Policy Proposal for Irrigated Agriculture in South Africa

DISCUSSION PAPER
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WATER RESEARCH COMMISSION

POLICY PROPOSAL FOR IRRIGATED AGRICULTURE IN SOUTH AFRICA

DISCUSSION PAPER

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EXECUTIVE SUMMARY

POLICY PROPOSAL FOR IRRIGATED AGRICULTURE IN SOUTH AFRICA

CHAPTER 1 : INTRODUCTION

In the new democratic South Africa there is a need to remove the inequality of the past and simultaneously to enhance economic welfare through greater efficiency and equity. Water is a scarce resource and water rights constitute a valuable economic asset. Irrigation policy should therefore enable private entrepreneurs to enhance productivity and profitability. It must also aid in the alleviation of wide-spread rural poverty.

This document aims to inform interested and affected persons on relevant issues regarding irrigation policy and to indicate what its authors would regard as appropriate policy directions.

CHAPTER 2 : POLICY PRINCIPLES AND GUIDELINES

Public policy, including irrigation policy, is an output of the political process; people or groups of people demand intervention or support (or withdrawal of intervention), which can only be granted by politicians and bureaucracies who act according to their own perceptions. This interaction occurs within the framework of the constitution. Fundamental rights as guaranteed by the constitution must always be respected.

The main objective of public policy is increased economic and social welfare: This involves four intermediate objectives of efficiency, equity, stability and order. Water allocation and water conservation policies must fall within this ambit for which decision rules and procedures are needed.

Approximately 40 000 small-scale farmers, 15 000 medium-to-large-scale farmers, 120 000 permanent workers, and an unknown number of seasonal workers are involved in irrigation farming, which consumes approximately 51% of South Africa's water on some 1,3 million ha. It contributes 25 to 30% of South Africa's agricultural output.

Water rights are important to those who make a living and invest capital, time and management in irrigation farming. It is the function of government to define water rights and to enforce rules: Legislative prescription is needed.

The following quantifiable medium-to-short-term goals must be met to satisfy the stated objectives:

- Increased regional employment.
- Establishment of people on existing irrigation schemes and promotion of labour-absorbing technologies.
- Increased production of staple foods.
- Prevention of pollution.

The policy goals must be: adapted to biophysical circumstances, technologically appropriate, financially and economically viable, institutionally manageable, acceptable socially and attractive politically.

The main emphasis in water and irrigation policy should be on the management of conflict between competing uses and users. It will be necessary to distinguish between what should be done by the national government, provincial governments, local government, communities and individuals. Effectiveness will require a movement away from central bureaucratic control toward private initiative. Irrigation farming will however always need some public support and government involvement. The challenge is to combine the discipline of the market process with responsible governance.

CHAPTER 3: WATER RESOURCES

3.1 Water availability in South Africa

Natural conditions on the South African sub-continent are not conducive to high and stable rainfall. Relatively humid, subtropical conditions occur in the east and mean annual rainfall decreases rapidly in a western direction. The southern coastal strip and Western Cape have a Mediterranean climate with higher rainfall than in the interior. The mean annual rainfall of South Africa is well below world average. Irrigation water requirements are strongly affected by the seasonal distribution of rainfall and its reliability, which are normally better in higher rainfall areas.

3.2 Groundwater resources

Most groundwater occurs in secondary aquifers, fractured rock and dolomite. The latter is more attractive as sources of groundwater for irrigation, but exploitation can have significant negative consequences such as sinkhole formation and subsurface subsidence.

There is a serious dearth of information on the occurrence, availability and use of groundwater. Its recharge from rainwater infiltration (which is small) determines safe yields of groundwater utilisation. About 5 400 million m^3 per annum can be abstracted on an economic basis.

The use of groundwater has grown significantly over the past 10 years, and may be about 2 000 million m^3 p.a., i.e. 37% of the potential exploitable resource. Increased reliance on groundwater should be supported by the strict application of scientifically formulated operating rules for the conjunctive use of this water and surface water.

Approximately 240 000 ha are irrigated by groundwater. The system of water rights, technological developments and the economics of irrigation will affect future growth in its use.

3.3 Surface water resources

Only 8.5% of the low average annual rainfall of South Africa (497 mm) finds its way to rivers as runoff. The mean aggregate runoff is 53 000 million m^3. Some rivers are of joint interest to South Africa and neighbouring countries. The non-uniform rainfall pattern and

drainage pattern have resulted in non-uniformity in the geographical distribution of stream flow. The relatively water-rich areas east of the escarpment are drained by steep rivers discharging into the Indian Ocean. The Orange River system drains about 48% of runoff. Even perennial streams have a strong seasonal character. Utilizable surface runoff is about 33 000 million m^3 p.a. with present technology. Existing dams have a combined storage capacity of over 50% of the total mean runoff. Only coastal rivers are largely unregulated by dams.

3.4 Water availability for irrigation

Virtually all irrigation schemes relying on groundwater are privately owned and operated; in many cases the groundwater source is sustainable at present levels of abstraction.

Irrigation uses about 51% of South Africa's surface water resources. More and more dams have been built over time and "normal flow" hardly exists any more; the legal definition can seldom be quantified in practice. Virtually all the large irrigation schemes are supplied from storage dams; water supply seldom corresponds with planning intentions. There is a move to transfer operation and maintenance responsibilities to irrigation boards with the State retaining control over water resources.

Practically all government water schemes were built for socio-economic objectives;economic viability criteria were not accorded much importance. Cost recovery (even operation and maintenance) was usually not required for State expenditure on government irrigation schemes. Large capital subsidies were paid to irrigation boards and private irrigators. Poor scheme management has been common; security arrangements for supply did not adequately consider local conditions and changes therein can improve efficiency. This can be done by variable draft operating rules that provide for significant restrictions and/or voluntary transfer in times of scarcity.

3.5 Issues relating to water supplies for irrigation

The following factors are likely to affect water supplies:

- Prospective changes in water rights legislation.

- Increased water supply prices.

- Regional resource management on a river basin that makes irrigators jointly responsible with other water users and stakeholders for reconciling increasing demands with limited supplies. Integrated river basin management systems may improve utilisation and decrease the unit cost of supplies.

- Changes in water quality.

- Potential new water sources for irrigation may be limited to the relatively undeveloped rivers in KwaZulu-Natal. About 1030 million m^3 may be available. Development of such resources should however be subjected to stringent evaluation; improvement in the efficiency of existing schemes and the upgrading thereof should have a high priority.

CHAPTER 4: LAND RESOURCES AND PRODUCTION

4.1 Land and climate

Less than 20% of South Africa has a sub-humid climate with a mean annual rainfall higher than 750 mm. Soils in this part of the country are generally less suitable for intensive cultivation. The rest of the country has an arid to semi-arid climate with medium to high water deficits relative to crop needs. Most cultivable soils occur in these regions. In large parts of South Africa, water supplementation through irrigation is essential for economic crop production.

Since water is scarce, irrigation should be applied only on soils with a high degree of irrigability. Most such soils occur in more arid regions with high irrigation requirements. While 1 300 000 ha is irrigated at present, another 280 000 ha of soil is suitable for irrigation; water availability appears to exist for only another 178 000 ha. Irrigation can be either permanent, supplementary or occasional. The largest concentration of permanent irrigation in South Africa occurs in the 250-750 mm rainfall zones.

Irrigation sometimes leads to deterioration of soil and/or water quality for downstream users, e.g. waterlogging, salt accumulation, surface sealing, subsoil compaction and low quality return flow. Good knowledge of irrigation water quality and its interaction with soil is needed to maintain the productivity of irrigated land.

Excessive losses from conveyance systems are often found in South Africa; excessive use of agro-chemicals has been reported, fortunately only in isolated cases. Irrigation farming is sometimes at the receiving end when sewage and industrial outflow reduces water quality, sometimes to levels that are toxic to plants and animals; levels are usually harmful long before toxicity sets in.

Intensive soil surveys should precede all new irrigation development.

4.2 Crop production

Approximately 12,0 million ha of land in South Africa is arable. In the absence of irrigation, rainfed crop production can feed approximately 20 to 30 million people whereas South Africa's population numbers about 42 million. Intensive irrigation production can feed an additional 10 to 15 million people, given the present situation. Improved efficiency will be necessary to feed the expected population of 60 million by the year 2010.

Irrigated crop production has benefited food security by supplying food at reasonable prices, supplying work opportunities and earning foreign capital.

In future, the commercially irrigated production of grains, pastures and industrial crops is likely to make way for more profitable crops such as vegetables, fruits, nuts and flowers. Grains will probably still be planted under irrigation, albeit on smaller areas, particularly for seed production and as indispensable rotational crops. Local conditions will probably cause continued irrigated fodder production in arid regions, where this has stabilised livestock production.

Productivity of irrigation water can be enhanced by improving the water use efficiency (WUE) of crops. This can be done with individual crops by better irrigation scheduling, by irrigating at night rather than during the day, and by improving water delivery technology. It can also be raised by using more or better accompanying inputs (cultivars, fertiliser, disease control, etc.).

The most important way to improve economic WUE is however the move toward crops with higher economic WUEs. Government-supported research, technical support services and specialist extension programmes are needed to improve WUE.

Realistic water supply pricing may also induce farmers to improve economic WUE.

CHAPTER 5: HUMAN RESOURCES AND MARKETS

5.1 Entrepreneurship and management

While entrepreneurship initiates economic and business activity, it is management that largely determines its success. Management involves decision-making and action on all phases of farming - procurement, production, financing, investment and marketing.

Managerial ability varies among individuals. Empirical evidence world-wide usually fails to show either increasing or decreasing returns to scale once a certain critical threshold of size has been reached. The evidence invariably shows increasing returns to quality of management. Good managers are able to expand their business successfully, while those of poor managers either contract or go insolvent. Therefore, policy regarding farm sizes has to be flexible, allowing successful farmers to expand and build on success, while allowing less successful farmers to contract to units small enough for their managerial ability. Given the high managerial quality involved in irrigation, this is even more necessary in irrigation than in rainfed farming.

The high managerial requirements dictate a need for special education, extension and training for irrigators. This education should, besides technical aspects, also include accountancy, financing and marketing.

Experience has repeatedly shown that in farming, overborrowing normally leads to financial failure. Less than 50% of capital should be financed by loans; equity capital is needed. A lack of equity represents a serious constraint to entry into irrigation farming.

5.2 Economic location

Farmers will produce for markets only if they can sell their products profitably. The ability to do so depends both on the market for the particular product and on the farm's economic location, i.e. the ability to reach markets at reasonable cost with produce in a state fit for marketing. Distance from markets, transport facilities and communication infrastructure are important considerations. Without sufficient and economic market access, irrigation schemes cannot expect to achieve success.

This has two important policy implications:

- New irrigation development must occur only where the economic location is favourable or can be made favourable.

- In many areas, particularly in erstwhile "homelands", the economic location is unfavourable mainly due to poor development of transport and communications infrastructure. Roads are often particularly poor. This can and should be rectified by the development of such infrastructure which will not only render irrigation more viable, but will contribute in other ways to local economic and social development.

5.3 Economic linkages between irrigation farming and the rest of the economy

The importance of any economic activity, including irrigation farming to the economy at large, goes much further than its direct contributions to employment, revenue, gross national product and generation of foreign exchange. An activity often causes "ripple" effects through the economy, as caused by backward and forward linkages. Forward linkages exist when other economic sectors use products as intermediate inputs or when they engage in economic activity to trade, distribute, transport or transform the product. The food and textile industries use farm products as raw materials and in this process, they also provide market outlets for other industries such as packaging materials, metal cans, transport, insurance, etc. Backward linkages exist when a sector represents a market for products of other sectors. The agricultural sector uses, for example, chemicals, machinery, building materials, etc. supplied by other sectors.

By 1994, 62% of consumers' food expenditure in South Africa represented forward linkages (1,65 times farmers' gross revenues). Agriculture and construction are the industries with the highest labour multipliers in South Africa; between 101 and 241 employment opportunities are created by a R1 million increase in the value of agricultural production. A contraction in agriculture production brings about a similar decline in employment. The total impact of a 10% change in agricultural output is a change of 1,2 to 1,4% in the economy as a whole. The multipliers of irrigation farming appear to have similar magnitude as agriculture as a whole. It is the economic and social lifeline of many rural areas.

5.4 The nature and intensity of irrigation farming

Irrigation farming has a more intensive use of inputs per hectare of land than rainfed agriculture. It absorbs more labour and fixed capital. Its nature demands higher levels of managerial aptitude. Median annual variable costs are about R6 000 to R7 000 per hectare, but can be much higher. Table grape or ginger production for example may absorb short-term inputs of over R28 000 per hectare.

5.5 Commercial irrigation farming

The intensity of commercial irrigation farming varies according to economic location, soil and water quality and stability of water supply. Profitability varies accordingly. Grains typically yield gross margins of R1 000 to R2 800 per hectare, vegetables often yield gross margins of R5 000 to approximately R10 000 per hectare and some fruits may be associated with gross margins of R15 000 to R23 000 per hectare.

Labour absorption also varies among crops. Tomato production can absorb between 3 600 and 10 000 labour hours per hectare p.a., while clementines and satsumas engage 3 600 to 3 900 hours per hectare per annum. At the other end of the continuum, lucerne production utilises between 100 and 230 labour hours per hectare p.a., whilst irrigated grain production absorbs only 40 to 70 hours. Labour absorption is typically higher in areas close to large concentrations of unemployed or under-employed labour.

Water use efficiency will be improved should farmers switch to crops with higher marginal value products in relation to water. Subsidised water tariffs represent an impeding influence. Subsidies on capital goods and credit as well as artificial product prices have reduced productivity. The only justifiable subsidies may be on employment and new farmer settlement - with a time scale added.

Irrigation farming can be very remunerative provided the following are present:

- High quality management
- Markets and the infrastructure
- Sufficient equity capital.

5.6 Small-scale irrigation farming

South African small-scale farmer irrigation schemes are beset with problems. These include scheme management, project planning and design, security of tenure, size of units, farmer participation, water management, debts, product prices, marketing, inputs, and services concerned with research, extension, mechanisation and other types of support.

There appears to be 202 small-scale farmer irrigation schemes involving some 47 500 ha. Only 37% of participants are commercially oriented. The remaining 63% are foodplot holders who may sometimes sell some produce.

There has in general been no selection of participants. Schemes are characterised by high population growth, an unequal gender distribution in the productive years and a high illiteracy rate. Women play a crucial role in all schemes. In small-scale commercial cases, males play a role that increases with the size of the unit. Household incomes are commonly below subsistence levels, high debt loads preponderate on some larger "commercial" schemes, and very few farmers show profits. There are exceptions among sugar cane farmers in KwaZulu-Natal and Mpumalanga and among some fruit producers. There is a lack of strong local organisations and leadership and hence also of farmers' participation.

Poor project management has usually been the major cause of poor performance.

The following may be regarded as major problems:

- Too much dependence on the government for technical and financial assistance, advice and training.
- Poor performances despite huge investments, due to technical, engineering, organisational and project managerial failures. Non-accountability has been a serious problem.
- Lack of participation by, and consultation with farmers.
- Lack of appreciation by irrigation authorities of socio-economic parameters.

- Insecure tenure.
- Inadequate decentralisation of power and responsibilities and lack of accountability on the part of decision-makers.
- Poor equipment and water works maintenance.
- Inappropriate irrigation technology.

5.7 Other important irrigation policy considerations

- Stability of water delivery and usage: The most effective solution may be to reallocate water as conditions change, using either water restrictions or voluntary transfer.

- Decision support for private enterprise: Many small-scale farmer irrigation scheme managers are well versed in technical matters but lack the necessary social and communication skills. Farmers become overdependent on government and other organisations.

There is a clear need to move to a participatory consultative approach concurrently with training of managers, extension workers and participants. Extension personnel need special training to handle situations at the small-scale farmer schemes. Literacy training should at many places be included in agricultural training and extension. There is furthermore a need to train local leadership and to stimulate local organisations.

- Security and nature of tenure and ability to expand: Private and secure tenure is necessary to attract top entrepreneurial and managerial talent to irrigation farming. Private tenure can take the shape of ownership or tenancy; the latter is preferred if the farmer is short on capital. Legislation may be needed to secure tenancy. Trial tenure, involving ten years, was applied successfully in the 1920s in schemes intended for the rehabilitation of poor white farmers.

- Research and farmer support: South Africa should concentrate on adaptive applied research to develop appropriate technology.

- Use of public funds for water system development: Because of high capital requirements to construct water works, all proposed use of public funds should be subjected to intensive evaluation of the technical and financial feasibility, the fiscal, social and ecological impacts and economic and social benefits and costs.

CHAPTER 6: LEGAL FRAMEWORK AND INSTITUTIONAL ARRANGEMENTS: PRESENT SITUATION AND PROPOSALS FOR THE FUTURE

6.1 Constitutional arrangements

The Constitution of the Republic of South Africa has set out a three-tier government structure comprising the national government, nine provincial governments and local governments. Each has its own domain of legislative powers and responsibility as described in the Constitution.

Aspects dealing with overall water resource planning and utilisation are a function of the national government and come under the jurisdiction of the Minister and Department of Water Affairs and Forestry. Land matters are also a national government concern, and are handled by the Minister and Department of Land Affairs, who are entitled to delegate powers to other appropriate authorities. It is not yet clear who will deal with matters of water pollution and land degradation caused by irrigation; the relative boundaries of the national and provincial governments have not been clearly delineated.

A compromise remains to be worked out between the national and provincial governments and local irrigated agriculture stakeholders regarding many facets of water and irrigation.

6.2 Land reform

The Green Paper on South African Land Policy sets out a vision and strategies for a just land policy which will build reconciliation and stability, contribute to economic growth and bolster household welfare. Land reform programmes rest on three principle components: land redistribution, restitution and tenure reform. The aim is to ensure security of tenure for all rural dwellers. The role of traditional and tribal authorities in this development is presently the subject of considerable debate.

