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MEETING FUTURE FOOD DEMANDS OF PAKISTAN UNDER SCARCE WATER SITUATIONS

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ABSTRACT

Water resources of the Pakistan are diminishing and there is very little scope of future water resources development. Unlike most of the developing countries, Pakistan consumes up to 98% of its fresh water resources for agriculture, however in future, the non-agricultural water requirements will increase its share depending mainly upon the population, leaving less water for agriculture. Presently, the water use efficiencies in irrigated agricultural areas are among the lowest in the world, which creates a lot of potential for water savings provided the utilization of available resources is made with wise management. The basis for such management is the proper estimation of the future availabilities from different resources and their requirements by different competitors. In this study, such estimations are made using the Policy Dialogue Model (PODIUM). The model uses 1995 data as a default and makes projection for 2025. This paper presents the food and water requirements situation in Pakistan under four scenarios: (i) business as usual (BAU), (ii) technological options (TECH), (iii) values and lifestyle (VALUES), and crop yield optimization (YIELDS). Both the TECH and VALUES scenarios enable Pakistan to achieve food self-sufficiency within the constraint of water scarcity. By increasing YIELDS to a level of China's and Egypt's 2000 in 2025, Pakistan will have a surplus of food grain without increasing its irrigated area but increasing irrigation efficiencies by only 20%. The water scarcity is not the only constraint for fulfilling the future food requirements of Pakistan. Low agricultural yields, high population growth rate, and low water use efficiencies, stress the adoption of effective resource management strategies that could address these constraints.

Keywords

Water scarcity, food production, water shortage, Pakistan, PODIUM, TECH, BAU, VALUES

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INTRODUCTION

Fresh water is globally a scarce commodity. The optimum utilization of water resources is utmost importance because the world as a whole is suffering from vast water shortages. Pakistan is presently faced with the situation that all its developed water resources are inadequate to meet the irrigation and other water requirements, and there are no prospects of augmenting the water availability in the near future (PWP, 2001). Continuous population growth with limited land and water resources has put enormous pressure on the economy of Pakistan. Alam and Bhutta (1996) estimated that 40% more food would be required by the year 2025 to feed the increasing population.

The water resources of Pakistan are 172.7 BCM, and are characterized by a great variation. The long-term historic data from 1922-23 to 1996-97 indicates a high of 230.42 BCM, and a low of 120.57 BCM. Apart from the annual fluctuations, there is a large seasonal variation in these flows as well. The flows, during the six months of the summer cropping season (i.e., kharif season), are around 142.09 BCM, while the flows in remaining six months (i.e., rabi season) are approximately 27.12 BCM that are only 16% of the average annul supplies (IWASRI, 1998)

The irrigated area of Pakistan is about 78% of the cultivated area, and ranks second in the world after Egypt that has almost 100% cultivated area under irrigation. Most of the irrigated agriculture is for cereal production, followed by cotton and sugarcane (Bhatti, 2002). Average yield of cereals are very low, some 16% less on average than comparable yields in the region, and less than half the yield potential for the major crops of rice, wheat, sugarcane and cotton. More than 90% of this yield gap is linked to serious inefficiencies in the cropping system. At the same time, enormous potential exists for improvement through increasing crop productivity.

FOOD REQUIREMENT OF PAKISTAN

Food consumptions in 1995

Total grain requirement reflects the diet pattern of any nation, and for its estimation per capita calorie supply and per capita food consumption are generally considered. Total grain consumption can be reduced if major portion of calories requirements shifts from grain products to non-grain products such as fruits, meat, milk and milk products. In Pakistan, generally 83% of total calories requirements are met through agricultural products; grain products contribute 55.5% and non-grain contribution is 27.5%.

In 1995, total grain consumption as food, feed and other uses in Pakistan was 23.5 MMT. Major contribution came from wheat (91%) followed by rice (72%) and pulses (68%). Apart from using grains as human food, about 5% (1.1 MMT) of total food grain consumption was used in animal feed, and 10% (2.33 MMT) was utilized as seed, waste and other uses. Major portion (about 31%) of this animal feed came from other cereals (barley, sorghum and millet), followed by maize (20%) and pulses

(12%). About 20% of rice, maize and pulses is used as seed, waste and other uses. The consumption of wheat as a seed, waste and other uses is only 7%.

