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# Conjunctive Use of Surface Water and Ground Water for Sustainability

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**ABSTRACT**

In the present era, surface water availability is inadequate to meet the crop water requirements and direct use of poor quality ground water is unfit for irrigation. Secondly, poor quality water directly and indirectly affects the soil physical, chemical and biological properties and reduces crop growth and yield on economic level. Conjunctive use consists of harmoniously combining the use of both surface and ground water in order to minimize the undesirable physical, environmental and economical effects of and to optimize the water demand in the soil. The main objective is to maintain both water and salt balances. Good quality water is mixed with poor one in a certain proportion (1:1, 3:1 and 5:1) before applying to the field in the blending mode or two water sources are used alternatively in cyclic mode. Utilization of poor quality ground water in conjunction with canal water is essential to enhance crop productivity, crop intensity, besides reducing agricultural losses from interruptions in irrigation and thus improve the food security through multiple uses of irrigation water than use of water from a single source.

**Keywords**: *Conjunctive use, Ground water, Surface water.*

Agriculture is the single largest user of water among different sectors comprising 79 % of total water receipt *i.e.* 48 % from surface water and 31 % from ground water sources. Competition among different sectors (agriculture, domestic and industry) is increasing day by day reducing the per capita availability of water. Higher demand and decreasing water quality has put enormous pressure on the agriculture sector prompting to use the available water resources more efficiently. These pressures are a result of the increasing demand for food and ever more limited possibilities for the extension of irrigation to other areas due to scarcity of land and water resources and costs of development. The World Commission on Water has estimated that, over next 20 years, annual investments in the water sector need to rise from $ 75 billion to $ 180 billion. Hence, the need of the hour is to use the available water in a holistic manner emphasizing both on the quality and quantity of water.

**Conjunctive use of surface and ground water**

Conjunctive use of surface and ground water is one of the alternatives which means "Use of surface water and groundwater consists of harmoniously combining the use of both sources of water in order to minimise the undesirable physical, environmental and economical effects of each solution and to optimise the water demand/supply balance" (FAO, 1995). It aims at maximising the benefits arising from the innate characteristics of surface and groundwater water use; characteristics that through planned integration of both water sources, provide complementary and optimal productivity and water use efficiency outcomes.

Historically, surface water has been the primary source, with groundwater providing an alternative source when surface water availability is low, particularly during periods of drought. However with increasing demand for water, the value of groundwater is achieving greater recognition and becoming an important primary source of water supply for irrigation. The increased value for groundwater more generally has been driven by growth in irrigated areas that were traditionally supplied from surface water and the use of groundwater for irrigation has been increased worldwide since the 1950s. According to Foster and Steenbergen (2011) spontaneous conjunctive use of hallow aquifers in irrigation canal commands is driven by the capacity for groundwater to buffer the variability of surface water availability enabling: Greater water supply security; securing existing crops and permitting new crop types to be established; better timing for irrigation, including extension of the cropping season; larger water yield than would generally be possible using only one source; reduced environmental impact and avoidance of excessive surface water or groundwater depletion.

**Why conjunctive use of ground and surface water**

- Water resource of either surface water or groundwater could not meet the water demand
- Quality of groundwater was poor and mixing of groundwater with surface water was required to improve the water quality.
- To reclaim waterlogged lands by gradually declining the ground water table

***Advantages***

- Improved security of water sources
- Protection of the groundwater level
- Reduced environmental impact
- Increase of agricultural productivity by fulfilling the water requirement of crops both in terms of quantity and time
- Control water logging and Salinization in canal command area
- Reduction in salt water intrusion with fresh groundwater
- Control over pumping of ground water reservoir
- Considerable use of saline water by mixing of the saline water with canal water to the extent that the quality of mixed water remains within tolerable limits of corps.
- Helps in augmentation of water resources in project command area through construction of augmentation tube well

**How to achieve conjunctive use**

Conjunctive use of water relates to a wise use of water resources in an integrated manner like the combined use of ground and surface water. Due to the augmented water source, higher water reliability can be achieved. Conjunctive use therefore functions as a buffer for periods of water scarcity. New water resource development is increasingly costly and often environmentally prohibited. So, the approach is to use surface water when the water table is high and change to groundwater when the water table is low. This technique might be especially important as a buffer function for mitigating impacts of climate change, such as increased heat and drought (Foster *et al*. 2010). Two types of conjunctive use of water are practised:

