# On-Farm Water Management

**towards**

# More Crop Production

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## Presentation on the Strategy Theme

## (On-Farm)

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## Introduction

Population growth in developing and less developed countries has caused a great concern on the global food security issues. In spite of the proportional water resource development worldwide, but yet the threat of hunger and malnutrition has not been diminished in these regions of the world. FAO has reported that the global food self sufficiency in developing countries will be reduced from 91% at the present to 86% by the year 2030.

Agriculture is the main source of food production; where 60% of the crop and forage production is coming from rain fed agriculture through direct use of rainfall (green water) and the rest 40% are irrigated agriculture contribution (blue water). The trend of crop land development in the past decades (1960 to 2000) shows, almost no change in the area under dry farming at the level of 1200 million hectares, but irrigated farming has experienced a continuous expansion up to 270 million hectares with largest increase during the 1970s, so called green revolution decade (Fig1); However, crop land per capita reduced progressively in this period and created many concern upon the future of global food security. Challenge of demand increase in other water consuming sections and environmental awareness makes the situation more complex and put the dream of world food security in more shadow.

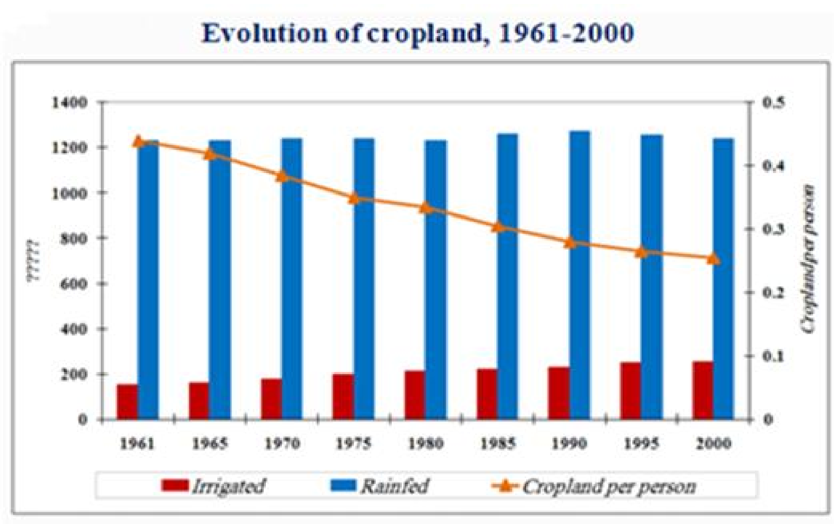



**Fig 1**

The ever increasing cost of water resources development further limits the available and affordable choices. So there are only few options before decision makers and technical staffs, more effective use of rain water in rain fed agriculture, water demand management, and water productivity improvement could be the most promising alternatives.

**Rain Water Productivity**

Precipitation is the main source of water availability to mankind which forms the surface and groundwater resources. But considerable portion of the inland precipitation dose not contributes to the Blue water, due to direct evaporation from the bare land or transpiration by the vegetation, including cultivated dry farming and natural pastures.

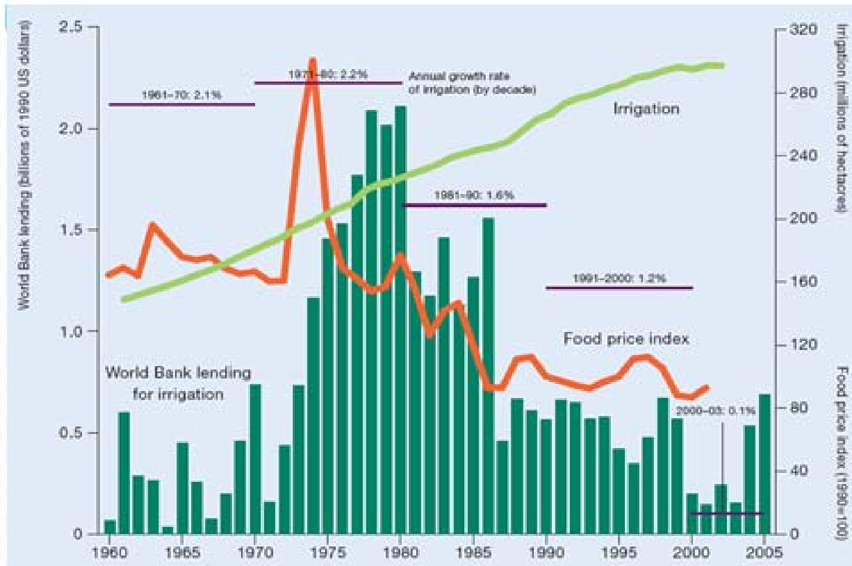
In spite of the importance of green water contribution to the global food supply yet little attention has been paid on its effectiveness. There are considerable opportunities to enhance the performance of dry farming and natural postures through introduction of better soil- agro technical approaches, improved crop verities to adapt the prevailing environment, and watershed management