During 1995, daily calorie supply was 2409 cal in Pakistan. Grain products contributed 56%, while non-grain agricultural products contributed 28% of the daily calorie supply. Daily calorie supply from animal products (from milk and milk products) was 17% i.e., 405 cal. Milk and butter/ghee contribute 58% and 18%, respectively, in the daily calories supplied by animal products. Grain products contribute to the majority of daily calorie supply. However, the contribution of grain products has been decreasing over the years, i.e., from 61% in 1965 to 56% in 1995.

Food requirements in 2025

There are three population projections, estimated by the National Institute of Populations Studies (NIPS), namely low, medium and high for 2025. These projections range from 208 millions under low projection to 237 million under high projections. Under historic trends in population growth rates, the projected population is 268 millions. Similarly, the United Nation Organization projected Pakistan's population in the range 246 millions to 263 millions with an average of 254 millions. Based on these estimates, Figure 1 shows the relationship between food requirements and population in 2025.

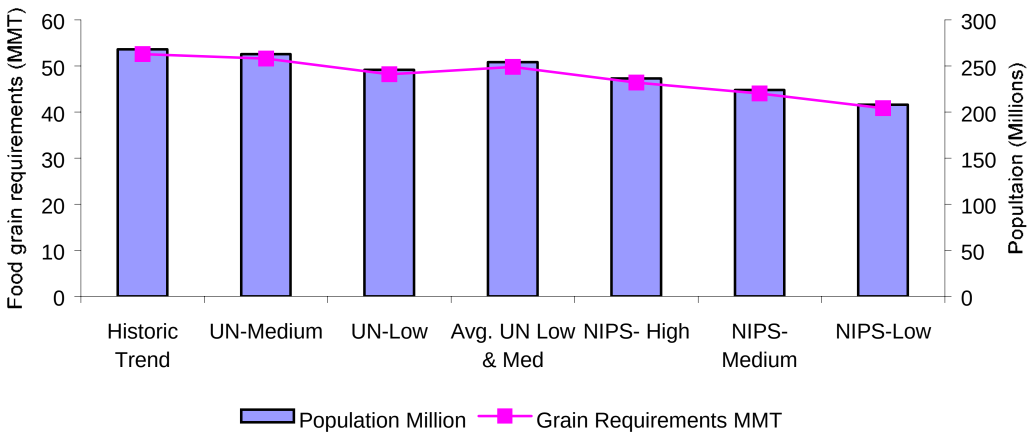

Figure 1. Food grain requirements of Pakistan in 2025 under different population projections.

SCENARIOS FOR MEETING FOOD GRAIN REQUIREMENTS

Business as usual scenario (BAU)

BAU scenario essentially assumes that the current policies on water resources management and development are continued and unsustainable water use may lead to regional water crisis and possibly a world water crisis (Gallopin and Rijsberman, 2000). Rice and wheat are the staple foods of Pakistan, and people have long history of cultivating these crops in the country. For making projection of food grain requirements, a trend of last fifteen years (1980-81 to 1994-95) is assumed to continue till 2025. The population projection for 2025 based on the past trend is 268 million with a growth rate of 2.61%. Table 1 presents the food grain consumptions and requirements under the business as usual scenario (1980-81 to 1994-95). The annual growth rates are far less than the population growth rate during this period. For sustainability and self-sufficiency in food grain, the growth rate in food production should be equal or greater than the population growth rate.

Table 1. Food grain situations in 2025 based on the business as usual scenario (1980-81 to 1994-95).

Food Items	Food grain consumption (MMT)	Production with no water constraint (MMT)	Production with water constraint (MMT)	Surplus/Deficit with no water constraint (MMT)	Surplus/Deficit with water constraint (MMT)
Rice	5.27	4.2	3.47	-1.07	-1.79
Wheat	38.97	37.7	27.55	-1.27	-11.42
Maize	3.18	2.43	1.82	-0.75	-1.36
Other Cereals	2.63	0.6	1.13	-2.03	-1.49
Pulses	2.51	1.7	1.19	-0.82	-1.32
Total	52.56	46.62	35.17	-5.94	-17.39

If there is no water shortage and the past trends in increasing cropped areas and crop yields continues, then a shortfall of 2.34 MMT is estimated in case of rice and wheat with overall shortage in food grain items is 11.30% (6 MMT). If only the past trend in increasing crop yields continues, there will be a huge gap between the food requirements and food production in the country.

