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WATER FOR AGRICULTURE

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ABSTRACT

The changing pattern of water use in Southern Africa, coupled with the population growth, has put pressure on agriculture. The restricted water resources in Bophuthatswana and the projected primary demand in the year 2010 are examined to establish the potential for agricultural use. It is clear that future planning should be carried out with more circumspection than ever before, and that no single sector can operate in isolation of the other sectors competing for water.

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INTRODUCTION

The pattern of water use in Southern Africa has changed significantly over the past century. At the end of the 1800's the major portion of water was used for agriculture, primarily irrigation. Water resource development was the responsibility of private sector initiative. Primary water supply schemes were built by local authorities. Direct diversion from rivers was generally practised for irrigation as few storage dams had been constructed.

In the early years of this century, the move towards more ordered water development gathered momentum after the proclamation of the 1912 Irrigation and Conservation of Waters Act. The Act encouraged the construction of storage schemes, and several major dams were built. The role of Government was further intensified following the Depression, when prevailing social conditions demanded accelerated development to alleviate matters. The drought which accompanied the Depression gave rise to development of several labour-intensive Government Schemes to accomodate destitute people from stricken areas.

The post World War II years saw a rapid rise in industrialization in South Africa. It soon became evident that the growing water needs of the mining, industrial and urban sectors would place an increasingly heavy burden on water resources. Agricultural water use, which had previously been rather extravagant, would face more and more competition and avenues for optimization would have to be found. At this time it was also realized that the 1912 Act, which promoted irrigation development, did not cater for the demands of a changing economy. A new Water Act (Act 54 of 1956) was proclaimed.

Through the 1956 Act, the State obtained authority of control over water in excess of existing users' rights, where necessary. The minister now had the power to ensure an equitable distribution of water for competing users. More rational long-term planning could also be performed. Scientific, engineering and economic investigations were undertaken in order to optimize the implementation of new strategies. The changing role of agriculture is best illustrated in (Table 1)

which depicts its contribution to the gross domestic product over time.

Table 1.

YEAR	AGRICULTURE	MINING	INDUSTRY	COMMERCE	OTHER
1920	22,2	18,3	7,3	15,6	34,6
1930	14,2	15,6	9,4	15,1	45,7
1940	12,7	18,7	12,4	13,9	42,3
1950	17,7	13,5	16,4	14,0	38,4
1960	12,4	13,7	20,5	14,2	39,2
1970	8,1	10,0	23,3	15,1	43,5
1980	7,1	22,1	22,6	11,6	36,6

Percentage distribution of gross domestic product of South Africa.

In the past two decades, planners and policy makers realized that perhaps the major challenge to meeting future needs lies not so much in legislation and control, than in a reorientation of traditional attitudes. The belief that water is an abundant natural resource, available at little or no cost, had to be modified towards the acceptance by beneficiaries, that they would have to pay the marginal cost of providing an acceptable security and quality of supply.

Agriculture in particular, has to move towards greater efficiency. Much work has already been done. Subjects such as groundwater abstraction, recycling and reconditioning of effluents, control over evaporation and seepage, rainfall stimulation, desalination, inter-catchment transfer, pollution control and improvement of irrigation techniques have all received intense attention. There can be no doubt as to the importance of technological research and innovation in the search for greater efficiency. Yet, despite all the advances, there is great concern over the degradation of not only water resources, but of the entire natural environment, and particularly in developing countries.

This paper briefly examines some of the underlying concepts of agricultural water use, with a focus on Bophuthatswana. Although Bophuthatswana cannot really be typified as a Third World country, it is nevertheless a developing country, and some valuable lessons have been learnt.

DEFINITIONS

The use of water in agriculture can be manifold but for the purposes of this paper the following three categories can be defined:

1. Water for irrigation

Included in this category are large scale commercial irrigation schemes, private commercial installations and small scale non-commercial schemes (eg. food-plots). Despite the decline in the contribution of irrigation agriculture to the GDP of South Africa, it is still the largest consumer of water. Forestry is also included in this sector.

2. Water for stock-watering

Stock farming is an essential and important component of agriculture, especially in rural Bophuthatswana. Recent years of drought, high stocking rates and the land tenure system have highlighted problems associated with stock-watering.

3. Aquaculture

Enterprises such as fish-farming, (including freshwater crustacea) and the harvesting of aquatic weeds are among those included in this category. Although such an enterprise would probably exist as an extension of (1) and/or (2), rather than on its own, it is nevertheless important enough to list as a separate category.