6.3 Water rights : The existing situation

Existing water rights law is the legacy of developments over approximately three centuries, and has its roots in Roman Dutch Law and English Law. The existing law is contained mainly in the Water Act, 1956 (Act 54 of 1956) as amended, and in about 33 other acts dealing with specific water schemes or specifically demarcated areas. The Water Act, 1956 *inter alia* regulates the control, use and conservation of water. The executive power is vested in the Minister of Water Affairs and Forestry. The Act does not itself specify water rights; these are contained in various documents issued in terms of the Act. Water rights for many properties have not been determined.

The provisions in the Act dealing with water rights rest on two cornerstones:

- Distinction between public and private water: The former consists of normal flow and/or surplus water. Public water flows in a known and defined channel and can be used for irrigation on at least two riparian properties. All other water, including groundwater, is private water. Normal flow in a public stream consists of the maximum quantity available for peak demand without storage. Water that has to be stored is surplus water.

- Distinction in rights between government water control areas and other areas: There are no property rights to public water, but persons have the right to use it.

In an area other than a government water control area, all owners of riparian land hold common property rights to all the water in the stream, and each is entitled to a share of that stream. In a government water control area the right to use both ground and public water vests in the Minister of Water Affairs and Forestry.

Rights to private water (excluding underground water) cannot be affected by proclaiming a government water control area. The owner of land with private water and groundwater (in a non-government water control area) has sole and exclusive right and enjoyment of such water: Limited property rights appear to exist.

The Discussion document: Water Law Principles (1996) suggests that:

- All water should be regarded as a resource common to all, and its use should be subject to national control.
- There should be no ownership of water, but right to its use.
- Location of water resource relative to land should not confer preferential use rights.
- In order to promote efficient economic allocation, the law should provide a framework to facilitate water allocation transfers.
- Rights should be allocated in a clear, secure and predictable fashion regarding assurance of availability, extent and duration of use without arbitrary restrictions on purposes of usage.
- Lawful existing rights should be protected subject to the public interest.

The approaches and methods to be followed are not clear, and many questions are unanswered, e.g. Will all rights be registered? Will undetermined rights be speedily quantified? Will water rights have security of tenure?

Other aspects that need consideration are effects on land prices, the need to avert disruption and the need for clarity in terms of the property clause of the Constitution.

It is necessary to have a market-related, willing-buyer-willing-seller arrangement for transfers in order to promote exchange from lower to higher valued uses. Existing procedures are often time consuming and expensive.

6.4 Determination of quantity of water usage, needs and requirements

This determination is done at various levels by various institutions, using different rules. Policy is needed to spell out who should perform this function and how it should be done.

6.5 Rendering water supply services

Various organisations render water supply services, e.g. individual private irrigators, small groups of irrigators co-operating with each other, irrigation boards and the Department of Water Affairs and Forestry. There is heterogeneity.

6.6 Steps to prevent water rights from being exceeded

Such steps are essential. Present practices show deficiencies but can nevertheless form the basis of new improved measures. Legal control measures largely consist of:

- Quantification of the right to use a certain portion of the water resource.
- Granting of permission to persons to erect, enlarge, alter or use water works.

The tactical options mainly involve:

- Impoundment control.
- Flow rate control.
- Abstraction time.
- Irrigated area control.

The Water Court has jurisdiction over public water but the Minister has the prerogative to implement all these measures and options over public and groundwater if he deems it in the public interest. The same is true with respect to water works intended for use of private water.

The State has extensive powers to control water usage, but manpower problems and financial constraints limit the ability of the State to do so. This should be addressed, perhaps by other procedures, e.g. a market process rather than administrative controls.

6.7 Legislative prescription to prevent land degradation and water pollution

These are various prescriptions under the Conservation of Agricultural Resources Act (Act 43 of 1983), the Water Act, 1956, and the Fertilisers, Farm Feeds, Agricultural Remedies and Stock Remedies Act, 1947 (Act 36 of 1947) that prohibit farmers from action that cause such problems. The efficacy of these measures is sometimes questioned.

6.8 Upstream agricultural and forestry activities that impact negatively on downstream water availability

Three types of upstream activities are involved: farm storage dams for livestock and limited irrigation, rainfed production of crops that consume large quantities of water (e.g. sugar-cane) and commercial afforestation with high water-consuming species. Particularly the latter two often have large negative effects on downstream water availability.

Whereas no special legislation appears to have been drawn up in terms of field crops, it has been done in respect of forestry. Commercial afforestation has since 1972 been subject to the Afforestation Permit System (APS) in terms of amendments to the Forest Act, 1968 (Act 72 of 1968) and thereafter, the Forest Act, 1984 (Act 122 of 1984). The APS presents some problems of its own. The period for which permits have been issued (normally 3 to 5 years) is unrealistic, considering that the production cycle of new afforestation varies from approximately 8 to 25 years. Failure to renew permits can cause mammoth financial losses. Too much leniency may have been shown earlier with respect to permits. The decisions have also largely been bureaucratic in nature. Another *modus operandi* must be found, possibly in terms of voluntary, market-like trades in rights to the water.

Up- and downstream users compete for rights to the same water and should be placed on an equal footing.

6.9 Allocation of water and water rights : the potential role of the market process

South Africa has limited opportunities to enhance water supplies economically by new waterworks. There is, however, substantial opportunity to ease the pressure of water scarcity by eliminating waste and improving use efficiency and water allocation, which can be done by either of two institutions:

- A centralised institution, controlled by a central manager with exemplary insight and wisdom who will allocate water optimally.
- A decentralised institution wherein users obtain the resource in a competitive market at a market price that reflects relative scarcities.

The former institution depends on a degree of knowledge and wisdom and economic models with a degree of sophistication that are as yet unknown and completely inoperative.

In water markets, water rights are exchanged between willing buyers and sellers. Under ideal circumstances, water markets result in efficient allocations of water rights to its highest use values. Water markets can eliminate shortages, lead to efficient pricing and limit distributional conflicts. Water markets must however be regulated by the State as problems may arise with monopolisation and deprivation of the poor.

Successful water markets have some prerequisites:

- Clear description of and title to water rights.
- Proper quantification.
- Security of rights and titles and jurisdiction of courts thereof.
- Water rights can have meaning only where water can be delivered.
- Proper treatment of third-party effects by judicial review, government intervention and/or personal voluntary resolution.
- Government involvement to ensure fair practice.

Variations in water markets exist internationally, and the markets appear to be successful, e.g. in parts of Spain, the USA and India. Chile has probably moved furthest in this direction, and this has been accompanied by large improvements in efficiency.

While water is regarded as a public good in Chile, individuals can hold private rights, which are categorised into a few groups, all of which have subgroups:

- Consumptive or non-consumptive rights.
- Permanent, contingent or discontinuous rights.
- Alternating rights.

Urban water rights are treated through companies with public bodies and private citizens as shareholders. Both buying and temporary leasing of water rights occur.

Water markets have been shown to be superior to administrative water allocations in terms of flexibility, security of tenure, pricing at or above real opportunity cost, predictability, efficiency and administrative feasibility and sustainability. Administrative allocations are better in terms of equity, political and public acceptability and efficacy.

The best solution is probably a controlled water rights market. Such a solution can potentially capture the benefits of a water rights market and administrative allocations. This can be achieved in a few steps:

- Specification of water rights (also who can hold which rights - individuals, communities, municipalities, utility companies, etc.).
- Administrative allocations, in which past inequalities are addressed.
- Registration of water rights, e.g. in deeds offices.
- Stipulation of the rules and constraints of the market.
- Opening the market.

6.10 Water supply pricing

Subsidisation of farming inputs, including water, has been an international phenomenon and water pricing has possibly nowhere fully recovered operational and maintenance (O & M) costs. South Africa has for long subsidised irrigation water, and this has led to inflationary land prices, yielding landfall profits to present land owners and representing costs to all others, including future irrigation farming generations. The linkage of water rights to ownership of land has moreover caused both subsidies and the scarcity value of water to be capitalised in prices of land - even though water is scarcer than irrigable land.

Separation of title to land from water rights will divide capital values between land and water rights; as water rights assume a value of their own, land prices will decline by an equivalent amount. This will forestall capital losses and simultaneously enable water allocation to become more efficient and equitable. Water tariffs must be increased to cover at least O & M costs. Water tariffs should differ from place to place, depending on local circumstances.

Volumetric pricing of water is superior to other pricing methods in terms of efficiency, and per unit of area pricing of water fares better than pricing based on quantities of other inputs or outputs. Volumetric pricing is thus preferable with per area-pricing as the next best alternative where volumetric pricing is impractical. Tiered volumetric pricing will provide incentives for efficiency.

New irrigators who have been disadvantaged by South Africa's history should receive a special dispensation. They should receive special training and extension, and financial support for a period of adjustment, e.g. 10 years. This support should be gradually reduced and eliminated according to a predetermined time scale.

6.11 Decentralisation of administration and control through local community participation

Operation and maintenance (O & M) is internationally often done ineffectively, inefficiently and at high cost if it is monopolised by a state entity under central direction and control: Those doing it do not really have a stake in it. Given the size and complexity of many water systems and the need to co-ordinate activities over entire hydrological systems, it can however not be done everywhere without an active role being played by the State.

Water User Associations (WUAs) have solved this problem in some countries by co-ordinating their members' actions and by representing their members in dealings with government. Compulsory membership of WUAs for irrigators is recommended as this will engender independence from government agencies.

CHAPTER 7 : POLICY PROPOSALS

7.1 Policy objectives

Water is scarce and should be used optimally. The general objective of public policy is improvement of general social and economic welfare. Available policy instruments, e.g. legal prescription, economic pricing, education and administrative control should be directed at this objective. A balance must however be struck between instruments.

7.2 General policy recommendations

- Water legislation and institutional reforms should be formulated and implemented in conjunction with accepted policies and objectives.
- Appropriate pricing and charging systems that reflect real opportunity costs need to be established, and decentralised decision-making is to be encouraged.

7.3 Water resources

- Increased use of groundwater resources should be supported by strict scientifically formulated operating rules.
- Irrigation development is an expensive way to handle socio-economic objectives. It should only be done after extensive investigation.
- In times of scarcity, water use for certain uses can be restricted either through operating rules or through voluntary transfer.
- Water resources management should be done on a river basin basis and should include all stakeholders.

7.4 Water-soil-crop relationships

- Better soils should receive priority for irrigation.
- Environmental damage must be minimised through sustainable irrigation practices; ecological and social responsibility must be developed among irrigators.
- Water use should be moved from crops with low physical and economic water use efficiencies to those which perform better.
- Water saving practices should be encouraged.

7.5 Commercial irrigation farming and modernisation

- More irrigators engaged in subsistence and near-subsistence irrigation should be introduced to commercial irrigation, using appropriate technology, i.e. labour absorbing, capital and water saving and sustainable technology. Research and extension should be directed at such technology.
- Irrigation farms must be of viable sizes and successful irrigators must have the right to expand.

- New irrigation development should preferably occur in areas with a favourable economic location. In previously neglected areas, transport and communications infrastructure should be supplied to improve economic location.
- Subsidies should be limited and tied to time scales.
- Rehabilitation of existing schemes should be prioritised above development of new schemes.
- Proper and thorough studies on economic, financial, fiscal, social and ecological impacts should precede expenditure of public funds.

7.6 Small-scale farmer irrigation schemes

Very few small-scale farmer irrigation schemes have succeeded, due largely to poor scheme management and a lack of communication with the intended beneficiaries.

- A multi-disciplinary task team should investigate the causes of failure, make innovative changes and develop training programmes for both project managers and farmers.
- "Top down" and autocratic administration and management of many small-scale farmer schemes must be remedied by devolution of responsibility; rural communities should be empowered to take more responsibility and WUAs formation should be stimulated. They will initially require institutional support, and they will also require legal powers and status. Extension agents can act as catalysts for the initial organisation of WUAs, but they are not to be allowed to dominate them. A needs approach is indicated.
- Infrastructure should be part of area development programmes.
- Irrigation technology on schemes should be evaluated in terms of appropriateness. Back-up services, e.g. in extension, credit, marketing, storage and project management need to be adequate. Government extension services should thus be reformed.
- A multi-disciplinary approach should be adopted in the planning of new irrigation schemes, including intended farmer participants.
- Settlement of projects where no settlement has yet taken place should receive priority. Farmer selection should be done in an objective, scientific manner.
- Policy regarding farm size should be flexible, and liaison is needed among all government departments involved.

7.7 The legal environment

Water resources management should involve the effective allocation, use and protection of water rights. This could involve the following:

- An effective institutional and regulatory management structure that will incorporate stakeholder participation.
- Priority to basic human needs and ecological matters.
- Effective criteria, procedures and structures to allocate water resources and rights fairly.
- Clear definition of water rights, effective registration and protection thereof.
- Prohibition of significant pollution.
- Transferability of water rights on a willing-buyer-willing-seller basis, and facilitation of procedures and facilities for such a process.
- Limiting expropriation to cases where higher priority or higher valued uses are contemplated, and fair compensation for such expropriation.
- Legal means to prevent water rights being exceeded; this will also involve measurement of water use.

7.8 Institutional choices

- Water markets are more efficient and flexible allocators of water rights than administrative decisions. The establishment of water markets subject to limited but well specified regulation is recommended.
- Certain poorer sections of the community will however need additional protection against exploitation by other parties.
- Water delivery prices should in the long run cover at least O & M costs; initial subsidisation of poorer, disadvantaged communities should however also be contemplated.
- Volumetric water supply pricing is preferable, and where this cannot be done, supply pricing should be based on area cultivated.
- Water rights should be separated from ownership of land.
- The administration, control and management of water schemes must be made more effective through decentralisation and improved local community participation. WUAs can play a crucial role in this regard.

7.9 Information

There is a serious shortage of information regarding irrigation farming in South Africa. Such information is crucial for the formulation of proper policy. A comprehensive wide-scale agro-economic-social survey is needed. This can form an initial data base which should be updated in the course of time.

CONTENTS

CHAPTER 4 : LAND RESOURCES AND PRODUCTION

CHAPTER 5 : HUMAN RESOURCES AND MARKETS

CHAPTER 6 : LEGAL FRAMEWORK AND INSTITUTIONAL ARRANGEMENTS : PRESENT SITUATION AND PROPOSALS FOR THE FUTURE

CHAPTER 7 : POLICY PROPOSALS

CHAPTER 1

INTRODUCTION

Any discussion or proposal for irrigation policy reform in South Africa must take place within the realities of the political, economic, social and natural environment. A range of particular issues must be emphasised in order to promote critical but reasoned debate.

Following the democratic change to a new constitutional dispensation, problems arising from previous political inequalities require urgent attention. Unequal political power in the past has given rise to imbalances in the currently apportioned water rights and to a skewed distribution of income. Land, water and irrigation policy reform is necessary to address justifiable claims that are made to gain access to water resources.

In doing so, however, it must be recognised that water resources are scarce and water rights are an economically valuable asset. In order to reduce uncertainty in a competitive economic environment, irrigation policy must clearly specify the rules and processes according to which change is to be negotiated. Individual entrepreneurs must be enabled, through private initiative, to continue creating wealth through profitable irrigation farming. Balanced economic growth in irrigated agriculture must be achieved through a combination of increased productivity, reallocation of rights to water resources and redistribution of income. In this process consideration should be given to productive investment, increased employment and income generation on the one hand, and to consumption investment, provision of basic services and humanitarian relief measures on the other (SANCID, 1995).

Given the existence of wide-spread poverty in rural areas, irrigation policy requires inclusion of support programmes in which public funds will be used to alleviate immediate hardships. This must be accompanied by an assessment of opportunities and constraints through participatory procedures and by the building of capacity to improve living standards by own efforts. The dignity and self-respect of individuals and rural communities must be improved by the encouragement of training for skills in farming and non-farming economic activity and by obtaining ownership of information which provides solutions to local problems.

Economic activity in the form of irrigated agriculture is directly influenced by climatic variability; it also has both beneficial and detrimental impacts on natural resources and the environment. The regular but often unpredictable occurrence of droughts and floods renders the adaptability of agricultural activities an essential prerequisite for success. The use and development of land and water resources can lead to degradation of the natural environment, mainly because of negative externalities and institutional failures. This situation worsens under conditions of lack of knowledge, low income levels, high time-preference rates, short planning horizons and lack of capital or finance. This often leads to a vicious cycle of events which can lead to over-exploitation of soil, vegetation and water resources. Irrigation policy must, therefore, provide for protection of the ecological balance of surface and underground water within catchment areas.

The purpose of this document is to inform interested and affected persons on relevant issues concerning irrigation policy. Many of the points raised are well established information which must however be re-stated within a holistic context. Other points and proposed new directions are not yet fully accepted, but are presented with the intention of influencing change constructively. The debate which is already under way must, however, remain issue-centred and move irrigation policy reform forward.

CHAPTER 2

POLICY PRINCIPLES AND GUIDELINES

2.1 CONSTITUTIONAL FRAMEWORK

All public policy, including policy involving water resources and their use for irrigation, is an output of the political process. It reflects demands for intervention and support, or demands for removal of such intervention and support, and the reactions of political decision-makers. Such demands are made by individuals or interest groups such as lobbies, who also promise political support on a wide range of issues and/or in the shape of campaign contributions (Easton, 1979). Decision-makers react in accordance with their perceptions of which benefits should be bestowed, and which not. This interaction takes place within the framework of the country's constitution. Changes in the constitution therefore automatically imply a re-examination of existing policies, the validity of which is to be questioned. Policy reform often turns out to be indispensable.