Technology, economics and private sector scenario (TECH)

The TECH scenario assumes a world optimistic of free market system, expects new technology to emerge; but assumes regulation or limitation of side effects of the above (Rijsberman and Gallopin 2000). Therefore, TECH scenario is based on the maximizing the use of resources without posing restriction on population growth rate. High population growth rate of 2.18% is assumed to be continuing till 2025. Rainfed area will be gradually brought under irrigation network to make full use of land and water. Resultantly, irrigated area will increase from 17.6 Mha to 20.2 Mha with an annual growth rate of 0.45%. New irrigation technologies will emerge, thus increasing overall irrigation efficiency to 71% in 2025, with an annual growth rate of 1.45%. As a result of technological improvement in the developing world, it will be possible to increase agricultural and rainfed crop yields from 1.98 t/ha to 4.52 t/ha (annual growth rate is 2.79%) and 0.4 t/ha to 0.5 t/ha (annual growth rate is 0.52%) respectively in 2025. The TECH scenario will not only make Pakistan self sufficient in food grain but also it will have a lot of surplus grain to export.

Values and lifestyle scenario (VALUES)

This scenario assumes promotion of fundamental human values (including fairness, freedom, respect for life, responsibility etc.,) and changes in life styles to avert a possible water crisis (Gallopin and Rijsberman, 2000). At the same time, it focuses in changing the attitude of people and requirements responsibility from each member of the society. It also encourages gradual shifting from agricultural to agricultural cum industrial nation till 2025. It assumes a lowest annual population growth rate of 1.19%. At the same time, it assumes a reduction in irrigated area at an annual growth rate of 1.7%, which will reduce the total irrigated area of 17.2 Mha in 1995 to 10.5 Mha in 2025. With the reduced irrigated area, the water conveyance system is assumed to improve and with the use of improved irrigation technologies, it will be possible to increase irrigation efficiencies at annual growth rate of 1.02%.

The emphasis will also be on shifting the problematic areas under crop production to industrial and residential states. The reduction in problem area and better availability of irrigation water, it is assumed that crop yields will increase from 1.98 t/ha to 5.38 t/ha in 2025. The important features of this option are that it requirements for eradicating the low productive and problem land from cultivation and converting it to industrialized zones. The remaining area should have full access to irrigation water based on the crop requirements. The agricultural land selected should be free of all sorts of troubles including salinity and water logging. A national cropping pattern should be designed depending upon the climate, water availability and agricultural practices and should be implemented by providing a better marketing facilities. More industries should be set up to engage a large number of manpower earlier involved in the agricultural practices. Cooperate farming may be adopted to increase agricultural yields and water use efficiencies and to reduce production costs.

Thus, VALUES scenario, which stresses on saving available water, makes restrictions on building large water storage reservoir and encourages shifting of financial resources to be utilized on water projects to industrialization. The food grain productions of the country under this scenario will meet the requirement in 2025, with not much food grain availability to export for foreign exchange.

Crop yield optimization scenario (YIELDS)

Average crop yields in Pakistan for wheat and rice are 2276 kg ha-1 and 1756 kg ha-1, respectively. There is a great variability in crop yields with some farmers achieving yields of 3874 kg ha-1 for wheat and 3545 kg ha-1 for rice. The productivity of water in Pakistan is among the lowest in the world, for example, in case of wheat, it is 0.5 kg m-3 as compared to 1 kg m-3 in India. In case of maize, it is lowest in Pakistan (0.3 kg m-3) and highest (2.7 kg m-3) in Argentina (IWMI, 2000). Figure 2 compares yields of major crops in Egypt and China with Pakistan. The rice and wheat yield of Egypt is 200% and 160% higher than yields in Pakistan, and overall cereal yields in Egypt is 4 times higher than Pakistan. Similar gaps in yield are seen while comparing Pakistan with China's agricultural yields of various cereal and non- cereal crops. It means that there is a substantial potential for increasing productivity of water in Pakistan. With matching grain yield of Pakistan to Egypt's 2000 level, food grain production under this scenario will be 84 MMT against the requirements of 41 to 53 MMT, and there will be a surplus of 30 to 43 MMT of food grains (Figure 3). If Pakistan's food grain production will be equal to China's 2000 level yield in 2025, the grain food requirements can be met very effectively without increasing the cultivated area (Figure 4). The increase in irrigation efficiencies will be an added advantage.