WATER RESOURCES IN BOPHUTHATSWANA

1. Surface Water

Bophuthatswana can in general be described as semi-arid to arid since it is situated, as the rest of Southern Africa, within a high pressure belt of the mid latitudes of the Southern Hemisphere. Due to the warm, dry descending air and the flat topography, the main rain-forming mechanism is the occasional convectional thunderstorm. These storms usually cover small areas, are of short duration, albeit intense enough to cause short-term flow in local streams.

Periodic droughts due to the anticyclonic activity over the interior have occurred in the years 1925 - 1933, 1960 - 1966 and 1978 to present. Paradoxically, severe flooding has also occurred fairly regularly. Furthermore, the annual evaporation exceeds the annual rainfall by a factor of 2 to 5. The relationship between rainfall and evaporation has a dramatic influence on river flow. In the western parts of the subregion, the percentage of precipitation that is observed as run-off is as low as 2.7%. What little water reaches our dams is further rapidly depleted by evaporation since storage basins are large and shallow, due to the topography. The capacity of dams is also impeded by the heavy sediment loads carried by rivers.

2. Ground Water

Secondary aquifers, consisting of weathered and fractured rocks which lie directly beneath the surface, contain about 80% of the groundwater in the sub-continent. At depths greater than 50m unweathered formations occur, which, because of their dense nature contain very little ground water. The permeability of these aquifers is also generally very low.

The possibility of exploitation of secondary aquifers is therefore limited mainly to the provision of water in rural areas for domestic use, stock-watering, very small scale irrigation and providing water to communities.

Bophuthatswana is however, fortunate enough to have some dolomite areas within its borders. Dolomites are composed of dolomite-rock, interbedded chert, shale and sandstone, in strata 200 to 1900 metres thick. Dolomite aquifers, especially those that are well leached, may be exploited on a larger scale for urban supplies and irrigation than ground water in hard-rock formations.

3. Total Potential

A summary of the surface and ground-water potential of Bophuthatswana is given in (Table 2).

Table 2.

District	Ground-water million m ³ /a	Surface-water million m ³ /a
Kudumane/Ganyesa	32,1	0,94
Taung	12,9	54,4 *
Ditsobotla	13,4	0,5
Lehurutshe	11,9	6,0
Molopo	8,5	20,55*
Madikwe	12,8	33,8
Mankwe	16,5	23,90*
Bafokeng/Odi II	9,0	0,7 *
Odi/Moretele I	17,0	27,7 *
Moretele II	3,8	0
Thaba Nchu	12,8	14,1
TOTAL	150.70	182,59

* Quantity includes water imported from Rep of South Africa.

Summary of water potential in Bophuthatswana.

The figures for ground-water are not the gross extractable quantities but reflect that portion of the ground-water which can be economically utilized. Surface water quantities are the assured yields of existing and potential dams, plus water imported from the RSA. Should the imported water be subtracted from the total, the natural surface

water potential of Bophuthatswana is only about 86 million cubic metres per year. Eerstepoort Dam, currently under construction, amounts to 33 million cubic metres per annum or 38,4% of the total natural potential of Bophuthatswana.

It is not only significant that the ground-water potential exceeds the surface-water by a factor of almost, 2, but also that a major portion of the surface water is concentrated in one locality. This is bad news indeed for irrigation development in Bophuthatswana.

URBAN AND INDUSTRIAL WATER DEMAND

The supply of water to the urban and industrial sectors requires a high assurance and must therefore be considered as a higher priority to agriculture. Since Bophuthatswana is a developing country, it is conceivable that the per capita water demand will increase. The use of automatic appliances, increasing provision of water and waterborne sewerage systems in homes will lead to this. Along with the population and industrialization growth, the total water need will also increase accordingly.

The projected primary water demand for Bophuthatswana in the year 2010 is compared with the total water resources in (Table 3).

Table 3.