In the transition through an interim to a final constitution and thereafter, the challenge becomes one of initiating and seeking policy improvements in order to accomplish the aims of the constitution. Change however requires recognition of the inviolability of fundamental rights entrenched in the constitution and the removal of legislative infringements on these rights. This applies specifically to the protection of water rights as real property and to freedom of contractual agreement in economic activity. Within these prerequisites, attention must be given to the objectives and strategies of policy, institutional forms and arrangements, the process of policy formation and organisational structures for implementation of policy.

2.2 POLICY OBJECTIVES AND STRATEGIES

The generally accepted main objective of public policy is increased economic and social welfare, with intermediate objectives of improved efficiency, equity, stability and order. These objectives cannot be divorced or isolated from agricultural or economic policy, neither

do they differ between different policy areas; they are interrelated, although the emphasis or weight attached to them may differ.

Similar arguments can be presented for the strategies of conservation and allocation of water resources. A water conservation strategy refers to decision rules according to which action is taken for the development and growth of, or increase in the quantity of available water for utilisation that will be physically, socially and economically efficient over space and time. A water allocation strategy refers to decision rules which are followed in order to apportion and transfer water between uses such as domestic, forestry, agriculture, industry and the ecology as well as between users such as different households in eg. rural settlements and different irrigation farming enterprises.

South Africa has over the last few decades reached the mature phase in its water economy in the sense that the water available for impoundment has become increasingly scarce and that engineering works aimed at water storage have become increasingly expensive to construct and maintain. It is in the changing environment of political reform and the mature phase of the water economy that the policy options for achievement of these objectives and application of strategies have to be debated (Backeberg, 1994).

It is essential to consider the following factual points of reference:

- Irrigated agriculture is an activity of people, and is primarily undertaken for the purpose of producing food and fibre by means of the artificial application of water for crop cultivation and animal husbandry within the constraints of available resources (cf. Spedding, 1988).

- People involved in irrigated agriculture comprise an estimated 40 000 small-scale farmers, 15 000 medium-to-large-scale farmers, 120 000 permanent workers, variable numbers of seasonal workers and the dependants of all of these.

- Irrigated agriculture currently consumes approximately 51% of water resources, and this water is utilised on some 1,3 million ha.

- Irrigated agriculture contributes 25% to 30% of South Africa's gross agricultural production, although it uses only 10% of cultivated land and 1,4% of the area of all agricultural land.

- In the course of economic development, the relative decline in the annual contribution of agriculture to the current level of 4 to 5% of the gross domestic product (GDP) is recognised. However, backward and forward linkages and the multiplier effect of economic activities in agriculture, including irrigated farming, still render agriculture vitally important for rural development.

- The previous statement is particularly relevant to irrigated agriculture because of the intensive nature of production. Irrigated agriculture exerts a stabilising effect on food production in times of seasonal or periodic drought; it provides stable opportunities for labour absorption, and it also contributes significantly to foreign exchange, specifically from exports of vegetables, fruit and industrial crops.

Within this context, existing or new opportunities must be utilised to enhance the contribution that irrigation makes to economic development. The focus must be on the assessment of water resources and the design of appropriate institutions. Available options to promote productive economic activity in irrigated agriculture mainly include the following (Serageldin, 1995):

1. Articulation of a broad natural resource policy incorporating water and soil management, food security, health improvements and environmental protection.

2. Treatment of water resources in a comprehensive, inter-sectoral framework that recognises interaction within river systems and allows integrated catchment management.

3. Decentralisation of functions to self-financing organisations on a local level with stakeholder participation.

4. Comprehension of the growing scarcity and economic value of water and therefore a change of emphasis towards proper incentives, pricing and regulation of markets.

2.3 WATER INSTITUTIONS

Water resources are scarce. The main emphasis in water and irrigation policy should therefore be on the management of conflict between competing uses and users. A balanced set of policies and institutions is necessary to improve the effectiveness of the management of water resources. This must involve both private enterprise and public authorities. The policy problem can largely be narrowed down to the selection of appropriate institutional forms and arrangements for individual and collective choice. Water institutions include customary rules, water rights and legislation. Completely specified rights which are permanent or which empower individuals and groups in the long run to exercise control over the use of water will provide security for investment. Under such specified rights, those affected will have to approve reallocations and the rights will therefore include just compensation for expropriation and will also provide correct incentives to take decisions in private interest. These rights and obligations are the "rules of the game" for economic behaviour and interaction between households and enterprises in irrigated agriculture, and also between irrigated agriculture and other demands on water resources. Efficiency and equity in the process of investment, production, marketing, financing and consumption activities will be achieved by combining the discipline of the market process with responsible governance.

Two issues are important in this regard:

Firstly, water rights describe the relationship between people in respect of a bundle of rights which provides access to net benefits over time. Transfer is the way according to which lawfully apportioned rights can change: Although the rights are permanent, transfers need not be. Preference ought to be given to the valuation of benefits and costs through free participation and negotiation of mutually beneficial market transactions. A rights-based market approach to the trade of water rights, either by sale or lease agreements, allows the exchange of water rights from lower valued to higher valued users or uses. It furthermore

provides flexibility in responding to climatic variability, increasing water tariffs and fluctuating product prices.

Secondly, the capacity of the national government must be strengthened to perform its functions of defining water rights and of enforcing rules. Definition of rights involves quantification of the volume or percentage of flow, the reliability of supply and the preference order to use water. Enforcement requires policing and ensuring compliance with rules, specifically with reference to measurement of actual water consumption, water quality changes and instream flow requirements. Legislative prescriptions are clearly necessary for protection of third-party interests and against damage to the ecological balance. It also involves specifying administrative procedures for the application and approval of transfer of water rights. In this regard attention must be given to e.g. infrastructure requirements and impacts on the area of origin (Rosegrant & Gazmuri-Schleier, 1994; Easter, Feder, Le Moigne and Duda, 1994).

2.4 GOALS OF SUSTAINABLE IRRIGATION POLICIES

The success of long-term objectives of increased economic and social welfare needs to be measured over the medium to short term according to a range of quantifiable goals. These goals consist mainly of the following:

- Increased regional employment and income generation on irrigation farms, especially on irrigation schemes with unused capacity, through increased investment and production, in response to market potential.

- Establishment of people on existing irrigation schemes and promotion of labour-absorbing practices to contribute to the alleviation and reduction of poverty, following an approach of integrated rural development.

- Higher production of staple food products for local consumption and adding value to luxury products on a local level for export according to comparative advantage.

- Prevention of deterioration in water quality and increasing health threats as caused by point and non-point pollution of water, and protection of river ecosystems and the natural landscape in order to maintain bio-diversity and to promote outdoor activity or tourism (Backeberg, 1994).

These policy goals will be **sustainable** only if they are

- adapted to biophysical circumstances,
- technologically appropriate,
- financially feasible,
- institutionally manageable,
- socially acceptable,
- economically viable, and
- politically attractive.

One-sided emphasis on any one or a combination of some of these elements will create imbalances and require trade-offs. Involvement of stakeholders in policy formation, transparency and accountability for government decision and actions is, therefore, essential.

2.5 PROCESS OF POLICY FORMATION

Policy formation is an incremental process of ***formulation and acceptance*** following consultation on a national level, while ***execution*** naturally takes place on a provincial or local level. Although these are different levels, formulation and execution are inextricably linked through ***evaluation*** of feed-back on obstacles or the impact of implementation (Cameron, 1991).

It is important to draw a distinction between the responsibility of the national government to formulate a national policy and a desire that may exist to exercise central control. Similarly, policy instruments must be designed to influence decisions on especially local level, rather than to intervene in private economic activity through encompassing legislation. A major part of policy reform, therefore, requires deregulation and a movement away from central

bureaucratic control to the facilitation of private entrepreneurial initiative. It also requires renewed attention to a service-orientated management style and organisational change to accomplish this. It requires a participative rather than an authoritarian approach. The approach requires arms-length government involvement which concentrates on engineering and hydrological support services.

2.6 ORGANISATIONAL STRUCTURES

In the new constitutional dispensation, management of the supply of water resources is a national responsibility, while management of the use of water resources in irrigated agriculture is a provincial responsibility. Various liaison committees have been proposed to achieve co-ordination between national and provincial government departments regarding water and agricultural matters (Department of Water Affairs and Forestry, 1995). The ability of provincial and local governments to perform their important functions requires special attention. With decentralisation the capacity of provincial governments must be strengthened through the provision of adequate staff, training to improve capabilities and sufficient funding to deliver services on a local level. Priority needs to be given to various aspects related to the provision of agricultural, technical, economic and extension support services.

2.7 PUBLIC SUPPORT SERVICES FOR PRIVATE CAPITAL INVESTMENT

Continued support of irrigation farming through direct and indirect subsidisation of irrigation development must necessarily be compared with other public investment alternatives and the desire of the government to reduce fiscal deficits. The following points need consideration:

- Irrigation farming provides an economic existence for large numbers of people in rural areas.

- Existing investments in water supply infrastructures must be utilised to full capacity.

- Agricultural activities provide household food security and the potential of earning foreign exchange.

- Backward and forward linkages with input supplying and product processing industries form the basis of economic development, especially in semi-arid areas.

While arguments can be made to provide public support services, reduced subsidisation accompanied by deregulation and decentralisation will mobilise private investment in irrigated agriculture. This will free public funds for social investment in education, health, housing and basic water supply and sanitation.

Recognising the complexities of irrigation policies, various aspects of water and land resources, production, human resources, marketing, the legal framework and future institutional arrangements are discussed in the following chapters.

PRIORITIES

- Recognise the importance of irrigation to South Africa, both in the economic and social sense.
- Give due recognition to the central rôle of water rights when policy is framed.
- Formulate policy goals in terms of the intermediate objectives of improved efficiency, equity, stability and order.
- Take note of the distinction between national policy formulation and central control.
- Demarcate the fields of national, provincial, local and individual responsibility.

CHAPTER 3

WATER RESOURCES

3.1 WATER AVAILABILITY IN SOUTH AFRICA

The dominant influence on the availability of water in South Africa is its physical position in the southern mid-latitudes characterised by high-pressure meteorological systems and associated dry, descending air masses. These weather conditions that prevail over most of the sub-continent are not conducive to high and stable rainfall. The shape of the sub-continent and its topographical features further influence the rainfall distribution. Of considerable importance to this distribution is the warm Agulhas current flowing southwards in the Indian Ocean off the eastern seaboard and the cold Benguela current in the Atlantic Ocean flowing northwards off the west coast.

The warmer, moist air masses along the eastern part of the sub-continent are more likely to result in precipitation than the cooler, more stable air masses flowing in from the west. In addition, the spine of South Africa is formed by the Drakensberg mountain range extending from north to south approximately parallel to the east coast. The orographic effects caused by the Drakensberg escarpment stimulate precipitation from the incoming moist, unstable air masses and provide the final significant influence on rainfall distribution over South Africa.

The interior plateau is noticeably devoid of topographical features which could have a major influence on rainfall distribution and is warped in such a way that the watershed between the drainage systems flowing north and east towards the Indian Ocean and south and west towards the Atlantic Ocean passes along the Witwatersrand, the heartland of socio-economic activity in South Africa.

Figure 3.1 illustrates the distribution of mean annual rainfall across South Africa, resulting from the combined influences of the major meteorological dynamics in the southern mid-latitudes, the shape of the sub-continent, the ocean currents along its coasts and the main topographical features from mountain-forming forces over geological time. From the point

of view of irrigated agriculture it is significant that relatively humid, subtropical conditions occur in the east (mean annual rainfall more than 800mm) while the mean annual rainfall decreases rapidly in a westerly direction. Rainfall along the southern coastal strip and in the Western Cape, where the climate is described as Mediterranean, is also generally higher than in the interior of the country. It is estimated that the average mean annual rainfall for the country as a whole is only 497 mm per year, well below the world average of 860 mm per year. It is perhaps of even greater significance that about 65 percent of the country receives less than 500 mm per year (Department of Water Affairs, 1986).

Water requirements for irrigated agriculture are also strongly affected by the seasonal distribution of rainfall in relation to crop water requirements. The variability in time of rainfall, i.e. its reliability, also determines the extent to which reliance is placed on irrigation for successful crop production.

The influence of the variability and reliability of rainfall on the success of agriculture cannot be overemphasized. While it is relatively easy to quantify and represent the seasonal distribution of rainfall as illustrated in Figure 3.2, the critical aspect of reliability is much more intractable. In general, the higher the mean annual rainfall, the more reliable is its occurrence. In essence, the duration and intensity of subnormal or deficient rainfall define the severity of drought conditions and the need for irrigation. The water requirements for irrigation of a particular crop are clearly dependent on the rainfall distribution in the season as well as on many other factors. In most circumstances, rainfall is the most variable factor determining irrigation water requirements. Irrigation requirements can only be supplied from groundwater sources or from runoff in our rivers.

3.2 GROUNDWATER RESOURCES

Over most of South Africa groundwater occurs in secondary aquifers comprising mainly weathered and fractured rock at shallow depths, usually not more than about 50 m below surface. Primary aquifers, such as alluvial sand deposits, are very uncommon and occur mainly in small areas along the South African coast. However, dolomitic deposits occur in thicknesses of 200 m to 2 000 m in a number of extensive areas of the country and are

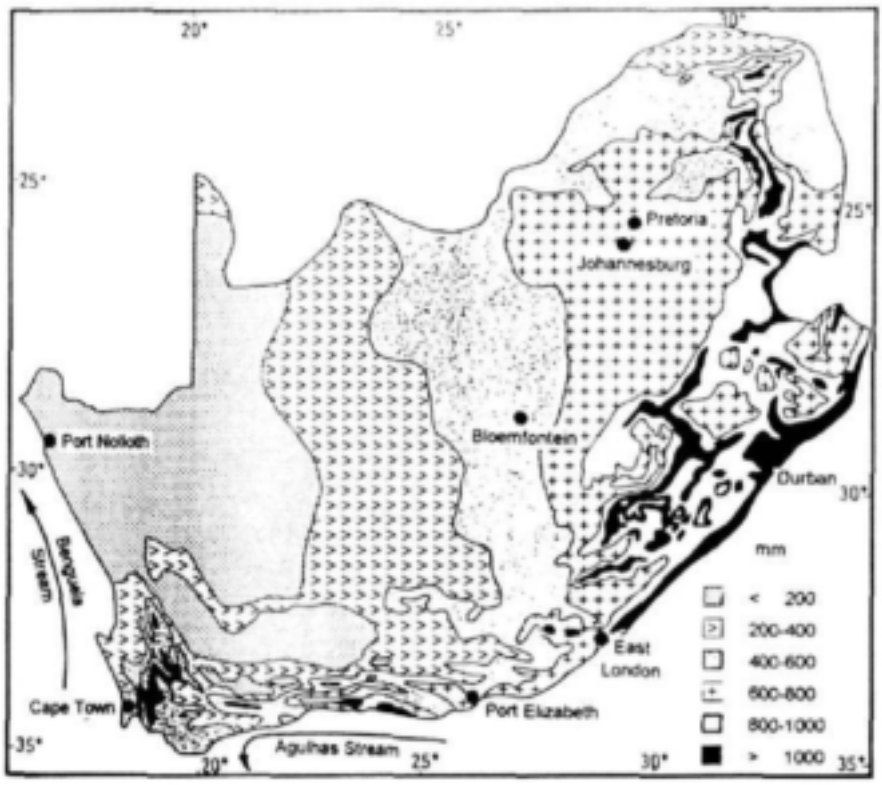

Figure 3.1: Mean annual precipitation

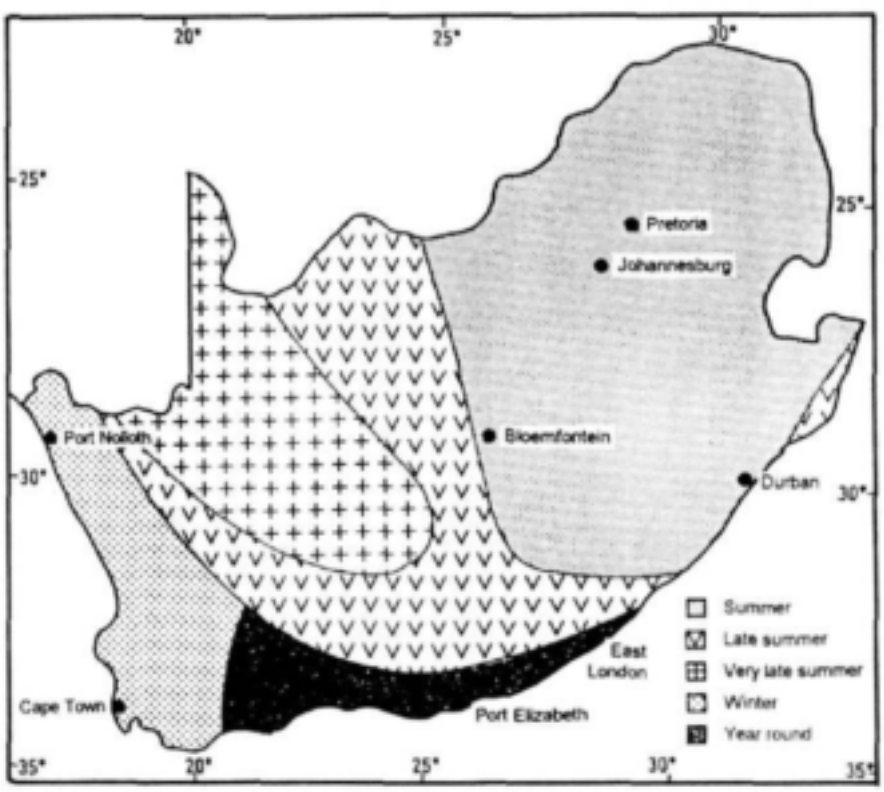

Figure 3.2: Seasonal rainfall regions

Figure 3.3: Distribution of dolomitic and of primary aquifers

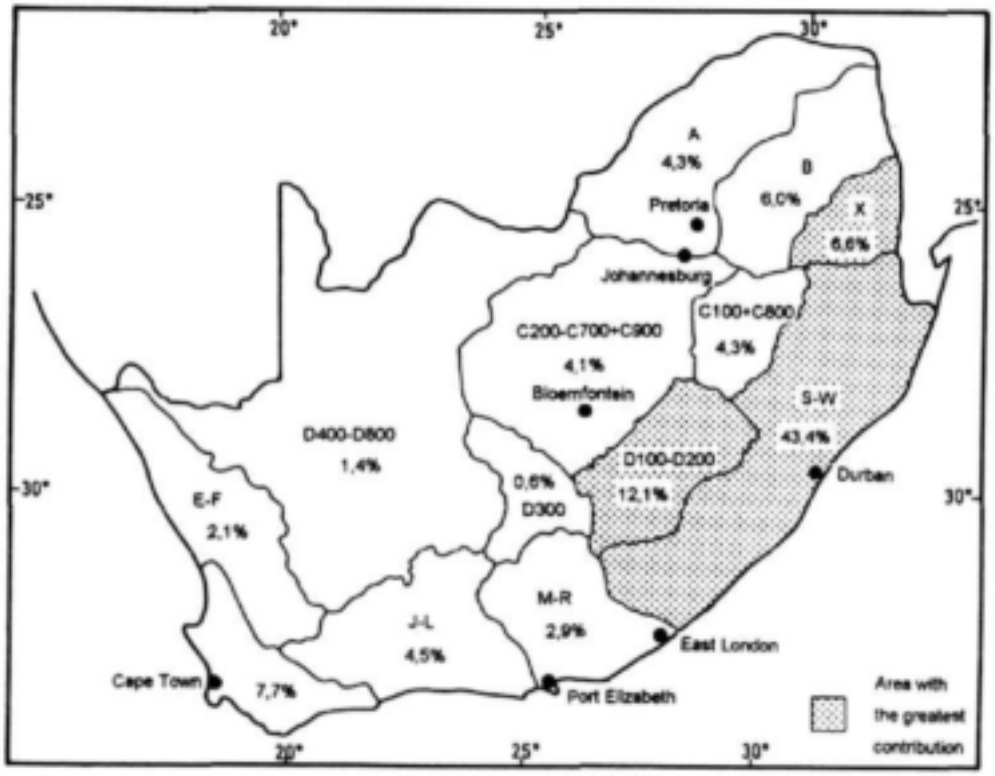

Figure 3.4: Percentage of the total annual runoff of the river systems

potentially high-yielding sources of groundwater with sometimes very large capacity. (See Figure 3.3.)