WATER REQUIREMENTS UNDER DIFFERENT SCENARIOS

The water requirement, which includes water for domestic and industrial use, is 176 BCM for the base year (1995). The water requirements for 2025 will vary from 100 BCM to 275 BCM. Under the BAU scenario, the water requirements will be as high as 275 BCM, which is more than the available water resources of Pakistan. The irrigation water requirements for TECH and VALUES scenarios will be 135 BCM and 80 BCM, respectively, which is less than the water requirements in 1995. The lowest water requirements will be under VALUES scenario, as the cultivated area is reduced and the irrigation efficiencies are increased. The domestic water requirements will also be minimum in the VALUES scenario. The total water requirements in 2025 under YIELDS scenario will be less than the water requirements of the base year, and will remain within the availability of water resources.

Whatever will be the choice, there is no need of crying over the "shortage of water" but try to make such institutional measure to fully utilize the available water resources. There must be a shift in thoughts towards "more crop per drop". A trend needs to be set for better survival. There must be an integrated approach to tackle the problem. The population growth rate should be brought as low as possible and then select from the available options to meet the food and water requirements for that population.

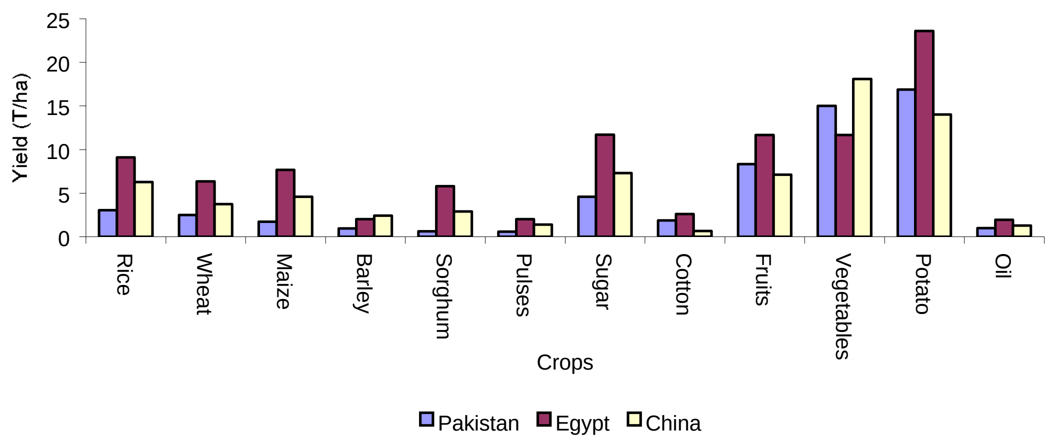

Figure 2. Comparison of Agricultural yields of Pakistan with Egypt and China in 2000.

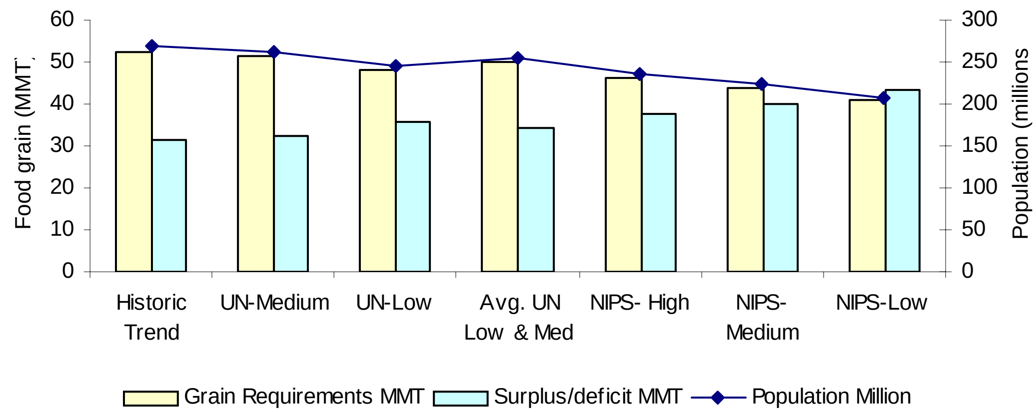

Figure 3. Food grain situation of Pakistan with matching grain yield of Egypt in 2000.