District	Total avail water million m ³ /a	Primary demand million m ³ /a	Surplus/ Shortage million m ³ /a
Kudumane/Ganyesa	33,04	20,4	12,64
Taung	67,3	23,7	43,60
Ditsobotla	13,9	21,9	(8,00)
Lehurutshe	17,9	11,0	6,90
Molopo	29,05	29,2	(0,15)
Madikwe	46,6	12,8	33,8
Bafokeng/Odi II	9,7	30,4	(20,7)
Odi/Moretele I	44,7	11,0	(65,3)
Moretele II	3,8	7,2	(3,40)
Thaba Nchu	26,90	12,8	14,1
TOTAL	333,29	298,80	34,49

Water Balance

Disregarding the distribution of water it is apparent from the above, that 34,5 million cubic metres of water will be available for agriculture in the year 2010. This translates into an area of between 3500 ha and 4000 ha, when irrigation development is considered. The

total area under irrigation at Taung, Dinokana and Tsholofelo is 3955 ha. Bearing in mind that the year 2010 is only 24 years hence, the question of whether more irrigation development is justified might be asked.

Thus far, only the quantitative aspects of water supply and demand in Bophuthatswana have been considered. Another extremely important facet of water use is quality. It is a world wide characteristic of arid and semi-arid regions for rivers and storage dams to become progressively salinated. Eutrophication, the enrichment of water sources with plant nutrients, is a major water quality problem in Southern Africa. The discharge of effluents rich in soluble phosphates and nitrogen accelerates this natural process. Apart from the effects of pollutants mere evaporation and use of water can account for large increases in concentrations of dissolved mineral salts. If salts are not leached or flushed out of the soil profile, salinity will continue to increase to saturation levels. Long-term exposure to saline drinking water constitutes a direct health hazard.

It is safe to say therefore, that without costly preventative and remedial measures, the deteriorating quality of water will in effect reduce the quantity of water available for beneficial use.

IRRIGATION DEVELOPMENT IN BOPHUTHATSWANA1. Taung

Taung Irrigation Scheme, the largest scheme in Bophuthatswana, has a history going back to 1881 - 82, when the Irrigation Engineer of the Cape Province reported on the possibility of irrigation to Cecil Rhodes, then Prime Minister of the Cape Colony. After much deliberation and several interruptions due to wars, droughts and the Depression, the Vaalharts Scheme was finally completed in 1946.

The Taung Scheme was laid out for flood irrigation from earth leidams, with 1,7 ha plots allocated to individual farmers. Drainage problems due to seepage from these leidams soon led to their abandonment. This action nullified internal control and caused further deterioration.

In the early seventies a process of reorganization and redevelopment was initiated by the Bophuthatswana Department of Agriculture. In the period 1977 to 1982, 2515 ha of flood plots were systematically converted to centre pivot irrigation. The last phase to be developed was 850 ha under conventional sprinkler, with some differences. The layout of the underground pipes was done in such a way that conversion to drip/micro irrigation can be accomplished with minimum expense, adding only filtration units and laterals.

The total capital investment of the redevelopment amounts to R21,18 million. The new controlled overhead irrigation provided the farmers with a more efficient means of irrigation, not only from a water use point of view, but also with respect to uniformity of application. The risk of salinity and a rising water table was therefore considerably reduced. The main crops currently produced are cotton, maize, peas and wheat.

There are currently 412 farmers on the scheme, organized into 5 primary co-operatives, which in turn, are members of a secondary co-operative. The annual income per farmer is in the region of R10 000.

2. Tsholofelo and Dinokana

Tsholofelo was the first of two smaller irrigation schemes, developed in 1982 by Agricor. The scheme is 285 ha in extent and receives its water from Ngotwane Dam. The major crop is citrus, being 124 ha in area, utilizing micro irrigation. On the balance of the scheme cash crops are grown. Ultimately, the scheme will accommodate 40 farmers.

Dinokana Irrigation Scheme was commissioned in 1984 and is gravity fed from the Dinokana eye situated in the Dinokana Dolomite Compartment. The main activity is commercial vegetable production under 48 ha drip irrigation. No farmers have been settled on the scheme yet. Total area under irrigation is 100 ha.

3. Disaneng

Disaneng Irrigation Scheme, 200 ha in extent, derives its water from the Disaneng Dam. Currently managed by the Department of Agriculture, small scale table grapes and peaches are grown, while on the balance a suitable cash crop rotation is followed.

FUTURE OF IRRIGATION IN BOPHUTHATSWANA

1. Taung

A recent exercise on the future of Taung Irrigation scheme has shown some interesting results. Through careful crop and crop rotation selection and taking into consideration crop water requirements as per the most up to date information available, it was concluded that with the current allocation of 54,41 million cubic metres, the irrigation area at Taung could be increased to 4955 ha. This represents an increase of almost 40%! The calculations were also based on the assumption that the total scheme will be converted to a similar sprinkler/drip configuration described earlier. The total capital requirement to achieve this is in the region of R20 million.