**Cyclic use of surface water and ground water**

Pazhanivelan *et al*. (2006) reported that alternate use of alkali water (AW) and canal water (CW) in rice and rice fallow crops viz., greengram, sunflower and cotton resulted in significant increase in grain yield over sole use of alkali water or mixed use of both alkali and canal water. Conjunctive use of canal water for rice and alkali water for greengram recorded the highest rice grain equivalent yield (3860 kg ha $^{1}$) and BC ratio (2.43) followed by conjunctive use of 1:1 ratio of canal and sodic water for rice and alkali water (2904 kg ha $^{1}$ and 2.33) for greengram. Greengram after rice with alkali water irrigation was agronomically efficient and economically viable without deteriorating soil health. Cyclic use of AW and CW also affected the soil properties like pH, EC and ESP like significant decrease in soil pH, salt concentration and exchangeable sodium content. Experiment conducted by Rasouli *et al.* (2013) revealed that in wheat cultivated land where irrigation were given through alternate use of low saline water and high saline water or by mixing low saline water and high saline water the salinity was reduced as compared to that of high-salinity water only. Singh and Panda (2012) reported that irrigation in mustard with saline groundwater (EC - 7.48 dS $m^{-1}$) gave a yield as high as 95% of the optimum crop yield obtained with fresh canal water. The temporal variation in salinity showed that mustard yield responds to the average salinity of the soil during the growing season. Thus saline groundwater may be a good water source to exploit for supplemental irrigation. He also stated that there was a significant impact of alternate use of canal water and saline water on plant height of mustard than use of canal water or saline water or mixed use of canal and saline water. No significant difference was observed in WUE while using only canal water and alternate use of canal water and saline water. Shammi *et al*. (2016) demonstrated with different types of irrigation water from shallow tube well and deep tube well with respect to total dissolved solid and observed that shallow tube wells were containing lower TSD (484.03 mg/l) as compared to deep tube well (628.28 mg/l). Similarly, alkalinity and sodium hazard was also found low in samples collected from shallow tube. So, it could be an excellent source of irrigation water whereas higher total hardness (TH), sodium adsorption ratio (SAR), soluble sodium percentage (SSP) and other important analysis indicated that most of the surface water and deep tube well (DTW) were not suitable for irrigation. Therefore, the best irrigation water quality was from shallow tube well (STW). For sustainable and efficient utilization of the existing water resources, cyclic conjunctive uses of river water, STW and DTW as well as excavation of pond to store rainwater can be adopted.

**Combined use of surface water and ground water**

Asad Samar Qureshi and Ilyas Masm (2002) conducted an experiment to observe the long term effect of different quality irrigation water and found that average root zone salinity was reduced by mixing the poor quality groundwater in different ratios with the good quality surface water *i.e*. canal water. For the marginal groundwater areas, mixing of groundwater and surface water in a 1:1 ratio will be the most feasible option. Mixing of groundwater more than this ratio can create serious salinity problems in the long run. Farid *et al*. (2017) noticed a positive impact on soil characteristics organic matter, N content and EC under alternate irrigation with fresh water (F) and saline water (S) in different proportions (*i.e*. 2F:1S, 1F:1S, and 1F:2S) over irrigation with only saline water. Sharma *et al*. (1994) suggested the use of poor quality drainage water in conjunction with fresh canal water

without undue yield reduction and soil degradation which will save the scarce canal water, reduce the drainage water disposal and associated environmental problems.

**Methods of achieving conjunctive use of surface and ground water**

- Groundwater may be used for irrigation within or near a commanded perimeter which cannot be served by the surface irrigation canal system.
- Groundwater may be used for supplementary irrigation in areas, where a surface supply is available for better crop growth and development.
- For supplementing surface waters and reduction of peak demands, size of canals and other structures ground water may be used.
- Groundwater may be used to guard against the insufficient surface water supplies in years of low surface runoff due to low rainfall. In the post-monsoon season of lean river flows and low supplies to diversion canals, ground water is an important supplementary source. The groundwater can either irrigate directly or be pumped into the canal system to augment its supplies. Surface and ground waters can be pooled at tails of channels which are subject to chronic shortages.
- Groundwater may be used to meet the demands of a part of the existing command of a surface water scheme and the released surface water utilized in areas where there is a deficit supply of water.
- Surface water may be used over an extensive area of the command as possible with reduced number of watering's. Groundwater may be used conjunctively for providing intensive irrigation to the extent possible.
- Saline/brackish groundwater may be mixed with good quality surface water to make the former suitable for irrigation.

## CONCLUSION

Conjunctive use of water was used so far for referring the coordinated and planned use of surface and groundwater. Combines / cyclic use of surface and ground water helps to improve the irrigation water quality and there by reduces the harmful effects on crop growth and development. In the present situation of water scarcity conjunctive use of water is the best option in which two or more water resources can be integrated and managed wisely in a sustainable manner.

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