriate situation for supplementary irrigation. Decision variable is rainfed area with different irrigation managements (autumn supplementary irrigation, spring supplementary irrigation, autumn+spring supplementary irrigations and rainfed managements). The total costs and income of agricultural production are found in statistical books of agriculture jihad in 2008-2009 growing season.

Results and Discussion: The lands around of rivers with suitable slope are about 30% of rainfed land of Kamyaran. The appropriate rainfed fields in sub-basins of A, B, C, D, E, F and INT were 125.39, 15.52, 18.11, 1111.26, 96.51, 48.13 and 49.55 Km^2, respectively. The results of Optimization model showed the supplementary irrigation managements are different in each sub-basin because of different discharge of river in each sub-basin in different months. The optimal supplementary irrigation management for barley rainfed fields is autumnsupplementary irrigation. The yields of barley rainfed fields increase about 90% by autumn supplementary irrigation. The optimal supplementary irrigation managements for wheat are different in each sub-basin, but autumn+spring supplementary irrigations is best managed if water resources will be enough in each sub-basin. Due to restriction of water in rivers at supplementary irrigation time, some of wheat and barley fields remain rainfed in A+B+C and D sub-basin. The results showed minimum and maximum increase of wheat production in D and INT sub-basins are 29 and 134%, respectively. Also production increasing are 87, 112 and 126% in A+B+C, E and F, respectively. Increasing of barley production in the sub-basins of E, F and INT, are 61, 96 and 96%, respectively. Other sub-basins of A+B+C and D remained in rainfed farming**.** Net benefit increase about 65 and 275% for wheat and barley fields respectively, in 2014. Water productivity in all sub-basins for both wheat and barley is 74.8 and 44.5%, respectively.

Conclusions: This study showed supplementary irrigation management increased the yield and net benefit in rainfed fields of Kamyaran sub-basins. Resultsshowed about 30% of rainfed land of Kamyaran, are suitable for supplementary irrigation. The results of optimization models showed total increase of wheat production in

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A+B+C,E, F, D and INT sub-basins are 87, 112, 126, 29, 134%, respectively. Also increase of barley production in the sub-basins of E, F and INT, are 61, 96 and 96%, respectively. The result showed production increase about double in Kamayaran region. Also, net benefit increase about 65 and 275% in wheat and barley fields respectively.It has been suggested in A, B, C sub-basin, autumn supplementary irrigation of wheat, in E, F and INT sub-basins, autumn and spring supplementary irrigation for wheat and autumn supplementary irrigation for barley and in D sub-basin, autumn and spring supplementary irrigation for wheat.

Keywords: Kamyaran, Net benefit, Optimization, Supplementary Irrigation.