

BRAZIL¹

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1. Introduction

Water occupies three quarters of Earth. About 97.2 percent of that are salty waters in the oceans and seas. Of the 2.5 percent left, 69 percent are ice in polar latitudes. The 31 percent left are liquid fresh water, however, nearly 30 percent are deep underground water, unavailable under presently known technology. Therefore, only about 0.3 percent of the total global water are available for men, in rivers, lakes and reservoirs (Cabral, 1998; Rebouças, 1999).

Worldwide, agriculture is the most significant user of fresh water, responsible for 70 percent of its use, compared to industrial (23%) and domestic (7%) use. Approximately half of the food supply in the world for the last 30 years has come from irrigated agriculture, and it is estimated that, in the near future, one half to two thirds of food production increment will come from irrigated agriculture. The global irrigated area, of 260 Mha in 1997, corresponds to 17 percent of the agricultural area and is responsible for 40 percent of total food production (Santos, 1998).

The cultivated area per inhabitant in the world, in 1984, was 2,970 m² and in 1995 it was 2,550 m². A decrease of 420M²/inh (16.5%) in 11 years caused by degradation, erosion, salinity, water shortage and urban expansion. In the case of irrigated agriculture, the global area was 221 Mha in 1984, which was

¹ Article prepared as a contribution to the Consultation to the Americas on Water for Food, at McGill University, Montreal, Canada, June 30 - July 02, 1999.

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equivalent to 464 m²/inh, and it raised to 255.4 Mha in 1995, corresponding to 449 m²/inh. While the total irrigated area increased 15.6 percent, the per capita value decreased 3.2 percent (Christofidis, 1998).

At the World Food Conference promoted by FAO in 1974, it was predicted that hunger would be eradicated in 10 years. At the next World Food Conference, in 1996, 22 years later, it was estimated that 840 M people were starving, which was equivalent to 14.5 percent of the global population, of 5.8 G inhabitants in that year. Despite these figures, steps were proposed to reduce by 50 percent the number of undernourished people by 2015. Predictions are that world population will stagnate at 12 G by 2050 (Christofidis, 1998).

According to Kennedy (1993), the production of cereals, the most important food crop, did not follow the population growth. Production of cereal increased at a rate of 1.0 percent a year and the population grew 1.7 percent a year. Studies carried by Population Action International (cited by Christofidis, 1998) estimated that there will be 2.5 G starving people by 2025, and that 36 countries will reach that year with only 700 m² per capita of arable land, considered to be the minimum required to feed a person consuming 2400 kcal/day. That consumption is equivalent to 1.0 kg of maize. FAO informed (Christofidis, 1998) that, in the last 25 years, food consumption increased by 10 percent more than food production in some 100 developing countries.

Such a scenario may raise the question: is Malthus becoming fashionable again ?

The world per capita consumption of grains (cereals) in 1990 was 330 kg/inhabitant-year. In that same year, Canada consumed an average of 974 kg/inh, the US 860 kg/day, Mexico 309 kg/inh, Brazil 277 kg/inh and Haiti 100 kg/inh. Considering that 1.0 kg of grain (maize) contains 2,400 kcal, that is equivalent to 2,160 kcal/day. 1.0 kg of grain requires roughly 1,000 L of water to be produced.

2. Brazil: General Characteristics

Brazil has a territory of roughly 8.5 Mkm², with a population of 162 million in 1998 and a total volume of available water estimated in between 5,327 and 5,610 km³/year, which is equivalent to a per capita value of 32,870 to 35,730 L/inh. Estimates indicate from 197,500 to 257,800 m³/S of water flow in its rivers, representing around 18 percent of the world potential. Of that total, about 90 percent are in the Amazonian region (North and Central West regions) where only 15 percent of the population live. The other 10 percent of the volume are found in the other three regions (Northeast, South and Southeast) that concentrate 85 percent of the population and represent 91 percent of the demand for water. Agriculture (and livestock) consume 61 percent of the water, industry uses 18 percent and municipal and domestic use come to 21 percent (Christofidis, 1999; Rebouças, 1999).