Dolomitic aquifers are much more attractive as significant sources of groundwater for irrigation than are secondary aquifers in hard rock formations, but exploitation of these resources can lead to significant negative consequences such as sinkhole formation and surface subsidence as occurred in areas around Carletonville as a result of mining operations.

There is a serious dearth of information on the occurrence, availability and use of groundwater in South Africa. The Water Research Commission (WRC) recently published information in this regard and the Department of Water Affairs and Forestry (DWAF) is producing a country-wide overview of groundwater potential. The first set of reports on this project have been made available for KwaZulu-Natal (1996).

Groundwater recharge from rainfall infiltration determines the safe yields of aquifers of any kind. Only a relatively small portion of rainfall infiltration can be abstracted from an aquifer via boreholes because much of this water is lost to evapotranspiration and deep percolation or other seepage losses. It has been estimated that about 5 400 million m^3 of water per annum can be abstracted from groundwater sources on an economic basis (Department of Water Affairs and Forestry, 1986). About 64 per cent of this potential is located in the dolomitic areas of the Northern Cape and Free State provinces and in the catchments of the eastflowing rivers draining the Drakensberg escarpment from the Umzimvubu River to the Crocodile River.

The use of groundwater has grown significantly over the past ten years, particularly for rural domestic purposes, stock-watering and for irrigation, as the unprecedented drought which has just been broken in most areas of the country caused usually reliable surface sources and springs to fail. A country-wide drought relief programme included the provision of boreholes and pumping equipment in large parts of the country for domestic use and for stock-watering.

In some areas of the country such as in the Luvuvhu River valley and along the Letaba River, failing surface water sources were augmented by groundwater development for

irrigation of mainly permanent crops. The total use of groundwater, estimated to be 1 790 million m^3 per annum in 1980, has possibly grown to about 2 000 million m^3 per annum, i.e. about 37 percent of the potentially exploitable resource. It is vitally important that this increased reliance on groundwater, particularly for irrigation, be supported by the strict application of scientifically formulated operating rules for the conjunctive use of this source and sources of surface water to ensure maximum utilization and minimum risks of future shortages.

Nearly 80 percent of the groundwater used in the country in 1980 was used for irrigation of about 240 000 ha (Department of Water Affairs and Forestry, 1986). This proportion has probably not changed much over the past 15 years and provides an indication that the present use for this purpose is probably about 1 600 million m^3 of water per annum. Reliable data on this aspect are not available.

Growth in the use of groundwater for irrigation will be influenced by factors such as the future system of water rights, technological development such as the electrification of rural areas and the economics of this type of agriculture.

3.3 SURFACE WATER RESOURCES

While the average annual rainfall over South Africa is a low 497 mm, only about 8,5 percent finds its way into rivers as runoff. The most recent authoritative estimate of the aggregate mean annual runoff of all rivers draining South Africa is 53 500 million m^3 (Water Research Commission, 1990). Much of this runoff originates in portions of catchment areas in neighbouring states; these rivers are therefore of joint interest to the co-basin states and water resource development must follow international principles of best joint utilization.

The combined influence of the non-uniform distribution of rainfall across the country and the drainage pattern that has evolved over geological time results in even greater non-uniformity in the geographical distribution of streamflow. This is illustrated in Figure 3.4 and Table 3.1 which are lifted directly from the publication Management of the Surface Water Resources of South Africa (Department of Water Affairs and Forestry, 1986). The significant feature

is that the Orange River system (including the Vaal River catchment and Lesotho) drains 47,8 percent of the runoff. The relatively water-rich portion of the country lies to the east of the escarpment and is drained by steep rivers discharging into the Indian Ocean. The rivers from the Mzimvubu to the Crocodile carry 50 percent of the mean annual runoff in all South African rivers.

Most of the area is drained by ephemeral rivers and perennial streams that occur mainly in the Western Cape province and east of the Drakensberg escarpment. It is important to note that even the perennial streams are strongly seasonal in character. The utilizable portion of the total surface runoff in South Africa, estimated to be about 33 000 million m^3 per annum using presently available technology, is dependent not only on the seasonal distribution of flow but also on the high degree of variability between seasons. Water supplies for a user sector should be available with an appropriate level of reliability or risk of shortfall. Variability in occurrence has to be counteracted by regulating flow in storage dams to ensure the desired degree of reliability of supplies.

Table 3.1: Mean annual runoff of river systems in South Africa

Drainage region		Surface area (km^2)	% of total area	Annual runoff (million m^3)	% of total annual runoff	Average annual precipitation over region (mm)	Runoff as % of precipitation
Region number	Region						
C10 and C80	Upper Vaal	38 609	3,0	2 288	4,3	751	7,9
C20 - C70 and C90	Lower Vaal	157 738	12,5	2 199	4,1	512	2,7
D10 and D20	Upper Orange	64 931	5,1	6 465	12,1	731	13,6
D30	Middle Orange	34 208	2,7	322	0,6	358	2,6
D40 - D80	Lower Orange	311 172	24,5	783	1,4	246	1,0
C + D	Total Orange	606 658	47,8	12 057	22,5	406	4,9
E and F	West coast	77 509	6,1	1 125	2,1	199	7,3
G and H	South-western Cape	41 073	3,2	4 112	7,7	542	18,5
J - L	Southern Cape	87 045	6,9	2 414	4,5	327	8,5
M - R	South-eastern Cape	67 390	5,3	1 561	2,9	456	5,1
S - W	Eastern plateau slopes	174 565	13,8	23 222	43,4	870	15,3
B	Olifants Basin (Transvaal)	73 534	5,8	3 191	6,0	660	6,6
A	Limpopo main basin	109 604	8,6	2 290	4,3	555	3,8
X	Delagoa Bay	31 157	2,5	3 554	6,6	842	13,5
TOTAL		1 268 535	100	53 526	100	497	8,5

Existing major dams in South Africa have a combined storage capacity well in excess of 50 percent of the total mean annual runoff and regulate virtually all of the runoff from the interior. It is estimated (Department of Water Affairs and Forestry, 1986) that the total water demand in the country exceeded 21 000 million m^3 per annum by 1995. This is almost 64 percent of the estimated utilizable resource. Only the coastal rivers remain relatively unregulated: These rivers also represent the largest potential for new development.

The use of surface water for irrigation has been classified (Department of Water Affairs and Forestry, 1986) according to its use in government water schemes, irrigation board schemes and private irrigation. The best information available for use in 1980 and estimates for 1990 and 2000, ignoring the effect of potential shortages, is given in Table 3.2.

Table 3.2: Estimated surface water use in irrigation (million m^3/a)

Irrigation schemes	1980	1990	2000
Government	2065	2511	2982
Board	2309	2636	3025
Private	4130	4548	4967
TOTAL	8494	9695	10974
Proportion of total use in South Africa	52,1	44,6	43,2

It is significant that private irrigators use about one half of the total quantity of water used for this purpose.

3.4 WATER AVAILABILITY FOR IRRIGATION

Virtually all irrigation schemes reliant on groundwater are privately owned and operated. In many cases the groundwater source is sustainable at the level of abstraction with reliable supply in the long run. When rates of abstraction are increased to levels in excess of the long run recharge rate, this obviously leads to overexploitation, even in the short term, and to a rapidly increasing risk of failure. This will require the exploration and development of new sources to increase the availability of groundwater for irrigation purposes. This option is however severely limited in South Africa because of the quantities usually required for irrigation.

About 50 percent of the water used from surface sources in South Africa is used for irrigation purposes; this proportion is expected to decrease with time to about 46 percent in 2010. In some river systems, the flow is sufficiently reliable for irrigation abstractions to be possible without the need for storage. For many years irrigation along the Orange River was not supplied from storage but the situation is now quite different after construction of large dams in the Orange River Project. Water resource development in South Africa is rapidly reaching the point where all significant surface sources have to be regulated to meet growing demands and reliance on riparian rights to so-called "normal flow" for irrigation is no longer viable. "Normal flow" has virtually disappeared as a significant water source and the legal definition can seldom be quantified in practice.

Virtually all large irrigation schemes in the country such as Vaalharts, Loskop and schemes along the Orange River are supplied from storage dams. The planning and design of these dams were based on the available hydrological information, assumptions regarding crop patterns and irrigation requirements and on policies regarding irrigation development. Situations and actual operation on irrigation schemes change continuously and hence the supply of water is usually not in accordance with planning intentions. The large schemes were usually developed as government water schemes or irrigation board schemes. It is the declared intention of the State to transfer responsibility for the operation and maintenance of government schemes to irrigation boards while retaining control over water sources.

Most, if not all, government water schemes built for the purpose of supplying water to government irrigation schemes were designed to meet a socio-economic development objective of the government of the day. To address the "poor white" problem and to resettle returned ex-servicemen were typical objectives. The indications were clear: water resource development could be used to solve social problems and irrigation provided an opportunity for new people to make a living, usually from small farms, and to contribute to the food economy of the country. This was done at State expense and cost recovery, sometimes even operating and maintenance costs, was usually not a prerequisite.

Large capital subsidies for irrigation development were also made available to irrigation boards and to private irrigators. The development and use of the water resources for irrigation in South Africa was not subject to strict economic criteria for vialibility. As a result distortions in decision-making could be expected and examples of inefficient and ineffective irrigation schemes abound.

Whichever way an irrigation scheme is administered, the reliability of supplies is dependent on the operating rules adopted. Examples of poorly operated schemes and resulting failures in supply are not uncommon in South Africa. Chapter 5 points out that numerous schemes developed for small scale irrigators have never really worked well. It is critically important for a scheme to be operated in such a way that the security of supply matches the farm management practices and crop patterns. Permanent crops with capital intensive irrigation equipment require a much higher security of supply than do annual crops with less sophisticated irrigation systems. Government as well as irrigation board schemes are characterised by a serious deficiency in institutional capacity to manage the complex arrangements and gain maximum benefit from the scarce water resources.

The hydrological characteristics of most South Africans rivers are such that significantly more water can be made available from a storage unit by reducing the arrangements aimed at assurance of supply. System yield can be increased by accommodating restrictions on use more frequently, for longer periods and to a greater degree. While this is often possible on irrigation schemes, the flexibility in supplies for domestic and strategic users such as power stations is much more limited. Carefully managed surface water sources for supplying a number of different user groups with different characteristics usually present opportunities for increasing the utilization of available supplies. Variable draft operating rules with provision for significant restrictions on use by some sectors such as irrigation may be necessary.

An alternative or complementary approach may be to have voluntary transfers of water between users in times of water scarcity.

3.5 ISSUES RELATING TO WATER SUPPLIES FOR IRRIGATION

3.5.1 Water rights

It can confidently be expected that the law in relation to water rights in South Africa will be amended in the near future (see Chapter 6). Although the actual amendments have still to be agreed, the indications are that the emphasis on riparian rights attaching to portions of land in perpetuity will arguably be phased out. This will affect rights to the use of water for irrigation and could, for instance, put pressure on holders of such rights to exercise them rather sooner than later and make it possible for rights to be traded.

3.5.2 Cost of water

There are clear indications, supported by recent announcements, that the price of water for all uses including irrigation will be adjusted upwards to better reflect the cost of supply or perhaps even its value. This could have significant impacts on the economics of irrigation and the use of modern technology.

3.5.3 Regional resource management

Consideration of the option for water resource management on a river basin basis could lead to the irrigation sector being jointly responsible with other user groups and stakeholders for reconciling increasing demands with strictly limited supplies. Management of the competition between user groups such as forestry and irrigation for the available resources will be a major challenge in future. A strategy of river basin management at regional level, which also takes into account the interests of neighbouring countries in cases where these are co-basin states, will make it possible to integrate the development and management of water resources closely with increasing emphasis on rational decision-making. The policy framework could be set centrally. Increasing attention will then be focused on the already controversial subjects of efficiency and effectiveness of water use for irrigation.

Integrated resource management systems, including aspects such as quantity, quality, reliability, cost and flexibility could lead to significant benefits in the form of increased utilization and decreased overall unit cost of supplies. Examples of water resource management at river basin level to achieve these objectives are to be found in Chile and Australia.

Increasing attention is being given to river basin management as an option in South Africa. There is a strong indication that if legislative provision for this concept could be made in the already complex constitutional and institutional arrangements in South Africa, then significant opportunities could be found for increasing the beneficial use of the water resources of South Africa. Irrigated agriculture should play a major role in developments of this nature to provide the flexibility of use necessary to increase effectiveness.

3.5.4 Water quality

Water quality is becoming of increasing concern to irrigation, both from a supply point of view and with respect to the environmental impacts of irrigation. As the use of the water resources of South Africa intensifies, the general quality of supplies, both surface and groundwater, declines. The most significant water quality problems facing irrigation are:

- high sediment loads of surface runoff usually resulting from poor land use and soil conservation practices;
- high salinity resulting from natural sources as well as from the discharge of waste water into river systems;
- eutrophication of stored water resulting from enrichment by nitrates and phosphates; and
- raised water temperatures in some isolated cases.

The emphasis on the management of water resources in South Africa is increasingly directing the attention towards agriculture and irrigation in particular as a source of streamflow pollution. This could lead to financially unaffordable burden being placed on irrigators, and attention will have to be paid to minimizing the problem by improving management. This problem occurs in limited areas and is as yet not very severe.

3.5.5 Potential new water sources for irrigation

It has long been recognized that all the factors of production for irrigated agriculture such as good soil, water supplies, management expertise and a profitable market for products have to be present to ensure success. Of these factors of production water is very scarce, costly to develop, store and transport and therefore it is likely to determine the location of new irrigation development. Strong arguments have been made in favour of the proposition that existing water sources should first be utilized for irrigation, in conjunction with other competing use sectors such as community water supply, before new sources are developed for this purpose.

Existing water sources are often associated with existing irrigation schemes which are not fully or effectively utilized. Such opportunities for expanding irrigation activities in South Africa are to be found mainly in the Western Cape, Eastern Cape, KwaZulu-Natal and the Northern Province. In some cases existing schemes can be expanded (see Chapter 5). About 530 million m^3 of water per annum can be used in this way.

New, undeveloped sources of water likely to be available for new irrigation development are probably limited to the relatively undeveloped rivers of KwaZulu-Natal. In a recent review the DWAF estimated that up to about 1 028 million m^3 of water per annum could possibly be used from new sources for irrigation in South Africa.

There is overwhelming evidence to show that using water resources for irrigation is a very expensive way of stimulating socio-economic development.

Opportunities for utilizing new water sources for irrigation should be subjected to stringent evaluation and will probably gain favour only after efficiencies on existing schemes have been increased significantly, and after existing schemes have been upgraded and rehabilitated. Development should also occur strictly in relation to the land reform programme of the Government.

PRIORITIES

- Water resource assessment within catchment, and on irrigation schemes: The dearth of reliable and accurate information on the actual quantity of water used for irrigation and of the value derived from this use is a matter of serious concern. There are strong indications that this information deficiency has a serious impact on management decision-making not only at farm and river basin level but also at strategic level in relation to the allocation of scarce resources in the country.

- The use of scientifically formulated operating rules for the conjunctive use of groundwater.

- Design of a system of water rights that will cause the use of groundwater for irrigation to be both effective and sustainable.

- Integrated water basin research management involving also neighbouring states with interests in particular river basins.