**Agricultural Water Productivity**

The world irrigated area has experienced the greatest rate of development through 1970 to 1985, but because of water resources limitation and decline in investment on irrigation infrastructure, due to its lower rate of return, this expansion diminished to the lowest level, about 0.1% in the beginning of this millennium (Fig 2). Therefore we could not expect any dramatic change in the rate of irrigated area in future. What remains to do to cope with the ever increase in food demand is to do better job with the available soil and water resources in this sector. This objective can be reasonably achieved by:

a. Crop yields enhancement at farm level
b. Optimizing crop water requirement estimation

c. Upgrading the level of irrigation water management to eliminate the non productive water losses.



*Source*: Based on World Bank and Food and Agriculture Organization Data

**Fig 2**

**a.** Crop Yield Enhancement

One of the preliminary aims of agricultural researches in the last half a century was to convert the livelihood agriculture to economical and industrial agriculture, through manipulating the input resources to agricultural production. The improved crop verities, through conventional plant breeding techniques and more recently bio- technology and genetic engineering has proven great opportunities in this respect. However such improvement has not been experienced or adopted globally. Fig 3 demonstrate this potential capacity which remains to be realized in developing countries compared with the performance in developed countries as an example for maize production. Although irrigation water is the key player in this scenario but its effectiveness in total crop productions is limited. Other production inputs such as appropriate soil- agro technology, improved seed and crop varieties, environmental adaptability, and most importantly the management may have more impacts.

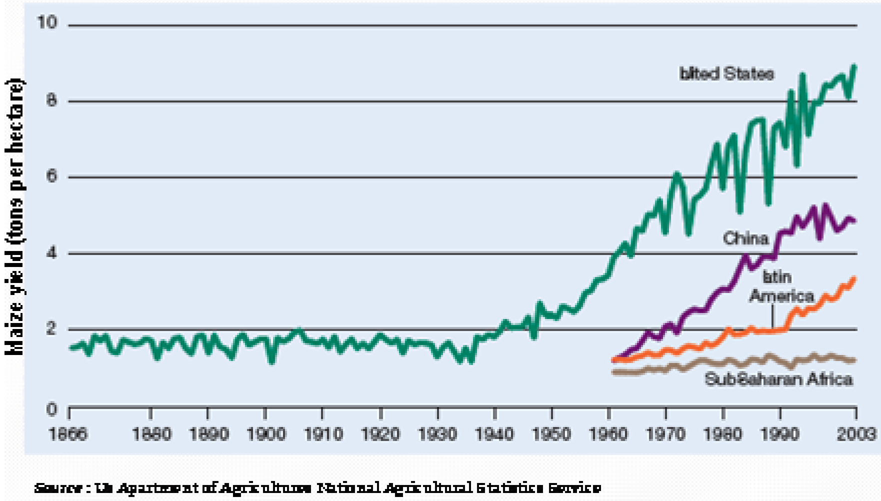



**Fig 3**

**b.** Optimizing crop water requirement (demand management)

The conventional practices for crop water requirement estimation result some over estimation of what, in reality, crops need for their physiological consumption. This is partially due to consideration of evaporation from bare land at the farm level within the context of crop water need. Any attempt to minimize or control this evaporation losses would in effect reduces actual evapotranspiration, ET, at farm level.

The evaporation part of ET amounts from 30% of crop transpiration and more depending on the irrigation application technology and management. The other misconception of crop water requirement calculation based on climatic data is that they normally estimate the potential crop ET rather the actual ET. But in real world the potential crop ET occurs where there is no limitation in moisture availability in the soil profile and this is the case which never prevails. FAO publication No. 56 is a considerable improvement in this respect by introducing appropriate coefficient to convert potential ET to actual ET. The applicabability of FAO 56 approach should be monitored in different location for further recommendation or to find more simple adjustment approaches.

**c.** Irrigation water management

- The Economical Consideration

Typical crop- water production function demonstrates that the rate of change of yield diminishes as irrigation increases Fig 4.