Considering the present daily per capita demand for multiple uses of 1,134 L/inh, that would require only 0.83 percent of the potential volume existing in the Brazilian rivers. However, that demand is still below the minimum standards considered as a healthy diet, of 1,535 L/inh. And the world average for a healthy diet is in the order of 2,736 L/inh (Christofidis, 1999). From the 54 largest dams built in the world, with capacities varying from 205 to 21 Gm³, 6 are located in Brazil; and in none of the Brazilian states the per capita availability of water reaches the "water stress" level of less than 1,000 L/inh, considered by the United Nations as a reference value (Rebouças, 1999).

As it can be observed from the above figures, although the total volume may give an impression of abundance, the uneven distribution creates an equity problem that has already become critical in terms of water shortage, especially in the case of the semi-arid regions (parts of the Northeast and Southeast). Christofidis (1998) informed that water conflicts have already emerged in the watersheds of Guaira (São Paulo state), Verde Grande river (Minas Gerais state), Paraíba do Sul (São Paulo, Rio de Janeiro and Minas Gerais states), Bom Jardim (Goiás state) and several smaller river basins in the Northeast and Southeast.

Scarcity of water is becoming gradually more frequent and the competition for its use is severely growing in many parts of the world. *Agroanalysis*, a journal of the Getúlio Vargas Foundation (Brazilian Institute of

Economics) dedicated to studies on agricultural economics, edited a special issue, in 1998, on water resources and irrigation. The slogan adopted for that issue said "Water: the commodity of the turn of the century". That expression illustrates the importance that water is consistently taking in the world scenario. As a consequence, society is being forced to recognize such importance and to demand a more careful use of water resources from planners and decision makers.

According to Lopes & Silva (1998), the population annual growth rate in Brazil was 1.23 percent in 1997 and it is estimated to be 0.92 percent by 2015. If the average value is taken (1.07%) and considering the above mentioned population in 1998, an estimate would be that, by 2015, the Brazilian population will be in the order of 194 million in 2015, and 212 million by 2025, an increment of 30 percent in the number of stomachs to be fed. By 2015, still according to the same authors, there will be a deficit between consumption and production of roughly 2,27 Mt of rice and 1.11 Mt of beans, although a superavit of 9.22 Mt of corn is expected. They predict a need to produce 65 Mt of grains by 2015.

Agriculture in Brazil is a very important activity. Total agricultural area is around 50 Mha, with a potential to cultivate another 60 Mha potentially usable for rainfed agriculture. Its importance is not only related to food production, but it is also economic, having been responsible for 30.7 percent of Brazilian exports in 1997, involving a amount of US\$ 16.2 billion. The annual commercial trade of the agricultural sector generated a positive balance of US\$ 8.7 billion in the same year. It is also quite relevant in terms of job opportunities. In 1996, the agricultural sector employed 16.6 million people, out of a total labor force of 68 million, representing 24.5 percent, as compared to services (22%) and the industry (20%). Brazil holds 32 percent of the world exports of soybean meal; 17 percent of soybean oil; 14 percent of grain soybean; 16 percent of coffee beans; 14 percent of tobacco; and 8.5 percent of sugar (Christofidis, 1999).

Another important aspect to be mentioned is the fact that agricultural (including livestock) production, per se, represents roughly 10 percent of the National Gross Product (GNP), equivalent to approximately US\$ 81 billion. However, if the agribusiness (including the "off farm gate" operations) is considered, the sector's importance will jump to 40 percent of the GNP, or US\$ 321 billion, a major change in its significance.