- Better management of existing infrastructure: The information deficiency is accompanied by a serious lack of institutional and management capacity to use of the water supplies available for irrigation optimally. This problem is particularly important at the present time when the socio-economic development of all of the people of South Africa, particularly those previously disadvantaged, enjoys highest priority.

- Rehabilitation i.e. technical upgrading and improved water supply services: From the point of view of managing the water supplies available in South Africa, very limited opportunities exist for further irrigation development. Apart from upgrading and improving existing schemes to improve the efficiency of water utilization, new sources for this purpose are really only available in the well-watered eastern part of the country.

CHAPTER 4

LAND RESOURCES AND PRODUCTION

4.1 LAND AND CLIMATE

4.1.1 Introduction

In South Africa an area comprising less than 20% of the total area has a sub-humid climate with generally a mean annual rainfall of more than 750 mm. This small part of the country is characterised by mountainous terrain with high run-off, indigenous forests and timber plantations with rather little cultivation of land. The rest of the country has an arid to semi-arid climate, implying that rainfall in this area is 50% or less of the annual evaporative demand for optimal plant growth or production. Generally speaking, soils in this part of the country do have a good crop production potential, provided that the normal soil water deficits are alleviated through irrigation. The total annual soil water deficit, or irrigation requirement, varies from approximately 800 mm in the cooler, wetter regions, to 1500 mm in the warm, dry regions. The deficit is not an annual constant; it varies from year to year, depending on the rainfall distribution during a particular season.

4.1.2 Irrigability of land

Theoretically all land could be irrigated, but the consequences of incorrect management or incorrect selection of irrigation areas can be disastrous, causing irrigation areas to become completely waterlogged or saline, thus rendering those areas unfit for continued irrigation.

Based on irrigation potential, soils can be grouped into five classes:

Class 1: Very suitable, deep, well-drained soils without limitations. These soils can sustain the production of a wide variety of crops for several generations with low management requirements.

Class 2: Soils that are suitable for irrigation, but have minor limitations that will reduce the sustainability of crop production in the long run, with high management requirements.

Class3: Risky soils, with serious limitations that require special management and/or reclamation measures. These soils have a high risk of becoming waterlogged and/or saline and, therefore, have very high management requirements.

Class 4: Soils with very serious limitations, making them unsuitable for long-term irrigation development, but on which small amounts of irrigation can be applied occasionally. Such soils have very high management requirements and also have a high potential for causing environmental damage.

Class 5: These soils are unsuitable for irrigation due to poor drainage and other factors hampering the sustainable production of crops. Irrigation of these soils will cause permanent damage to the environment.

Where water is limited, it is preferable to use only land satisfying the criteria for classes 1 and 2 for irrigation. In South Africa, large areas of deep, well-drained soils that are very suitable for irrigation (classes 1 and 2) are found in the drier climatic regions which are characterised by a higher irrigation demand. The majority of the soils in the wetter climatic regions, where the irrigation demand is lower, are prone to waterlogging during seasons with above average rainfall. It is the exception rather than the rule to find large areas of classes 1 and 2 land in the wetter climatic regions.

4.1.3 Geographical distribution of irrigation

The total irrigated area in South Africa is estimated at 1 300 000 ha. The area under irrigation for each of the major drainage regions (Figure 4.1) is presented in Table 4.1. A similar distribution for the different provinces is shown in Table 4.2. Both tables differentiate between very suitable (Class 1), suitable (Class 2) and risky (Class 3) soils. Irrigation is found over the whole country and is fairly evenly distributed amongst the provinces. The tables indicate relatively large areas under irrigation in the Western Cape. This can be ascribed to the storage of runoff water during the winter and its use to supplement the relatively low summer rainfall.

Figure 4.1: Main drainage regions of South Africa

Table 4.1: Areas currently under irrigation and land suitable for potential irrigation development in the different drainage regions

Drainage Region	Very suitable		Suitable		Risky		Total	
	Current ha	Potential ha	Current ha	Potential ha	Current ha	Potential ha	Current ha	Potential ha
A	97 202	6 800	36 093	3 850	22 398	100	155 593	10 750
B	42 757	7 800	35 290	1 950	9 919	400	87 966	10 150
C	106 801	14 336	62 897	9 050	16 831	2 956	186 529	26 342
D	48 717	16 387	74 060	10 995	13 515	2 040	136 292	29 422
E	19 680	0	28 084	3 990	10 592	2 249	58 356	6 239
F	2 025	0	525	0	0	0	2 550	0
G	29 948	0	48 728	2 888	24 748	1 362	103 424	4 250
H	29 611	6 480	22 873	6 750	17 976	8 200	70 460	21 430
J	21 635	0	21 080	550	1 821	190	44 536	740
K	5 112	2 100	7 824	4 000	2 230	9 000	15 166	15 100
L	6 991	500	15 898	1 500	3 526	2 400	26 415	4 400
M	1 725	0	1 478	400	260	0	3 463	400
N	4 583	40	9 927	40	1 611	0	16 121	80
P	600	8 000	2 140	2 550	1 750	800	4 490	11 350
Q	5 227	2 094	46 348	8 000	11 427	4 200	63 002	14 294
R	403	150	1 661	830	516	445	2 580	1 425
S	8 497	10	10 374	110	1 623	120	20 494	240
T	4 727	5 916	7 072	6 443	5 423	2 042	17 222	14 401
U	16 365	2 226	18 085	2 161	4 948	819	39 398	5 206
V	24 282	14 331	23 185	16 854	15 788	5 400	63 255	36 585
W	22 340	31 289	23 900	11 222	5 836	6 965	52 076	49 476
X	114 459	20 450	5 285	620	1 000	0	120 744	21 070
TOTAL	613 687	138 909	502 807	94 753	173 638	49 688	1 290 132	283 350

Source: Committee on a Food and Feeding Strategy (1990)

Table 4.2: Areas currently under irrigation and land suitable for potential irrigation development in the different provinces

Provinces	Land								"Water available for further development
	Very suitable		Suitable		Risky		Total		
	Current ha	Potential ha	Current ha	Potential ha	Current ha	Potential ha	Current ha	Potential ha	
Eastern Cape	34 568	14 524	94 995	19 370	25 367	14 735	154 930	48 629	52 000
Free State	39 104	14 496	41 131	12 580	18 745	2 146	98 980	29 222	10 000
Gauteng	16 925	4 100	6 895	1 600	2 864	0	26 684	5 700	0
KwaZulu-Natal	66 627	52 552	71 762	31 955	31 855	15 056	170 244	99 563	77 000
Mpumalanga	129 225	31 250	25 426	4 070	2 769	490	157 420	35 810	7 000
Northern Cape	80 965	8 707	71 356	5 250	9 553	1 340	161 874	15 297	20 000
Northern Prov	61 752	6 100	46 898	3 550	26 496	1 420	135 146	11 070	2 000
North West	83 660	700	16 306	1 800	3 352	100	103 318	2 600	0
Western Cape	100 861	6 480	128 038	14 578	52 637	14 401	281 536	35 459	10 000
TOTAL	613 687	138 909	502 807	94 753	173 638	49 688	1 290 132	283 350	178 000

Source: Committee on a Food and Feeding Strategy (1990)

*DWAF (1995). Discussion document on future irrigation in South Africa (Table 2).

Three types of irrigation can be distinguished. *Permanent irrigation* occurs when the full irrigation requirement of the crop is applied to avoid plant water stress and to ensure optimal yields. With *supplementary irrigation*, less water than the irrigation requirement of a crop is strategically applied to decrease the impact of plant water stress during sensitive growth stages. *Occasional irrigation* refers to irrigation that takes place only when water is available. Table 4.3 clearly shows that the largest concentration of permanent irrigation is found in the 251 - 750 mm rainfall zones. *Occasional irrigation* is applied on 38% of the 156 200 ha of irrigation in the very low 126 to 250 mm rainfall zone. It is also evident from Table 4.3 that supplementary irrigation becomes more important and occasional irrigation less important in areas with an annual rainfall of 500 mm or more.

Table 4.3: Total areas under irrigation in the different rainfall regions

Region	Rainfall mm	Total ha	Type of irrigation			Mode of irrigation		
			Permanent %	Supple-mentary %	Occasional %	Flood %	Sprinkler %	Micro %
1	(< = 125)	19 174	92.5	.0	7.5	66.6	8.3	25.2
2	(126-250)	161 197	61.1	.4	38.5	77.1	16.8	6.1
3	(251-500)	399 278	86.7	7.7	5.7	42.8	43.6	13.6
4	(501-750)	488 543	75.2	20.8	4.0	21.0	65.4	10.8
5	(> 750)	221 940	81.5	16.6	1.9	5.3	80.9	13.8
Total		1 290 132	78.3	13.1	8.6	32.8	54.4	11.8

Source: Committee on a Food and Feeding Strategy (1990)

The estimated area with soil that is suitable for new irrigation development is indicated in Table 4.1 for the different drainage regions, and in Table 4.2 for the provinces. An estimated additional 280 000 ha of soils possess those physical characteristics that make them suitable for irrigation development. According to estimates (Department of Water Affairs and Forestry, 1995) water is available for the development of an additional 178 000 ha (Table 4.2). However, before developing new potential, attention should be given to the

upgrading or expansion of existing schemes. This area is estimated at 66 700 ha (Department of Water Affairs and Forestry, 1995).

4.1.4 Effect of irrigation on natural resources and the environment

In the long term, irrigation often leads to a deterioration in soil properties, and the result is decreased productivity. This happens when unsuitable soil is irrigated,when water of questionable quality is used and when management practices are used that are not suitable for the situation. A good knowledge of irrigation water quality and its interaction with soil is therefore necessary to maintain the productivity of irrigated land. Some problem areas are listed below.

- *Waterlogging and salt accumulation:*

  All over the world, large irrigation schemes tend to become unproductive due to waterlogging and/or salt accumulation, making the soil unsuitable for crop production. The fall of some civilisations has been attributed to waterlogging and salinization of irrigation schemes. This is mainly caused by over-irrigation, leakage from canals and storage dams, irrigation of unsuitable soils and/or a deterioration in water quality. This problem can be alleviated by the selection of deep, well-drained soils (Classes 1 and 2) for irrigation development, the use of good quality irrigation water and by a scientifically based water management programme. It is estimated that approximately 18% of the irrigated area in the RSA experiences some degree of detrimental effects caused by either waterlogging and/or salt accumulations (Table 4.4). The Conservation of Agricultural Resources Act (Act 43 of 1983) and the White Paper on Agriculture (1995) determine that an occupier of land is responsible for the conservation of natural resources, and is responsible for the implementation of preventative and/or corrective measures. On-farm drainage systems is thus the responsibility of the occupier. Because of the importance that the Government attaches to the protection of the environment, it supports the farmer in the implementation of preventative and/or corrective measures through payment of subsidies for the installation of on-farm drainage systems, where necessary. On government irrigation schemes, the State constructs central drainage systems to which farmers can link their on-farm systems. It is thus the responsibility of the irrigation

farmer to prevent waterlogging and/or salt accumulation in soils and to undertake the rehabilitation of affected soils through appropriate soil and water management practices, for example the reclamation of salt-affected soils through the installation of subsurface drainage and application of soil ameliorants, and the use of sound irrigation scheduling methods. Irrigation scheduling indicates when and how much irrigation must be applied. By not wetting the soil to the upper limit, storage for rain, following an irrigation, is created, thus decreasing the risk of accidental over-irrigation.

Table 4.4: Estimated percentages of waterlogged or salt-affected irrigated land in the different provinces

Province	Waterlogged or salt-affected		
	Severely %	Moderately %	Total %
Eastern Cape	6	13	19
Free State	6	18	24
Gauteng	5	15	20
Kwazulu-Natal	5	9	14
Mpumalanga	1	5	6
Northern Cape	4	20	24
Northern Province	12	14	26
North West	3	5	8
Western Cape	9	15	24

- *Surface sealing and subsoil compaction*

Irrigation often destroys surface roughness or structure, leading to the sealing of the soil surface, with a resultant decrease in infiltration rate and an increase in runoff. This problem is found in most South African soils, because of the fineness of the soils. Surface sealing is a major problem in approximately 80% irrigated soils, hampering irrigation efficiency, especially with centre-pivot systems. Many sandy and sandy loam soils are also susceptible to subsoil compaction by implement traffic. Subsoil compaction results in shallow root systems that can contribute to high drainage losses and overirrigation. Tillage and crop production practices that can alleviate but not solve the problems are available.

- *Water losses from conveyance systems*

  The leakage from canals and pipelines of the older irrigation schemes often exceeds planning norms. The design norm for concrete-lined canal systems in the RSA is 1,9 *l*/s.1000 m^{-2} of wetted lining, compared to the design norm of 0,35 *l*/s.1000 m^{-2} as quoted by overseas authors. Research in the RSA has indicated losses varying from 12% to 27% for some concrete-lined canals in the Free State and an average allowance of 25% for earthen canals in the Eastern Cape. Leakage losses in excess of 30% out of an earthen canal has been measured in one case (Snyders, 1996; Bang, 1996). These losses contribute to waterlogging and are an unproductive loss of irrigation water. However, concrete lining of canals is not necessarily economically justified and depends mainly on the value of crop production as determined by management and market potential.

- *Impact of excessive application of agro-chemicals*

  The aim to increase water use efficiency, that is, to obtain high yields per unit of water applied, requires intensive pest control through the use of agro-chemicals. The injudicious application of these chemicals could create a health hazard for humans, or may harm the environment. Although this is not a general problem, isolated cases are being reported from time to time.

- *Irrigation systems*

  Care should be taken that the method of water application and the design of the irrigation system ensure the most efficient application and control of irrigation. Evaporation, run-off and deep drainage losses should be minimal. It is interesting to note from Table 4.3 that flood irrigation is preferred in the low rainfall areas, while sprinkler and micro-irrigation are preferred in the higher rainfall regions.

- *Low quality return flow*

Irrigated agriculture can in itself be a major contributor to the deterioration of downstream water quality through low quality return flow and saline seepage from river banks. Irrigation with saline water causes soils to salinise, and this results in a more saline return flow and seepage. Several cases have been reported in South Africa where the downstream deterioration of irrigation water quality could be ascribed to upstream irrigation activities, for example the Breede River, Great Fish River and Olifants River.

- *Irrigation with dangerous substances*

Irrigation with the outflow of industries and sewage could be dangerous if the outflow contains high levels of pathogenic organisms, such as *Escherichia coli*, or elements that can become potentially toxic at high levels, or if it is applied through sprinkler irrigation systems directly onto plants and then ingested by humans and animals. Amongst the elements with this potential are: fluoride, cadmium, barium, nickel, copper, zinc, mercury and chromium, even though intake in small quantities might sometimes be beneficial.

Sewage outflow usually has a high sodium content and, if it is used in irrigation, it could destroy soil structure within a few irrigations to such an extent that the water infiltration rate of the soil could become virtually zero.

The pH of the effluent could be so high or low that it could have a marked impact on the pH of the soil, to the detriment of crops that are grown under irrigation.

One of the problems in the use of effluent in irrigation, is that it seems to be very difficult to determine the exact chemical composition, which is influenced by the time of day that a particular industry discharges its effluent into the sewage system.

Runoff or return flow to surface streams or drainage to the underground water resources from fields irrigated with water containing environmentally dangerous substances should

be prevented at all costs through low application rates that restrict downward water movement past the root zone.

- *General impacts*

Irrigation could have a serious and wide-spread impact on the environment. The replacement of natural vegetation of an area by cultivated crops can also destabilise river banks by cultivating too near a river. The Act on the Conservation of Agricultural

Resources (Act 43 of 1983) determines that cultivation should not take place nearer than 30 m from a river bank. This is to ensure that enough natural vegetation remains to stabilise the river banks and thus prevent erosion.

Aihoon *et al.* (undated) describe a situation that is found in many irrigation areas. They found that total dissolved salts (TDS) in the Olifants River at Loskop often reached upper limits of 1 050 mg/l. These upper limits and the fluctuations in TDS concentrations influence the survival of aquatic and terrestrial fauna and flora along the river which later flows through the Kruger National Park. Other water users, e.g. rural domestic consumers of river water without purification facilities are influenced, since the dissolved salts affect the taste of drinking water, and washing requires higher quantities of detergent or soap. The increasing TDS levels and specifically the chloride levels affect agriculture itself, especially tobacco production. Some other cumulative effects include the reduction in the lifespan of irrigation equipment, as well as costs to the industrial and other water users downstream. Future socio-economic costs may include unemployment and urbanisation of unemployed people that may arise when TDS and chloride concentrations reach levels at which the production of irrigated crops becomes impossible.

The construction of dams and weirs in river systems could subdivide small populations of rare aquatic organisms, which in turn could threaten the future existence of those organisms. Silt sedimentation in rivers could lead to the destruction of food sources for larger aquatic organisms and thus lead to their extinction.

4.1.5 Type of irrigation schemes and soil quality

About 26% of the total area irrigated is found in state schemes, 30% occurs under irrigation board control and 44% of the area is under private irrigation. To ensure long-term low-risk sustainable irrigation on state schemes the selection of highly suitable Classes 1 and 2 soils is a prerequisite and provision must be made for the installation of subsurface drainage systems wherever required. Where irrigation board and private schemes are equipped to handle a higher risk, the irrigation of Classes 3 and 4 soils might be considered, provided the possible consequences are taken into account.

Intensive soil surveys should be conducted before approving any new irrigation development and the lessons learned from the past should be taken into account when the suitability and quality of the soils are evaluated for irrigation. Planning should also include environmental impact studies.

PRIORITIES:

- Protection and reclamation of land resources to maintain or improve resource productivity.
- Replanning and upgrading of existing irrigation schemes with unused or surplus capacity.
- Proper soil and ecological evaluation before any new irrigation development.