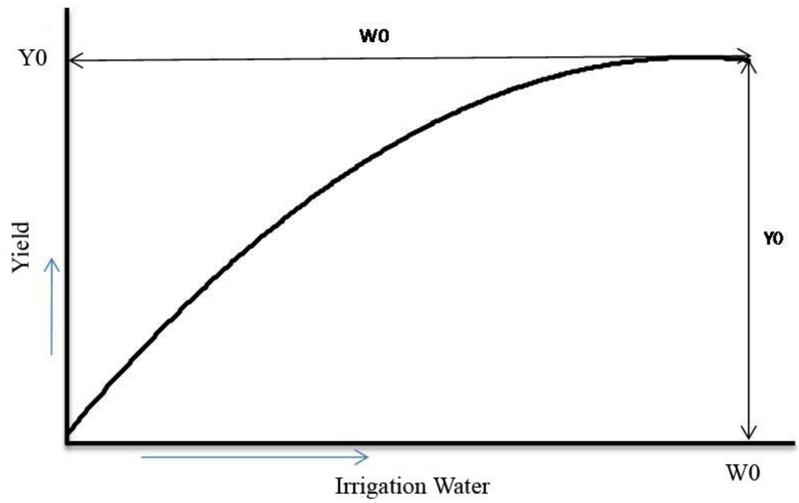



**Fig 4**

There is a point in this function where extra water has no yield increase consequences and hence no beneficial use, i, e, $Y_0$ = Potential yields, $W_0$= Maximum irrigation requirement. From economy point of views the optimum operation point within the context of such production function is where marginal cost of supplying water equals the marginal benefit out of crop production, and that is, in all irrigation schemes below the point of potential yield ($Y_0$, $W_0$). There are several considerations in determination of such optimal operation point in any irrigation planning, crop species and varieties, timing of imposing irrigation deficit, the economical parameter are the examples. More land can be irrigated by a given quantity of water through adapting this approach

- Irrigation water losses Management

Irrigation water losses are another issue which contributes to the estimation of gross irrigation water requirement. In conventional method of water losses or irrigation efficiencies evaluation, at farm level, any deep percolation to the soil profile beyond the root zoon and, run off the farm are considered as on- farm irrigation losses. Whereas in reality, particularly where water resources are limited, these water losses may be a useful source of water for a farmer in downstream. So in basin wise, this water is not lost and is used in another location if they are not discharged to any poor quality water resources. So irrigation water losses are the portion of irrigation water which does not contribute to the crop production process, and they are also non recoverable or reused elsewhere. Any evaporation from bare land at the farm level is falling in this category. However to have successful investment in minimizing irrigation water losses such concept of irrigation efficiencies should be acknowledged.

**Recommendation**

a. Green water should be recognized as a potential water resource for food supply, so improving its effectiveness need to be in any agenda dealing with global food security. Rain water harvesting, storage and recharging ground water has been practiced historically and contemporary. But improving and upgrading natural pastures and dry farming and forestry management will have more pronounced impacts in this respect.

b. Conventional crop water requirement (CWR) computation based on climate data and simplified assumption such as availability of moisture in the root zoon will lead to overestimation. Attention of research institute and soil-water- crop scientists should be diverted to the techniques dealing with more direct responses of crops to water deficit. Attempts have been made in FAO technical report No. 56 to overcome some of the misconception of prevailing CWR competition, but yet on farm evaporation, as the non beneficial water use remains within the context of proposed procedure

c. Irrigation application technologies should focus on the systems to minimize the non- beneficial evaporation at farm level. Sub surface micro irrigation, mulching and covering of soil surface by different means are the examples of such approaches.

d. Green revolution, so called in the seventies, to boost crop yield at farm level did not succeed well. It was in fact a blue revolution that is the global food development was mainly due to allocating more water to agriculture, rather than focusing on other production inputs. However there is a limit to this approach, so it is the time to invest in research and technology to improve crop yields per hectare by optimizing other crop production inputs, proper seed and plant selection, appropriate agro- techniques from planting to harvest, effective fertilizing, pest, and plant deceases control, and most important updated farm management are the keys to the successful future farming particularly in developing countries.

e. Water resources are a very valuable commodity. They must be consumed in an economical context and framework. Agriculture as the main user of water should, by all means, consider the economical output of water relative to its value and costs. Researches and practices show that satisfying all crop water requirements is not economical process. Deficit irrigation is a promising approach in any Crop- Water – Soil models. In the case of cereals up to 30% irrigation deficit might be close to the optimum solution in most cases. There are many evidences that accepting 20% irrigation water deficits in a normal cropping pattern with cereals as the main crop is quit a good approximation of the optimal water allocation.

f. Irrigation sciences have not demonstrated any drastic innovation or conceptual improvement during the past decodes as well as other applied sciences. The three most important questions as: How, When and How much to irrigate are yet answered through old concepts, whereas they are mostly indirect approaches and approximation of the reality. Limitation of fresh water availability, population growth, boosting water demands, increasing cost of water supply and distribution, and access to new technologies and sciences should force us, here at ICID, to facilitate and encourage new ideas to restructure the way of our thinking about irrigation to the advantage of crop production processes.

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