2. Eerstespoort

Although the proposed Eerstespoort Irrigation Scheme is still in the planning stage, it merits discussion as this project represents the only opportunity for Bophuthatswana to develop a scheme of this magnitude, starting with a clean drawing board.

The Eerstespoort Dam, situated in the northwestern corner of Madikwe has a gross capacity of 204 million cubic metres. The 95% assured draft (under restricted operating rules) is 52 million cubic metres per year. Subtracting compensation water, primary requirements etc., a nett amount of some 34 million cubic metres is available for irrigation. With the proposed crop mix, using the optimum techniques, an area of around 3500 ha could therefore be irrigated.

Current planning indicates that a 6 - 12 ha plot, depending on the crop mix, will provide a farmer with an acceptable nett income of R12 000 per annum (August 1985 values). Farmers will be members of primary co-operatives, and will do their own decision making and management within the co-operative framework.

The capital investment required for developing new irrigation schemes has become extremely high. The total physical development of Eerstespoort was estimated at around R68 million (present value).

This amounts to just under R19 500 per ha. In order to realize some economic benefit, high value (and therefore high risk) crops must be grown. In the case of Eerstepoort, citrus was seen to form the backbone of the economy.

The high risk crops, in combination with the inherent water scarcity in Bophuthatswana, dictate sophisticated management and technology. Irrigation scheduling, crop rotations, weed and pest control, post harvest processing and judicious marketing are all factors which need to be carefully controlled. Furthermore, modern irrigation technology such as computer controlled micro irrigation on orchards for example, will have to be implemented to ensure that the limited water is used at maximum efficiency.

The above considerations present a dilemma for development agencies when the human element is taken into consideration. It is Agricor's declared policy that individual farmer participation should be established on development projects as soon as is practicable. The situation that confronts the newly recruited farmer when he arrives on the scheme is one of a bewildering array of sophisticated concepts, procedures and techniques. Coupled with this might be a foreign social system such as a co-operative village, quite unlike the tribal configuration in which the individual grew up. It is conceivable therefore, that individual decisionmaking will at best be severely impaired during the first few years on the scheme. At worst, some farmers will simply not make it.

In the broadest sense the above dilemma is essentially a conflict of objectives. The question of whether agriculture should be developed through people or whether people should be developed through agriculture, has been asked. In reality, the answer probably lies somewhere in between. This is a particularly sticky problem for irrigation agriculture.

No attempt will be made in this paper to answer these questions. Suffice it to say that developers should approach irrigation scheme planning with great sensitivity and wisdom. Carefully phased implementation schedules and a special emphasis on training should

always feature in development strategies. However, the desire to develop and the will to rise out of a state of poverty and complacency, are things which cannot be instilled in people by a development agency. It must come from within.

CONCLUSION

Agriculturalists and irrigation developers will have to take cognisance of a growing water demand in the urban and industrial sectors. This does not mean however, that development must stop because urban and other demands will eradicate the surplus at some point in the future. The march of science and technology in the fields of irrigation, weather modification, genetic engineering, water purification and recycling, will continue to provide solutions to problems facing mankind today.

The development of new schemes, as well as the upgrading of old schemes must proceed with great circumspection by planners. Crops grown under irrigation should preferably not be those which could be grown on dryland but should rather represent import substitution. Genetic engineers and plant breeders will have to introduce more drought resistant and water efficient cultivars.

There is vast potential for aquaculture in Southern Africa. Water in storage dams waiting to be used for irrigation need not stand idle. Fish farming and the harvesting of aquatic weeds can realize additional economic benefit to offset the capital investment of an irrigation scheme. The production of rainbow trout, oysters, marron, catfish, tilapia and recreation have all been identified as saleable commodities.

Water for stock watering is not so much a problem in terms of quantities, as it is a problem of the distribution of the available quantities. Regional supply schemes such as the proposed Kudumane/Ganyesa scheme will ease the livestock concentrations in areas of existing watering points. If realistic stocking rates are achieved and maintained the demand for stock water should theoretically not increase.

Finally, the planning of any water related development project can no longer be performed in isolation by the various sectors. Wholistic planning, on a regional basis and with its origins in a national water management strategy, will form the basis for survival.

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