4.2 CROP PRODUCTION

4.2.1 Introduction

Due to climatic, topographic and soil conditions, only approximately 10% of the 120 million ha of total area of South Africa is arable. This figure includes marginal areas, and despite relatively high inputs, average yields of crops are low, as has clearly been illustrated by

maize and wheat in recent decades. Few opportunities exist for increased production per unit of land area. On the contrary, economic realities, soil degradation, increasing climatic variability, and some other factors can lead to decreases in production per unit area. Although only 10,8% (1,3 million ha) of the arable land is irrigated, it contributes approximately 30% towards national crop production.

Based on recommended dietary allowances, approximately 0,4 to 0,6 ha of rainfed cropland is required to feed one person. Without irrigation, South Africa can economically produce food for a population of approximately 20 to 30 million. Intensive production under irrigation enables one hectare to sustain 10 people, thus an additional 10 to 15 million people at the current extent of irrigation. At best, agricultural resources in South Africa can produce enough to economically feed a population of 50 million people. According to official statistics, the present population of South Africa is 41,7 million and can reach a figure of 60 million by the year 2010. Optimum utilization of all crop production resources, especially irrigation water, is therefore obviously essential.

Irrigated crop production has certainly had a beneficial effect on food security in South Africa. In order to attain food security, enough food must be available at affordable prices, and everyone, including the poorest, must have sufficient funds to enable them to purchase such food. While a country such as Japan with its high levels of income and particularly its diversified industrial and service economy can afford to import a large portion of its food needs and still have adequate food security, this is not the case in South Africa. South Africa has to grapple with high rates of unemployment and low wage levels for a large part of the working population. Agriculture needs to employ people and provide foreign exchange in order to accumulate development funds. Thus, food security will be enhanced in South Africa if more food can be produced than is locally needed, providing employment and income, foreign exchange, and locally produced food at competitive, reasonable prices.

4.2.2 Contribution of irrigation to crop production

Table 4.5 summarizes typical data for the utilization of irrigated land, and the contribution towards crop production. Table 4.6 lists the twelve most important irrigated crops in each

of the provinces, while Table 4.7 shows the most important crops in the major drainage regions. All estimates quoted in the tables refer only to commercial farming due to the lack of information on small-scale and subsistence farming.

Table 4.5: Estimated contribution of irrigation to commercial crop production in South Africa

CROP	AREA IRRIGATED		PRODUCTION	
	x 1000 ha	% of total area planted to this crop in South Africa	x 1000 t	% of national production
Maize	110	3	660	10
Wheat	170	12	740	30
Other small grains	52	3	200	6
Potatoes	39	70	1200	80
Vegetables	108	66	1330	90
Grapes	103	90	1300	90
Citrus	35	85	1100	90
Other fruit	95	80	1200	90
Oilseeds	54	10	108	15
Sugar-cane	60	15	4000	25
Cotton (Lint)	18	17	17	42
Tobacco	12	85	20	90
Lucerne	203	70	1600	80
Other pastures & forages	104	15	800	25

Table 4.6: Most important crops currently produced under irrigation in the different provinces

GAUTENG	Area (ha)	WESTERN CAPE	Area (ha)	KWAZULU-NATAL	Area (ha)
Maize	6 162	Vineyards	93 715	Sugar-cane	49 753
Lucerne	3 781	Lucerne	53 406	Rye-grass	30 583
Wheat	2 042	Apples	17 617	Maize	11 800
Tomatoes	1 803	Peaches	13 062	Kikuyu	10 666
Cabbages	1 675	Potatoes	9 493	Wheat	8 123
Pumpkins	1 263	Grass/clover	8 541	Soybeans	4 305
Rye-grass	1 039	Pears	8 502	Grass/clover	3 648
Peaches	1 036	Citrus	7 125	Potatoes	3 577
Potatoes	0 989	Wheat	5 783	Cotton	3 357
Other pastures	0 954	Apricots	3 150	Vegetables	3 351
Dry beans	0 934	Onions	2 775	Other pastures	3 026
Green peas	0 732	Subtropical fruit	2 730	Cabbages	2 949
MPUMALANGA	**Area (ha)**	**FREE STATE**	**Area (ha)**	**NORTHERN CAPE**	**Area (ha)**
Maize	23 792	Wheat	33 592	Wheat	66 837
Wheat	23 107	Lucerne	24 990	Lucerne	32 262
Sugar-cane	21 123	Maize	19 832	Maize	19 382
Cotton	17 798	Potatoes	6 227	Groundnuts	18 083
Tobacco	15 656	Rye-grass	4 453	Cotton	14 613
Citrus	12 307	Oats	2 499	Grapes	7 823
Tomatoes	9 650	Other pastures	2 035	Small grains	7 150
Oranges	8 721	Soybeans	1 992	Potatoes	4 342
Soybeans	6 555	Cotton	1 505	Dry peas	3 928
Bananas	5 927	Cabbages	0 955	Oats	3 265
Dry beans	4 162	Onions	0 633	Soybeans	2 020
Rye-grass	4 119	Small grains	0 619	Green peas	1 124
NORTH WEST	**Area (ha)**	**NORTHERN PROVINCE**	**Area (ha)**	**EASTERN CAPE**	**Area (ha)**
Wheat	27 294	Cotton	24 248	Lucerne	76 763
Maize	12 629	Maize	11 017	Small grains	10 720
Lucerne	6 837	Citrus	10 720	Maize	8 905
Cabbages	6 300	Wheat	10 215	Oranges	8 068
Onions	5 756	Other	8 530	Wheat	6 787
Tobacco	5 423	Avocado	6 580	Oats	5 890
Other oastures	4 245	Potatoes	6 184	Grass/clover	4 692
Rye-grass	4 126	Mangoes	5 505	Other pastures	4 465
Cotton	3 199	Tobacco	5 164	Apples	3 291
Peppers	2 691	Tomatoes	4 026	Rye-grass	3 102
Citrus	2 550	Bananas	3 950	Potatoes	2 877
Soybeans	2 000	Soybeans	3 039	Cabbages	1 281

Source: *Committee on a Food and Feeding Strategy (1990)*

Table 4.7: Most important crop types currently produced under irrigation in the different drainage regions

Drainage Region A	Area (ha)	Drainage Region B	Area (ha)	Drainage Region C	Area (ha)
Vegetables	42 400	Small grain	20 700	Pastures and forages	74 400
Small grain	29 600	Fibre crops	15 600	Small grain	61 300
Fibre crops	20 900	Vegetables	13 100	Summer grain	46 200
Summer grain	17 100	Summer grain	12 000	Vegetables	21 100
Pastures and forages	11 600	Citrus	8 600	Oil and protein seed	17 400
Subtropical fruit	7 900	Oil and protein seed	8 200	Fibre crops	10 800
Oil and protein seed	6 300	Pastures and forages	4 700	Vineyards/grapes	1 500
Citrus	4 300	Subtropical fruit	3 100		
Drainage Region D	**Area (ha)**	**Drainage Region E**	**Area (ha)**	**Drainage Region F**	**Area (ha)**
Pastures and forages	55 700	Pastures and forages	11 300	Pastures and forages	1 500
Small grain	32 000	Small grain	11 200	Vineyards/grapes	700
Summer grain	11 000	Deciduous fruit	10 800	Vegetables	200
Vineyards/grapes	6 900	Vineyards /grapes	8 600	Oil and protein seed	100
Fibre crops	6 800	Vegetables	6 500		
Oil and protein seed	3 100	Citrus	5 700		
Vegetables	3 000				
Drainage Region G	**Area (ha)**	**Drainage Region H**	**Area (ha)**	**Drainage Region J**	**Area (ha)**
Vineyards/grapes	46 400	Vineyards/grapes	36 500	Pastures and forages	30 000
Deciduous fruit	27 200	Pastures and forages	15 500	Vegetables	2 100
Pastures and forages	5 700	Deciduous fruit	9 800	Deciduous fruit	1 500
Vegetables	4 100	Vegetables	7 900	Vineyards/grapes	1 400
Subtropical fruit	3 000	Small grain	5 100	Small grain	1 200
Citrus	1 200				
Drainage Region K	**Area (ha)**	**Drainage Region L**	**Area (ha)**	**Drainage Region M**	**Area (ha)**
Pastures and forages	9 300	Pastures and forages	17 100	Pastures and forages	2 400
Vegetables	3 700	Deciduous	5 300	Vegetables	700
Summer grain	400	Vegetables	4 700	Small grain	100
Deciduous fruit	200	Citrus	1 500	Citrus	100
Vineyards/grapes	100	Summer grain	1 300		

Drainage Region N	Area (ha)	Drainage Region P	Area (ha)	Drainage Region Q	Area (ha)
Citrus	7 700	Pastures and forages	2 600	Pasture en forages	53 800
Pastures and forages	6 900	Vegetables	1 000	Summer grain	4 800
Vegetables	600	Small grain	400	Small grain	2 300
Summer grain	400	Summer grain	300	Citrus	800
Small grain	300	Citrus	100	Vegetables	100
Drainage Region R	**Area (ha)**	**Drainage Region S**	**Area (ha)**	**Drainage Region T**	**Area (ha)**
Vegetables	1 200	Pasture and forages	11 600	Pasture and forages	9 600
Pasture and forages	800	Summer grain	600	Small grain	1 800
Summer grain	100	Vegetables	400	Subtropical fruit	600
				Vegetables	600
				Summer grain	200
Drainage Region U	**Area (ha)**	**Drainage Region V**	**Area (ha)**	**Drainage Region W**	**Area (ha)**
Pasture and forages	23 100	Pasture and forages	22 500	Sugarcane	26 200
Sugar-cane	10 200	Sugar-cane	20 100	Fibre crops	4 200
Vegetables	7 900	Summer grain	8 100	Pasture and forages	3 100
Summer grain	1 400	Small grain	6 100	Summer grain	2 100
Oil and protein seed	900	Vegetables	5 000	Citrus	1 900
Citrus	600	Oil and protein seed	4 100	Vegetables	1 700
Subtropical fruit	500	Subtropical fruit	700	Subtropical fruit	1 400
		Citrus	400	Oil and protein seed	1 100
Drainage Region X	**Area (ha)**				
Subtropical fruit	34 200				
Citrus	23 200				
Vegetables	20 700				
Sugar-cane	14 300				
Fibre crops	6 000				
Oil and protein seed	3 600				
Pasture and forages	2 600				
Small grain	1 700				
Summer grain	1 000				

Source: Committee on a Food and Feeding Strategy (1990)

The shift towards more profitable crops will continue, with grain crops and pastures, and even industrial crops like cotton and sugar-cane, making way for more profitable vegetables, fruits, nuts, flowers and ornamentals in commercial irrigation farming.

Although grain crops can effectively be grown under rainfed conditions, they will remain part of crop combinations under irrigation i.e. for the production of seed, and as irreplaceable rotational crops for potatoes, tobacco and some vegetables. For instance, 12% of the 1,4 million hectares planted to wheat is irrigated, producing approximately 30% of the annual wheat crop. No viable alternative to wheat is available, especially during the winter cropping season. Irrigated wheat also has an important stabilising effect on the total wheat production.

Pastures and forages are often viewed as expendable irrigated crops. However, it must be borne in mind that the relative large areas shown in Table 4.6 and 4.7 also include areas that are minimally irrigated, often only to establish pasture as a rotational crop. Fodder from irrigated areas helps to sustain animal production in arid zones and forms an important component of fodder flow programmes in all regions.

Production of vegetables, flowers and ornamentals under shelters has increased in recent years and will expand further. It may increase profitability in small-scale operations and can certainly increase water use efficiency. It offers a viable option to many irrigation farmers to scale down on the quantity of water used for extensive irrigation, without loss of income. Successful implementation will however require specialized research and extension, improved managerial ability and market potential.

4.2.3 Potential for sustained/increased production

Opportunities for horizontal expansion of crop production under irrigation are limited (see Section 4.1). Competition with domestic, industrial and mining uses is likely to decrease agriculture's share of water resource use to less than the current 50%. Better utilization of available irrigation water is imperative. Apart from losses before reaching the farm the selection and maintenance of irrigation systems can limit water losses considerably. Alternative available technology like drip irrigation, and especially sub-surface drip, can in specific situations contribute to substantial savings in water and electricity, with an accompanying increase in yield.

In the short term, the most cost-effective way of increasing the productivity of irrigation water is to increase the water use efficiency of crops. The *physical water use efficiency* (physical WUE) is defined as the mass of marketable product per unit of water (t m^{-3}), while the *economic water use efficiency* (economic WUE) reflects the net income generated per unit of water consumed (R m^{-3}). The water content of products, and in the components of different crops utilised, varies and this renders it necessary to be careful in the interpretation of WUE. In comparisons of the productivity of water or the WUE of different crops the economic WUE should be used. The physical WUE is appropriate in analyses of the efficiency of management practices for a given crop or group of similar crops. Typical physical water use efficiencies for some crops are presented in Table 4.8.

Table 4.8: Physical water use efficiency (WUE) of several crops

Crop	WUE (kg m^{-3})
Grain crops as a group (10% moisture)	**0,15 - 1,6**
Wheat	0,8 - 1,4
Maize	0,8 - 1,6
Seedcotton	0,4 - 0,6
Sugar-cane (sucrose at 0% moisture)	0,6 - 1,0
Vegetables as a group (70-90% moisture)	**0,5 - 12,0**
Tomatoes (90% moisture)	10,0 - 12,0
Potatoes (73% moisture)	4,0 - 7,0
Cabbage (90% moisture)	12,0 - 20,0
Onions (88% moisture)	8,0 - 10,0

Wheat will be used as an example to illustrate the potential for improvement of physical WUE. The typical physical WUE for an average wheat yield of 4,5 t ha^{-1} produced with 550 mm of irrigation in the Loskop area, is 0,82 kg m^{-3}. A WUE of 1,3 kg m^{-3} is however achievable on farm scale, and unpublished results for six commercial fields scheduled and monitored during 1994 confirmed this. An increase of over 30% in physical WUE therefore appears to be attainable for the irrigated wheat industry as a whole.

Water use efficiency can be improved in a number of other ways. WUE is typically higher for autumn and winter grown crops. Irrigation is often more efficient if done at night than during daytime. Limiting irrigation during the vegetative growth stages of many crops has

a relatively small effect on yield. WUE can also be improved by limiting evaporative loss by means of longer intervals between irrigation or by mulches, etc.

Economic WUE of irrigated crops in South Africa varies from less than R0.20 m^{-3} to more than R10.00 m^{-3}, depending on input costs, yield and price. The economic WUE of grain crops is typically very low. Any decrease in the availability of irrigation water, or increase in the supply price of water, will adversely affect the production of crops with a low economic WUE, in favour of high value crops.

It is often argued that scarce irrigation water can be better utilized in the higher rainfall areas than in the dry regions in which many irrigation schemes are situated. This does appear to be a valid, common- sense argument. Fact is however that suitable soils are scarce in the higher rainfall areas, and that climatic conditions at the higher elevations of the interior (which include the higher rainfall areas) are often less favourable, with winters too cold for many crops, and summers often too short for many crops.

4.2.4 Factors which may improve water use efficiency

Current poor physical WUE is the main reason why many farmers

(i) neglect other important production inputs (cultivars, fertilization, disease control, production technology). Any input which increases yield without requiring more water raises the physical WUE; and

(ii) do not apply available irrigation scheduling technology; this may be due to lack of technical know-how or a perception that the net benefit from scheduling is low.

Prototypes of user-friendly computerized scheduling programmes have already proved successful on commercial farms, provided adequate technological back-up is available. Water savings of 20 to 30% were in numerous instances accompanied by increased yields and higher quality products. This approach can also be adapted for communal irrigation projects. An extended government supported specialist extension programme will, however, be required; correct irrigation management is a complicated process.

Economic water use efficiency can further be improved by realistic supply pricing of irrigation water. Many farmers' present approach is to make certain that inexpensive inputs are not limiting, and this often results in over-irrigation with a resulting low economic WUE. Increased relative costs of water, even on a sliding scale, could motivate better water management. Progress is also possible if only more farmers could be made aware of the cost of not irrigating properly both in terms of too high cost of electricity and fertilization or loss of income due to reduced yield and quality of crops produced. The correct signals will be given to farmers through increased water tariffs and marketable water rights (see Chapter 6).

PRIORITIES

- The continued production of foodstuffs and simultaneously the move to higher value crops which use water more efficiently must be regarded as a prime policy objective.
- Physical and economic water use efficiency must be improved. This will require government supported specialist extension programmes backed up by high level research and technical support services.
- Realistic supply pricing of water is needed to induce farmers to increase water use efficiency.

CHAPTER 5

HUMAN RESOURCES AND MARKETS

5.1 ENTREPRENEURSHIP AND MANAGEMENT

5.1.1 The importance of entrepreneurship and management

Entrepreneurship consists of the ability and willingness to start and conduct economic activity whilst taking all the risks and responsibilities associated with the endeavour. It involves the seeking of opportunities for more efficient utilisation of resources and accepting the risks accompanied with investments in farming. Management involves decision-making and action in all phases of farming activities, i.e. procurement, marketing, financing and production, within the constraints of fixed resources and in accordance with pre-determined objectives. Successful farming operations imply that objectives are achieved by correct decisions within an uncertain environment.

Management must decide what and how much to produce, what and how much input to use, when and where to produce and what to do with the product. Management must execute these plans; it also has to accept responsibility for actions, success and failure. It is mostly management that determines success and failure. Managerial ability varies considerably among individuals. This should always be kept in mind, particularly in a venture such as irrigation farming with its high managerial requirements.

5.1.2 Management and returns to size (scale)

Empirical evidence world-wide, including South Africa, generally shows that once a production unit exceeds a certain critical minimum size, productivity and cost per unit of product remain rather stable as size increases; economies or diseconomies of size can very seldom be verified empirically. It is concluded that in agriculture, economics of size is a very rare phenomenon.