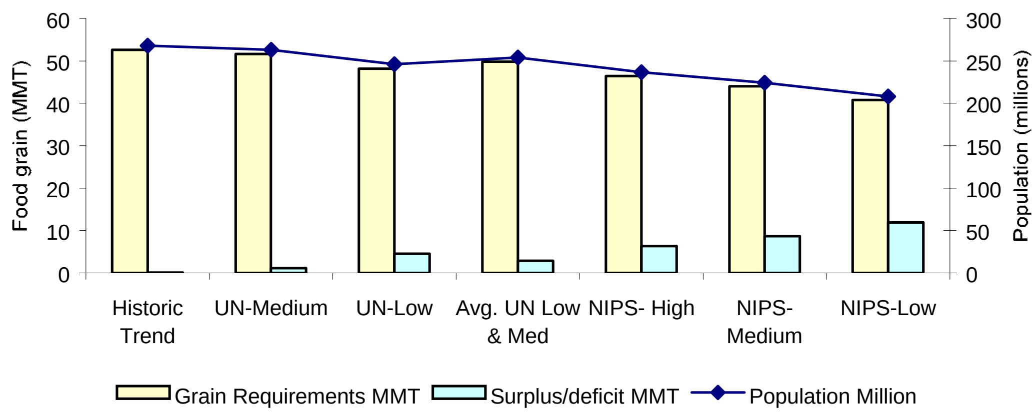

Figure 4. Food grain situation of Pakistan with matching grain yield of China in 2000.

CONCLUSIONS AND RECOMMENDATIONS

Water scarcity is a problem of today that affects everyone and in all aspects of life. It is therefore of utmost importance to understand the problem in its entirely, its causes and full ramification of the solution that one may think are the correct measures. There is need to develop all the available water resources by constructing small/medium and/or large storage reservoirs and then use this available water with out letting a single drop to waste. Then there are some other parameters in the Pakistan context that give strength to the conclusion that "water is not the only constraint" for Pakistan's self-sufficiency in food grain production. These include low irrigated yield and water use efficiencies and high population growth rate. Water crises can be avoided in the coming years by increasing agricultural yields and water use efficiencies while reducing or optimizing the population growth rates.

To attain self-sufficiency in food grain production and generate exportable surplus there need an optimal utilization, development and management of water resources. There needs a complete modernization and up-gradation of our agriculture infrastructure. Production of high value crops and a complete shift in our traditional agricultural production practices is also a prerequisite for self-sufficiency in food production. There is a need to have minimized conveyance losses in the irrigation system, adopted irrigation practices and move towards more efficient use of water through changes in cropping pattern and innovative irrigation practices. To increase agricultural production and save water requires greater access to irrigation technologies. There is a need to increase awareness of appropriate technologies and to facilitate research and technology developments that can assist smallholders improve the irrigated production. The need of the hour is to focus on two priorities to increase water productivity- ' more crop per drop' and to 'save water for other uses'. Thus the food grain requirements can be met through a combination:

1. Population of a country directly influence the food requirements and ultimately the water required to achieve the required grain productions. As a first step to shift Pakistan from the water scarce category, it should adopt measures to work in an integrated manner and try to control population.
2. Increasing yields, which requires an improved agricultural policy environment, covering input supplies, production efficiencies, prices and marketing as well as improved research and extension services.
3. Increasing irrigation intensity of the existing cropped land, which requires additional water to be available which will have to be achieved though a combination of improved water management and improved efficiency and additional water availability at critical times of the year. This would require additional/expansion of existing irrigation infrastructure.

4. Gradual shifting of the traditional irrigation techniques to high efficiency irrigation system such as drip irrigation system, could help increase crop yield and save a large quantity of water.

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