Irrigated agriculture in Brazil has expanded from 60 kha in 1950 to 2.87 Mha in 1998, of which 960 kha (33%) are the low flat lands in the South, mostly used for flood irrigation. It represents approximately 6 percent of the total national area planted and it is responsible for, 1.4 million direct jobs and 2.8 million indirect. Presently, the vast majority of irrigated areas are private, with only 4.2 percent of public irrigation schemes, comprising about 120 kha. The potential for irrigated agriculture is estimated in 49 Mha, of which 33 Mha are low flat lands for flood irrigation ("várzeas") and 16 Mha in upper lands (Christofidis, 1999) and an expansion of some 500 kha is expected by the end of 2000 according to the National Plan for Irrigation and Drainage

According to Santos (1998), the irrigated area in Brazil represents about 5 percent of the total planted area, but it is responsible for 16 percent of the total agricultural production and for 35 percent of the value of this production. Irrigated agriculture represents one of the most cost-effective ways to generate employment. The author presented some figures on the cost of job generation in different sectors of the economy (in US\$/job):

Chemistry & Petro-Chemistry	220,000
Iron industry	145,000
Livestock	100,000
Capital goods	98,000
Automobile industry	91,000
Industry in general	83,000
Telecommunications	78,000
Intermediate goods	70,000
Tourism	66,000
Agriculture in general	31,000
Irrigated agriculture (horticulture)	13,000

Although it is evident that agriculture is the most significant means of utilizing water for food production and that irrigated agriculture is comparatively more efficient in utilizing water, it is still important to mention that irrigation worldwide has been, in a general way, quite inefficient, as compared to potential levels of efficiency that could be achieved. Christofidis (1999) presented average values of 45 percent for irrigation efficiency worldwide and 62 percent for Brazil. An unavoidable trend will be for other sectors, such as industrial, urban, environmental and domestic, to make use of water that is presently being used by agriculture.

A very important issue related to the low efficiency observed in many of the irrigation schemes, especially in developing countries, is the absence of a well defined methodology for assessing the performance of the schemes with a global approach, that would encompass technical, economical and social factors, all involved in a systematic procedure to assess irrigation performance. For that to become feasible, it is necessary, in the first place, to select adequate performance indicators that fulfill the requirements of rationality, technical feasibility and cost-effectiveness. Second, these indicators will need to be included in a methodological procedure that could be widely used in the majority of the schemes, as a "common language" to be adopted. If that is achieved, it will represent a major contribution for the improvement in the use of water in agricultural production.

The International Commission on Irrigation and Drainage (ICID) created a Working Group on Irrigation and Drainage Performance (WG-PERF), composed by representatives of some 12 countries and the International Water Management Institute (IWMI), whose major objective is to develop a methodology for performance assessment of irrigation schemes. As a result of the creation of the WG-PERF, a program was outlined, called Research Program on Irrigation Performance (RPIP).

In line with RPIP, the Brazilian Agency for Agricultural Research (EMBRAPA), in association with the National Secretariat of Water Resources and the Inter-American Institute for Agricultural Cooperation (IICA) started the project RPIP-Brazil, in 1997, that has the objective of developing a methodology for assessing irrigation performance based on field data being collected in three major irrigation schemes in the country. The work is being carried out in connection with RPIP and keeping contact with the WG-PERF, as a forum for discussion.

Concerning the rational and equitable use of water in Brazil, an important step has been taken with the approval of Law 9433, the "Law of Water Resources Policy", sanctioned in 1997. The law is still to be regulated, before it can become completely effective, but it was the result of many years of discussions among politicians and the different sectors that represent the major uses of water in the country. The main features of the law are:

- (i) adoption of the watershed (basin) as the planning unit for water use;
- (ii) introduction of the multi-use concept: all users will have equal access to water use, with priority given to population domestic use;
- (iii) recognition of water as a limited, finite and vulnerable good;
- (iv) recognition of the economic value of water and therefore entitled to be charged for (principle of the "user payer" and the "polluter payer");
- (v) proposal for a decentralized and participatory management, in which individual users, civil society and other social organizations will be able to influence on the decision making process;

The law also creates some important new figures, such as:

- (i) a national policy of water resources;
- (ii) a national council of water resources;
- (iii) concession of rights for water use;
- (iv) water charges;

From the data and situations described, it is possible to observe that the Brazilian potential, in terms of water and food production, is impressive. On the other hand, there are problems to be resolved that are proportional to the continental size of the territory. However, some of the actions that are being taken offer alternatives and ways to face the problems, and look for solutions so that the country will be able to cope with the changes to come and therefore to prevent any eventual water or food crisis in the future.