In a free or relatively free market, the cause of returns to size lies in the difference among individuals with respect to managerial abilities. Better managers can manage larger units more successfully than poorer managers: They expand, while the less able managers' businesses contract. Eventually the more able managers control larger farm units.

Therefore, policy on farm sizes should be flexible, leaving room for the better entrepreneurs/ managers to expand, and also for poorer managers to contract should economic realities force them to do so. There is room for both large and small, particularly in irrigated agriculture. In fact, the desire for the efficient use of irrigation water as a scarce resource renders this a vital necessity.

(See Appendix for more detail.)

5.1.3 Fixed and operating capital

Capital is required for fixed investment, maintenance, operating and consumption expenditure. Overborrowing is a source of financial risk and often leads to insolvency. In order to restrict financial risks and to ensure liquidity, only a proportion of capital, certainly less than 50%, should be financed by loans. The major source of provision for initial farm operating and household consumption expenditure must therefore be equity capital. This is the case irrespective of the scale of farming operations: The only implication is that the amount of equity capital required varies. The lack of available equity capital is consequently an important factor limiting entry into farming, especially regarding capital-intensive irrigation farming. It also has an effect on tenancy arrangements; farmers with limited equity capital should lease rather than purchase land and accumulate funds until their equity is sufficient for land purchase and ownership.

5.1.4 Managerial requirements and education

To a very large degree, correct decision-making requires the ability to know where to find information and how to apply it.

Managerial requirements are particularly high in irrigation agriculture. Management requires knowledge concerning existing and prospective technology, product markets and input markets, as well as knowledge of the political, social and physical environment. It requires the ability to adapt to change. A number of individual variables such as practical experience, level of training, age, health, attitude towards risk, preferences and dislikes, family relationships, and social and cultural background exert an influence on managerial ability. Underlying these variables are personal characteristics which are prerequisites for correct decision-making. Identification and measurement of the most limiting characteristics can be problematic. Investment in human capital through education, training and extension is however more often than not the most important contributing factor to the economic success of irrigation schemes.

The high degree of illiteracy among rural black people in South Africa is a real stumbling block to management. Education - both of adults and children - is a prerequisite, one that will yield very high returns. An integrated approach, including literacy and health training, agricultural training and extension, and marketing and accountancy training, is indicated.

5.1.5 Special training and educational needs for irrigation farming

Lack of properly qualified management, extension staff and farmers is a major drawback to the effectiveness of many small-scale farming irrigation schemes (Bembridge, 1996). Training programmes at all levels should receive a high priority. Assessment of training needs should be the basis of any well-planned upgrading and restructuring of specific irrigation schemes.

Particularly in areas where irrigation had not traditionally been practised, most participants have little of the knowledge and skills required for irrigation farming. A bureaucratic "top down" approach to scheme management has been rather common. In these circumstances there has been inadequate training of farmers in irrigation farming skills. Training and extension are required in crop management, irrigation scheduling and techniques. There is a dire need for capacity building of local organisations to enhance water management in the small-scale farming sector (see paragraph 5.6.2).

An important basic need, particularly on commercially oriented schemes, is training in simple record keeping and interpretation of financial statements and records. Because of the high level of illiteracy among adults, such training needs to go hand in hand with functional numeracy and literacy.

The need for training in irrigation scheduling, crop management and farm management recording is by no means restricted to the small-scale farming sector. Many present commercial farmers also require similar training.

5.2 ECONOMIC LOCATION

Farmers will produce for markets only if there is an effective demand i.e. payment for farm products at a specified place, time and form, at an agreed price. Analysis of marketing potential and price tendencies for local and export markets, based on increased demand and/or existing or expected shortages of supply, has to take into account a number of issues:

- Points of delivery of products and available infrastructure (roads, railways, telephones, etc.);
- quantities marketed in the past;
- competitive production regions and expected production forthcoming from these areas; quality and grading requirements;
- costs incurred along the marketing channel (i.e. packaging, transport, storage, cooling commissions, etc.);
- price trends in the past and current price levels;
- income and/or price elasticities of demand, and projected price levels; and
- appropriate timing and duration of marketing to realise the highest possible price (Directorate of Agricultural Economics, 1995).

If there is very limited or no access to markets, irrigation schemes have no reasonable chance of success.

All or nearly all of the cotton, lucerne, tobacco, vegetables and bananas grown under irrigation is marketed within South Africa. In contrast, major portions of other irrigation farming products such as apples, table grapes, pears, plums, avocados and citrus fruit are exported. Irrigation products are important both for feeding the nation and for earning foreign exchange, the latter realising in excess of R2 600 million per year. In the absence of these exports, the balance of payments in South Africa would during some years, be under severe strain, thereby negatively affecting the country's economic growth potential. Maintaining South Africa's comparative advantage with regard to its export crops, is therefore extremely important.

Vegetable production for local consumption is largely concentrated in areas which either have transport links to the major consumption centres or which are not very distant from them. Lucerne hay production has largely been concentrated in drier areas with large concentrations of livestock, and has contributed much to the stability in livestock farming.

Economic location is largely determined by distance from markets, communications infrastructure, and particularly also transport infrastructure. These factors influence the ability of farmers in an area to obtain inputs economically, to transport products economically to markets and to obtain such prices as will make their efforts remunerative. Bulky and perishable products, e.g. flowers, most fruits and most vegetables, can be produced economically only if the economic location is favourable. These are also products with high economic water use efficiencies (WUE) under favourable conditions.

Thus, new irrigation development should occur only if the economic location is favourable enough to present hopes of success, or where it can be made favourable.

Many areas, particularly in former "homelands" are not that distant from markets, but their economic location is unfavourable because of poor transport infrastructure and almost if not completely, absent communications infrastructure. If the condition of roads is so poor as to lead to trucks breaking down, it results in economic location becoming extremely unfavourable. The development of transport as well as communications infrastructures will bring about considerable social and economic upliftment of communities which thus far have

been virtually isolated. It will, among other things, change non-viable irrigation agriculture to a potential source of growth.
(See Appendix for more detail.)

5.3 ECONOMIC LINKAGES BETWEEN IRRIGATION FARMING AND THE REST OF THE ECONOMY

The importance of any activity, including irrigation farming, to the South African economy can not be gauged merely by considering the gross value of production, its contribution to foreign exchange generation and its ability to generate work opportunities directly. Its economic linkages must also be considered. Linkages can be forward: Agricultural production, for example, delivers products that are transported, stored, processed, packaged and distributed. These forward linkages represent economic activity (and employment) made possible or stimulated by agricultural production. There are also backward linkages, in that agricultural production stimulates activities involved with the trade, manufacture, storage, transportation and delivery of the inputs needed for this production.

Backward and forward linkages and especially employment will depend on the degree to which inputs or products are locally provided and processed. For an area where most inputs are "imported" and products are "exported" to and from the irrigation scheme, employment opportunities are relatively small.

It can be expected that these figures will be higher on those schemes where value is added through processing, as sugar mills, cotton ginneries, citrus and apple packhouses or canning factories.

By 1994, the agricultural producers' share of the money spent on food in South Africa was 37,8 per cent; 62,2 per cent was therefore spent on activities involved with forward linkages, or 1,65 times the gross revenue of farmers. It has been calculated that a 10 per cent change in agricultural production has a total impact of between 1,2 per cent and 1,4 per cent on the South African economy (Van Zyl *et al.*, 1988). Agriculture and construction, are the two industries with the highest labour multipliers in South Africa. An increase of between 101

and 244 employment opportunities, thus approximately 170, occurs if the value of agricultural production increases by R1 million. A contraction in agricultural production brings about a similar decline in employment (Van Zyl *et al.*, 1988).

A regional study specifically on the impact of irrigated agriculture (Kirsten & Van Zyl, 1990) reveals irrigated agriculture to have similar forward and backward linkages as agriculture in total.

The implication is clearly that irrigated agriculture is a vital sector in the economy of some regions and provinces. Improved efficiency in irrigation can certainly be of considerable significance in the economies of for example the Northern Cape, Northwest Province, Northern Province, Mpumalanga and the Eastern Cape. Serious setbacks in irrigation farming will create economic and personal hardship for many in these provinces.

5.4 THE NATURE AND INTENSITY OF IRRIGATION FARMING

Irrigation farming differs from rainfed agriculture in a few important aspects. The availability of larger water quantities and the ability to control water use enable farmers to achieve higher and more stable yields of products per hectare of land. Such increased and more stable yields can however be obtained only by the increased use of other factors of production, i.e. labour, capital and management. Irrigation farming therefore absorbs more labour per hectare of land than most other forms of agricultural endeavour. Irrigation farming also requires considerable fixed capital in the form of waterworks, and often land levelling and other infrastructure such as buildings and sheds to handle a high volume of crops and to house machinery and workers. More medium term capital is needed in the form of machinery and equipment. Irrigated agriculture is always characterised by a more intensive concentration of machinery and equipment than in the case of other farming types. In orchard agriculture, the orchards themselves represent high capital investments per hectare of irrigated land.

The same applies in the case of short-term inputs. Large quantities of fertiliser, seed, pest control material, packing material, fuel, etc. are required per hectare of land in order to

achieve the yields strived for in irrigation farming. Annual variable costs vary considerably among different types of irrigation farming and different areas in South Africa. It is very rarely below R2 000 per hectare. The median is between R6 000 and R7 000 per hectare. Some special types of irrigation farming can be associated with much higher annual variable costs per hectare, e.g. table grape and ginger production where variable costs exceed R28 000 per hectare.

Such intensive cultivation, investment and labour use also require a high calibre of management. Irrigation farming is therefore also management intensive. It requires far above average technical, supervisory, financial and organisational skills.

5.5 COMMERCIAL IRRIGATION FARMING

There are distinct differences in the intensity of commercial irrigation farming in South Africa, measured either in terms of investment per hectare, labour use per hectare and the intensity of management. Intensive tomato or table grape production is for example more labour, capital and management intensive than, for example, the production of grains or lucerne under irrigation. The intensity and type of irrigated agriculture are largely affected by the availability of water, its stability, the quality of the soil and water, and economic location. An unfavourable economic location renders the profitable production of many products, e.g. perishable or bulky products such as many vegetables, impossible. It also reduces the ability to produce many fruits profitability. Irrigation, even with the existence of sufficient water resources, will remain an underdeveloped farming activity in some former "homelands" until good transport and other communications have been established. A combination of unfavourable economic location and poor water quality has for example caused a rather less intensive farming type (lucerne as feed for sheep and goats) to be most profitable in the Great Fish River Valley.

The differences in economic location, soils and water have also caused both the profitability and labour use to differ among successful irrigation farmers.
(See Tables in Appendix for more detail.)

Annual gross margins, as published by the Department of Agriculture for 1994/95 were generally in the following ranges:

Fruits:	R4 000 - R23 000
Vegetables:	R1 400 - R10 000
Tobacco:	R3 300 - R9 000
Lucerne	R2 800 - R4 500
Grains:	R1 000 - R2 800
Industrial crops:	R1 400 - R2 700
Potatoes:	R2 700 - R5 200

In general, the more intensive types of irrigation agriculture are also the most remunerative.

Labour usage also depends on the type of crop, the amount of work necessary and the degree to which mechanisation is a viable or practical possibility. Whereas most work involved with wheat, maize and lucerne production is readily mechanisable, this is certainly not the case with bananas, tobacco, tomatoes and particularly harvesting operations of most fruits that can be bruised. Typical ranges in labour hours used per hectare (See Appendix Table A.3.2) are as follows:

Fruits:	Clementines and Satsumas:	3 600 - 3 900 hours p.a.
	Bananas:	1 620 - 1 860 hours p.a.
	Citrus and Subtropical:	1 200 - 1 500 hours p.a.
	Nuts:	130 - 240 hours p.a.
Grains:		40 - 70 hours p.a.
Lucerne:		100 - 230 hours p.a.
Vegetables:	Tuber and root types vegetables:	1 050 - 2 800 hours p.a.
	Other vegetables:	410 - 1 300 hours p.a.
	Tomatoes:	3 600 - 10 000 hours p.a.
Tobacco:		1 050 - 2 250 hours p.a.
Industrial crops:		200 - 2 000 hours p.a.

These figures can perhaps be placed in some perspective by considering that a worker has approximately 2 200 working hours available per year. However, agricultural chores have distinct seasonal variations. The result is that much harvesting of fruit is done by casual seasonal labourers. Regular, permanently employed farm workers may be overextended during some months while having time on their hands during others.

Labour absorption is typically higher in areas close to large concentrations of unemployed or underemployed labour, such as KwaZulu-Natal, Mpumalanga and the Northern Province.

Efficiency of water use will certainly be improved should farmers switch over to crops with higher marginal value products to water. Subsidised water tariffs represent an impeding rather than a positive influence.

The experience with commercial agriculture is that irrigation can be very remunerative provided the following are present:

- High quality management
- Markets and additional infrastructure
- Sufficient capital, particularly equity capital.

Commercial irrigation farming has directly and indirectly been beneficiaries of a wide range of subsidies. Capital goods such as machinery were the object of very generous tax concessions for many years until 1988; interest rates on agricultural credit had long been subsidised, with the Government making special provisions to help farmers who had fallen into arrears with debt obligations; grain prices were kept stable and above free market prices by Government intervention under the Marketing Act; and water tariffs have been lower than the operating and maintenance costs involved to deliver irrigation water.

In the long run these direct and indirect subsidies did more harm than good. They encouraged overmechanisation and reduced labour employment; Marketing Act operations acted as disincentives for the use of water for higher value crops than grains, *de facto* subsidisation of water tariffs having given the market signal that water is a cheap and

abundant resource, thereby encouraging wastage. If anything is to be subsidised in future, it can be subsidisation of employment and irrigation settlement schemes of disadvantaged farmers. This should however be subject to a strict time scale.

Many of the commercial irrigation farmers are on schemes, the physical infrastructure of which is becoming old and in need of rehabilitation. Rehabilitation will in by far the majority of cases, if not invariably, be more cost-effective than development of new schemes, and should therefore take precedence over development of new schemes, if public money gets involved.

Prosperous irrigation farming spills over to other sectors and employment. The opposite will occur if irrigation farming is to suffer setbacks.

5.6 SMALL-SCALE IRRIGATION FARMING

5.6.1 Introduction

Research has shown that in South Africa, as in Africa as a whole, small-scale farmer irrigation schemes are beset by varying combinations of problems. These include scheme management, project planning and design, security of tenure, size of units, farmer participation, water management, debt load, pricing policies, marketing, inputs, extension and research services, as well as mechanical and other support services (Bembridge, 1996).

5.6.2 Small-scale farmer schemes

There are, as far as can be ascertained, 202 small-scale farmer irrigation schemes in South Africa involving 47486 ha. Of the 37108 participants, only 13867 (37%) can be regarded as being commercially oriented. The remaining 23239 (63%) are foodplot holders who may sometimes sell a proportion of their produce (see Table 5.1). In addition, there are a large number of smaller schemes (< 2 ha) comprising commercial gardens, foodplots and household gardens. Excluded from Table 5.1 is one small scheme in the Free State (QwaQwa). Details of the various individual schemes are provided in the Appendix. Farmer

characteristics, including personal, socio-economic and socio-psychological factors are also documented in the separate Appendix to this Discussion Paper (Bembridge, 1996).

Table 5.1 Small-scale farmer irrigation schemes in South Africa, 1996

Province	No. schemes	Area irrigated ha	No. farmers	No. food plots	No. commercial	Main commodities
Eastern Cape	25	9 460	7 365	3 752	2 613	Maize, vegetables, citrus, lucerne
Western/Northern Cape	5	487	1 004	905	99	Vegetables, deciduous fruit, lucerne
North-West	20	3 874	880	342	538	Wheat, cotton, vegetables, maize, lucerne, fruit
Northern	102*	19 895	7 425	310	7 115	Maize, vegetables, groundnuts, wheat, cotton, citrus, fruit
KwaZulu/Natal	33	8 341	18 745**	17 190	1 555	Sugar-cane, maize, vegetables
Mpumalanga	17	5 429	1 689	740	949	Sugar-cane, vegetables, fruit
TOTAL	202	47 486	37 108	23 239	12 869	

* Includes 22 schemes (5 257 ha) not yet settled

** Details of farmers on 14 schemes not available

Twenty-two (22) irrigation schemes, comprising 5 257 ha in the Northern Province, have not yet been settled. These schemes offer a potential to settle small-scale farmers, as well as to provide irrigation for food plots aimed at food security.

5.6.3 Characteristics of scheme participants

With few exceptions, there has been no selection of participants on small-scale irrigation schemes on the basis of farming and entrepreneurial ability, or trainability.

The main demographic profile of communities participating in small-scale irrigation schemes is a high population growth (2,8% per year), an unequal age/gender distribution in the productive age groups (20 - 50 years) and a high dependency ratio. Farming and other household activities, particularly on the smaller units, are increasingly left to women and older men. In the case of small-scale "commercial units", the larger the unit, the greater the

preponderance of male participants. Women play a crucial role in all schemes particularly in weed control and harvesting operations.

Age distribution among scheme participants tends to be skewed towards the upper age groups. Approximately 60% of participants can be regarded as illiterate. This is a particular disadvantage of some of the larger schemes, where many participants are unable to interpret financial statements.

Although irrigation farming has contributed to household food security and income, household incomes were in most cases well below minimum subsistence levels. On some of the larger "commercial" schemes such as Makhatini in KwaZulu Natal, Taung in the North-West Province, and Ncora in the Eastern Cape, farmers carry high debt loads and not more than one in four showed a profit from irrigation farming. A general conclusion is that with the exception of sugar-cane farmers in Mpumalanga and KwaZulu Natal, and certain fruit farmers, income from irrigation farming has been disappointingly low. The viability of many schemes becomes questionable.

