THESIS

OPTIMUM CONJUNCTIVE/CYCLIC USE OF FRESH CANAL WATER AND SUPPLEMENTAL SALINE GROUND WATER FOR BALANCED ROOT ZONE SALINITY

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By

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ABSTRACT

Water is the most important need for the human being as well as for the whole ecological system. Today the world is facing a great scarcity of water but the uneven distribution of water is more challenging. Pakistan has the world's largest irrigation canal system and about 93 percent of the country's agriculture mainly depends upon this canal system. But in the last few years country is facing a growing shortage of water. Due to shortage of canal water, farmers are impelled to use ground water of varying EC under different techniques like conjunctive and cyclic to fulfill their water demand.

Main objective of this study is to simulate SWAP model for investigating sustainability of various scenarios of sweet canal water and saline ground water uses (mixing ratio, alternate use, irrigation depth, water EC.) and select the optimum combination.

The study was based on data of detailed investigations of the data collection.The water flow and solute transport model, SWAP was used to study the performance on crop transpiration and soil salinity behavior over a period of 10 year. The upper boundary conditions of the system were described by reference evapotranspiration rate, irrigation and rainfall and zero flux was defined as bottom boundary. A 480 cm soil profile was divided into three layers. The soil water retention and hydraulic conductivity curves for these three layers were defined by Van Genuchten-Maulem (VGM) model. The model was previously calibrated using the field measured data for 1991-94 periods.

The simulations were done for long-term impact of soil salinity for base scenarios, conjunctive water use scenario and cyclic water use scenario. This base scenario included (1) all irrigations with canal water and (2) all irrigations with ground

water of EC 3, 6, 9 or 12 dS/m. Ground water of varying quality (EC_G 3, 6, 9 and 12 dS/m) may be used in conjunction with canal water by mixing in 1:1 ratio. The two conjunctive water uses include: (1) first irrigation with canal water and remaining with conjunctive water (J14) and (2) all irrigations with conjunctive water (J05). The two cyclic water use scenario include: (1) irrigations with alternating one canal water and one ground water use (C11) and (2) irrigations with alternating one canal water and two ground water (C12) of varing quality EC_G 3, 6, 9 and 12 dS/m. All simulations were made for a period of 10 years with initial root zone EC of 4 dS/m.

For all irrigations with canal water the root zone EC varies 1.8 to 2 dS/m. For all irrigations with ground water of EC_G 3 dS/m the root zone EC increases to 7 dS/m, and the relative transpiration (T_R) for wheat and cotton maintains at optimum level. Thus this irrigation use is sustainable. For all irrigations with ground water of 6, 9 and 12 dS/m, the root zone EC increases to 13.3, 18.6 and 20.3 dS/m respectively and there is mild to severe affect on relative transpiration for wheat and cotton; these water uses are not sustainable.

For ground water EC_G 3 dS/m the root zone EC for conjunctive water use scenario J14 and J05 remains around 4.0 and 4.5 dS/m respectively. The relative transpiration for wheat and cotton maintains at optimum level. These water uses are sustainable for extended period of time. For ground water EC_G 6 dS/m the root zone EC for conjunctive water use scenario J14 and J05 maintain 5.7 and 7.9 dS/m respectively and the relative transpiration for wheat and cotton remains at optimum level. So, these water uses are marginally sustainable. For ground water EC_G 9 dS/m the root zone EC for conjunctive water use scenario J14 and J05 varies from 8.6 to 10.0 dS/m respectively and relative transpiration decreases severely after few years. These water uses are unsustainable for extended period but may be adopted for few years only and then discontinued. For ground water EC_G 12 dS/m the root zone EC for conjunctive water use scenario J14 and J05 remains 10.2 and 14.2 dS/m respectively and relative transpiration decreases severely. These water uses are not sustainable.

For ground water EC_G 3 dS/m the root zone EC for cyclic water use scenario C11 and C12 remains 4.4 dS/m and 4.8 dS/m respectively. The relative transpiration for wheat and cotton maintains at optimum level. These water uses are sustainable for extended period of time. For ground water EC_G 6 dS/m the root zone EC for cyclic water use scenario C11 and C12 maintains 7.9 and 10.9 dS/m respectively and the relative transpiration for wheat and cotton fluctuates around at optimum level. So, these water uses are marginally sustainable. For ground water EC_G 9 dS/m the root zone EC for cyclic water use scenario C11 and C12 remains 10.9 and 15.1 dS/m respectively and relative transpiration decreases severely after few years. These are unsustainable for extended period, but may be adopted for few years only and then discontinued. For ground water EC_G 12 dS/m the root zone EC for cyclic water use scenario C11 and C12 maintains 14.1 and 14.2 dS/m respectively and T_R decreases severely. These are not sustainable.

For management water use scenario, irrigations for conjunctive and cyclic water use are done first seven years with conjunctive/cyclic and remaining three years with only canal water for 10 years. Management water use scenario is sustainable to use in the field for a long period of time except EC 12 dS/m.

It is concluded that conjunctive water use and cyclic water use scenarios with ground water of EC 3.0 dS/m is sustainable. Ground water EC 6.0 dS/m is marginally sustainable. Ground water EC 9.0 dS/m is unsustainable for extended period, but may be adopted for few years only and then discontinued. The ground water EC 12.0 dS/m is not sustainable. Management water use scenario is sustainable to use in the field for a long period of time except EC 12 dS/m.

Study recommends that high EC_G of ground water must be used only in areas having a good performing subsurface drainage system to ensure adequate profile leaching. The EC_G of 3.0 and 6.0 dS/m for conjunctive and cyclic water use is sustainable cautiously. The EC_G of 9.0 dS/m for conjunctive and cyclic water use is marginally sustainable. The EC_G of 12.0 dS/m for conjunctive and cyclic water use is not sustainable. For only ground water, the EC_G of 3.0 dS/m is sustainable. The EC_G of 6.0 and 9.0 dS/m used once for a while followed by canal water. The EC_G of 12.0 dS/m never be used.