A major constraint throughout many of the small-scale farmer irrigation projects is the lack of strong local organisations and leadership, which in turn leads to low levels of participation.

Lack of good management, particularly at project level has undoubtedly been the major cause of poor performance on a large number of projects.

5.6.4 Evaluation of small-scale farmer schemes

A recent survey of small-scale farmer irrigation schemes indicates that successful small-scale farmer irrigation schemes depend on integration between technology, management, participants and the socio-economic situation (Bembridge,1996).

Some major problems and issues identified in the small-scale farmer survey are as follows:

- Except for some of the sugar-cane projects in KwaZulu-Natal and Mpumalanga, small-scale farmer irrigation schemes are almost invariably dependent on the Government for technical and financial assistance, as well as for advice and training.

- Despite huge investments, the performance of most small-scale farmer irrigation schemes has been poor. Exceptions are some of the sugar-cane schemes in Mpumalanga and KwaZulu-Natal, as well as Tyefu in the Eastern Cape. There have been technical, engineering and organisational failures. The engineering failures led farmers to distrust the reliability of water on offer. However, poor scheme management was the major cause. Other schemes operated unsatisfactorily due to a combination of social and technical factors: They were either subject to poor maintenance or there was conflict between communities mutually, or between communities and project management. There was also a large element of non-accountability: Generous farmer support packages ensured the continuation of many projects, even though these packages caused farmers to accumulate large debt loads. A large gap exists between the level of technology and the level of performance on many projects.

- The history of small-scale farmer irrigation schemes in South Africa has not been one of participation by, or consultation with, the supposed beneficiaries. Except for the sugar cane schemes in Mpumalanga and KwaZulu-Natal, there have been no formally constituted water user associations or similar local organisations: Although farmer liaison committees do exist on many of the larger schemes, they lack strong leadership and managerial competence. Feedback from various schemes showed participants' level of satisfaction to be generally low, due mainly to lack of incentives and security in terms of land tenure, standardised size of units, a lack of credit, limited and expensive inputs, poor market access and insufficient extension services.

- Large-scale irrigation projects for small-scale farming have been imposed and conceived essentially on the basis of civil engineering and crop technology criteria, and without adequate knowledge of other production and socio-economic parameters.

- The present irrigation land allocation and tenure system undoubtedly has an inhibiting effect on smallholder irrigation development, particularly on commercially oriented schemes. Farmers on the larger "commercial" irrigation units invariably perceive the need for individual land ownership, which will provide security and incentives, and where market forces can operate and land change hands. This will allow the more efficient farmers to consolidate land units into viable farming propositions, and provide collateral for inputs and credit.

- The Government Green Paper on land reform suggests that local communities should decide on the best form of tenure to meet their needs. It should be recognised that any land reform programme has to take into consideration the views of households without irrigation rights, as well as non-agricultural issues, such as urban security of tenure, and old age security. These issues may well cause local conflicts of interest.

- Besides the problem of security of tenure, the large Makhatini, Ncora, Qamata and Taung projects have been ineffective mainly because of inadequate decentralisation of power and responsibilities, and non-accountability on the part of decision-makers. The project participants have, over the past two decades, developed serious misgivings about their ability to manage their own affairs. This has resulted in farmers depending on Government or government-appointed management agencies for the operation and maintenance of projects, resulting in inefficiency and cost-ineffectiveness. The top-down bureaucratic approach tends to discourage grass-roots initiative and endeavour.

  This type of development was based on the mistaken assumption that technological innovations *per se* would be sufficiently attractive to automatically stimulate farmer participation. Farmers were simply left out of the planning, design and implementation phases. They were not sufficiently informed as to what their future role in the operation and maintenance of the project was to be. Farmers tended to perceive agricultural inputs and services as more important to them than the irrigation system's effectiveness. Farmers' perceptions have been affected by the "benevolent autocratic" style of management applied on most irrigation systems. This resulted in overdependence of farmers on government and other management agencies.

- Economic analysis was beyond the scope of the survey. In any event, although the existence of secondary social and other benefits renders realistic analysis of individual projects difficult, it is rather unlikely that on present performance, most schemes can be justified purely on economic grounds. Where data exist, total gross margins on most schemes were shown to be poor. As might be expected, farm surpluses were low on the smaller farming units. Irrigation development based on high-return cash crops can yield returns close to those of non-agricultural investments.

- Small pump schemes with windmills on boreholes and rivers play a very important role in augmenting food production through small foodplot irrigation schemes. Lack of maintenance of pumping equipment however poses a problem. In many instances participants perceive this as the responsibility of the "Government".

- On many projects the use of centre pivots and sprinklers has proved not only costly, especially for the cultivation of low value crops, but also unsuitable for small-scale farmers due to poor maintenance, damage and theft. Research has shown well planned gravity irrigation on-field systems to be at least as efficient, and certainly more economic, than centre-pivot, sprinkler or drip systems.

- The lessons of collective experience of small-scale farmer irrigation schemes in South Africa make it necessary to break away from past policies to embrace a new balanced approach. The new approach needs to be comprehensive and participatory, aimed at alleviating poverty and increasing economic production of food and cash crops, as well as being environmentally sustainable.

  Local communities need to be consulted to ensure stability of both agricultural production and the environment. The role of women on foodplot schemes is particularly important.

(See Appendix for more detail.)

5.7 OTHER IMPORTANT IRRIGATION POLICY CONSIDERATIONS

5.7.1 Stability of water deliverance and use

South African rivers are subject to variable and unstable water flow between seasons and years. In hydrological regions with large urban concentrations, e.g. the Vaal River, the smaller variation in non-agricultural water demand causes the availability of irrigation water to fluctuate even wider, thereby inducing large financial risks in irrigation farming.

Three strategies can be employed to reduce these risks:

- subjecting all new development regarding water storage to sound economic and financial analysis;
- phasing out subsidisation, which is often counter-productive; and
- designing institutions which will allow reallocation of water to its most efficient use as conditions change.

The most promising way to achieve these strategies will probably be voluntary transfers in reaction to economic incentives. This implies a market in which water use rights can be transferred voluntarily between willing buyers and sellers. Changes in historical water policy, and certainly also in the Water Act, will therefore have to be effected.

5.7.2 Decision support for private enterprise

Many managers of small-scale farmer irrigation schemes are well versed in the technical aspects of irrigation, but lack the social and communication skills that are necessary to effect integration of scheme participants into the decision-making, operation and maintenance of the scheme. Farmers tend to rely too much on Government and other agencies to assist in their farming operations. On most schemes the relationship between farmers and project management is that of customer and supplier. Farmers tend to perceive management as an external organisation rather than part of a project team. There is a clear need to move towards a more participatory consultative approach to project management concurrently with

training of managers, extension workers and participants.

Extension services have traditionally been weak in the small-scale farming sector and not well oriented towards irrigated agriculture. There is a dire need to train extension workers in irrigation methods, crop technology, farm management recording, as well as in communication skills in transferring knowledge and technology to farmers with low levels of literacy. Literacy training should, where necessary, be part and parcel of agricultural training and extension.

A critical factor in sustained irrigation development is trained local leadership and effective local organisations. With the exception of sugar cane schemes in Mpumalanga and certain parts of KwaZulu/Natal, there is a general lack of effective local level organisations and leadership trained to a level to take on responsibility of certain operational and maintenance tasks on irrigation schemes. There is not only a need for leadership training, but also for policies which will give local organisations the necessary powers and status to participate effectively in the management of irrigation schemes.

5.7.3 Security of tenure and the ability to expand

Because of the scarcity of water and the intricacies of irrigation farming, it should be able to draw the best managerial farming talent in the country. It should be an attractive proposition to such people. Therefore, opportunities in irrigation farming must be able to compete with those in other occupations. This implies an ability to build on success by expanding operations. It also renders security of tenure vitally important. Private tenure is needed. Traditional communal tenure has a lack of breadth in rights, particularly in the right of exclusion. It does not appear uncommon to have other people's livestock trespassing on small irrigation farmers' fields without the latter having efficient recourse to legal means for compensation or prevention of repetition. Under such a system, individual farmers' security is severely restricted. The irrigation farmer must be able to reap the benefits of improvements to land; property rights must be secure and expropriation or other dispossession should occur only with full and just compensation at market value. On the other hand, a farmer who rents land must be safe from unjust and unfair termination of lease

and unjust increases in rental rates. Some legislation is indicated in this respect.

5.7.4 Land tenure

Land tenure revolves about the way of holding land rights. Because of the high degree of individualism needed to manage irrigation farming, individual tenure is certainly needed; the irrigation farmer must have the ability to make all the important production decisions on his own, and he must have the right of exclusion for the whole year.

Individual user rights do not automatically imply that the farmer has to own all or some of the land he farms. A factor that influences the relative benefits of ownership and tenancy is the solvency ratio of the farmer. A farmer with very limited capital is better off renting land.

A "ladder" of tenure, similar to the system followed in the settlement of poor white irrigation farmers earlier this century, holds promise for the settlement of new farmers now and during the next two or three decades. That system involved a trial period of ten years to ensure that those in irrigation were people who would be able to manage.
(See Appendix for more detail.)

5.7.5 Research and farmer support

Research must develop systems that are best adapted to the natural, economic and social conditions in South Africa. Being a relatively small and non-wealthy country, South Africa must concentrate on adaptive and applied research. This will require highly trained, able and motivated research personnel, with irrigators and irrigation communities being closely involved.

5.7.6 Use of public funds for water system development

Water system development, e.g. new storage and reticulation systems, become increasingly expensive to construct and maintain as demands increase relative to water availability. Such

development can create a severe strain on public finance and has to compete with other fiscal demands.

It is therefore vitally important to subject any new proposed development to thorough feasibility studies that encompass the financial, economic and social benefits and costs before any decisions are made and action is taken.

A systematic procedure must be followed for the purpose of policy advice on investment of public funds in irrigated agriculture. It is essential that this multi-disciplinary, professional input be made by considering the total environment affecting decisions and actions by executive government authorities. In the case of each scheme, quantifiable goals, resource limitations and alternative application of funds must be considered on farming, regional and macro-economic level.

The process starts with a policy problem statement and ends with a political decision. Therefore, for the purpose of incremental policy-making, the politically relevant facts of the issue must be clearly identified. Public participation and involvement must be achieved through negotiating forums in resource management districts of catchment areas. A number of phases of investigation follow, of which the detail of information depends on the specific circumstances. In general, three types of feasibility studies must be performed:

- Technical and financial feasibility of representative farms.
- Impact analyses of mainly a fiscal, social and ecological nature.
- Economic and social benefit cost analyses.

Performance of feasibility studies requires capacity building within government departments and by private consultants. Co-operation by local, provincial and central government authorities is also necessary for the systematic initiation, analysis, planning, acceptance, execution and monitoring of projects.

Finally, all investigations and reports must be transparent and debated in public. This necessarily requires official accountability by administrative and political office-bearers in both the executive and legislative authorities (Backeberg, 1994).

PRIORITIES

- The importance of irrigation development to South Africa's economic and social life must be recognised and understood.

- The importance of small food plots for sustenance of poor rural people must be realised, and these food plots must be persevered with for purposes of rural food security. National food security and economic progress require maintenance of existing commercial irrigated agriculture and the emergence of a new group of commercial farmers from former subsistence-oriented small irrigators.

- Plot sizes of commercial units must be large enough to be viable. Those farmers who have the ability must be able to expand by either buying or renting more land and/or water. If this does not happen, irrigation farming can expect a managerial drain.

- The above can be possible only if tenure allows for tenurial security and for individual decision-making. The intricacies of irrigation farming dictate individual tenure. Young farmers who lack capital must be able to rent rather than buy land. The security of both land owner and tenant must be guaranteed.

- Special inputs are needed for the extension and training of irrigation farmers. Where necessary, this should include literacy training. Training should include both the technical aspects of irrigation and financial/economic aspects. Accountancy/bookkeeping and marketing training are as important as technical training.

- Research should concentrate on appropriate technology which under present South African conditions will involve capital and water saving technology that absorbs labour.

- On irrigation schemes where top-down management has been practised, this has to be converted to participatory management styles.

- Subsidies on capital and irrigation water are to be phased out and eliminated as being counterproductive. Subsidisation of training and, for a limited period new farmer settlement and labour employment, may constitute better use of public funds.

- Reallocation of water, for example to higher value crops, or to more productive farmers, will in many cases improve water use efficiency. The market is the most efficient mechanism to effect such reallocations.

- As poor transport and communications infrastructure prevents many areas from achieving the desired levels of irrigation farming (particularly in the erstwhile "homelands"), such infrastructure development should, together with education and health services, constitute top priority uses of public funds.

- Rehabilitation of existing schemes should in most instances have preference over new water infrastructural development in the use of public funds. All future use of public funds should be the object of careful scrutiny regarding technical and financial feasibility, fiscal, social and ecological impact, as well as economic and social costs and benefits.

CHAPTER 6

LEGAL FRAMEWORK AND INSTITUTIONAL ARRANGEMENTS : PRESENT SITUATION AND PROPOSALS FOR THE FUTURE

6.1 CONSTITUTIONAL ARRANGEMENTS

The existing constitutional arrangement in the Republic of South Africa at the time of writing is a three tier government structure, as set out in the Constitution of the Republic of South Africa. The finale Constitution has not been certified by the Constitutional Court.

If the Constitution is referred back to the Constituional Assembly, then there are various possibilities. As far as agriculture, irrigation, water and land are concerned, the different possibilities will have nearly the same implications. This part ot the document is so structured, that it caters for all (or at least most) of the possibilities.

6.1.1 The first tier, the national government

The parliament on national government level has the power to make laws for the Republic, although it is restricted as far as those matters which are reserved for the legislatures of the nine provincial governments are concerned. The executive authority vests in the president. He or she appoints the necessary ministers to form the cabinet together with the president and the executive deputy president. Each minister is accountable to the president and parliament for the administration of his or her portfolio.

6.1.2 The second tier, the nine provincial governments

The Republic of South Africa is divided into nine provinces, each with its own legislature. These legislatures are competent to make laws for their provinces with regard to matters which fall within the functional areas as specified in the Constitution. A law passed by a provincial legislature prevails over an Act of Parliament, except where among others it is necessary to pass a law at national level for the maintenance of essential norms or standards.

A province has executive authority over all matters in respect of which such a province exercises its legislative competence and matters delegated to it by a law of Parliament. The executive authority of a province vests in the premier of that province. He or she appoints members to serve with the premier on the Executive Council. Each member of the Council is accountable to the premier and the provincial legislature for the administration of his or her portfolio.

6.1.3 The third tier, all the local governments

One of the duties of the different local governments is to make provision for access by all persons residing within its area of jurisdiction to potable water.

6.1.4 Who regulates which functional areas?

The provisions dealing with the powers of national and provincial governments effectively mean that the national government and the different provincial governments should decide which of them should regulate or administer certain elements of the functional areas for which the provincial governments are responsible. This necessitates a constructive partnership between the national and provincial administrations.

The functional areas *water and land* are not the responsibility of the provincial governments, although certain aspects related to water and land fall within their area of responsibilities. Furthermore, local governments also have legislative powers regarding certain land and water-related functions. Tribal authorities, observing systems of traditional law, likewise perform certain land functions in terms of the powers given to them by indigenous law, as well as by the administrations who operated in the former homeland areas.

On the other hand the functional area *agriculture* and certain elements associated with agriculture are the responsibility of the provincial governments. Therefore, aspects dealing with the overall water resource planning and utilisation are a function of the national government and should be regulated and administrated by the national government. The minister responsible for the overall function of water resource planning and utilisation is the

Minister of Water Affairs and Forestry, who exercises this responsibility through the Department of Water Affairs and Forestry.

No final agreement between the Department of Water Affairs and Forestry, the Department of Environmental Affairs and Tourism and the provincial governments has been reached as to who should regulate water pollution. The Integrated Pollution Control Project will address some of these aspects.

Aspects dealing with land matters are the function of the national government and are to be regulated and administrated by the national government. The responsible minister is the Minister of Land Affairs, who exercises this responsibility through the Department of Land Affairs. The Land Administration Act, 1995 (Act 2 of 1995), makes provisions for the assignment and delegation of powers to the appropriate authorities.

No final agreement has been reached concerning who is to regulate agriculture and land degradation due to water utilisation. The national government will apparently be responsible for national strategies such as marketing standards and norms, while the provincial governments will be responsible for supporting the development of irrigation farming. It is therefore still an open question how and where aspects such as land degradation due to water utilisation and soil conservation will be regulated, on national or provincial level.

A workable compromise should be reached between the national and provincial government on the one hand, and the national and local irrigated agriculture stakeholders on the other hand as far as water resource management and irrigated agricultural policies are concerned. This compromise should be structured according to the provisions of the Constitution of the Republic of South Africa.

6.2 LAND REFORM

The Green Paper on South African Land Policy, released on 1 February 1996, sets out the vision and implementation strategy for a South African land policy that is just, builds reconciliation and stability, contributes to economic growth, and bolsters household welfare.

6.2.1 Land reform programmes

The central thrust of the Green Paper consists of land reform programmes which should address the current land ownership and land development patterns as these strongly reflect the political and economic conditions of the apartheid era. The land reform programmes rest on three principle components, namely land redistribution, land restitution and land tenure reform. The aim of these programmes is to ensure security of tenure for all rural dwellers regardless of the system of land-holding. This is in line with national land policy.

(See Appendix for more details on the different programmes.)

6.2.2 Traditional and tribal authorities

Considerable debate is going on about the role of traditional and tribal authorities in the new South Africa. For many chiefs the commitment to traditional tenure arises from genuine concern for welfare and equity. In their view, they hold land in trust for their people. They allocate the land to people on the basis of *citizenship* and give consideration to equity. The land allocation decisions may not be egalitarian, but pressures to allocate land to everyone means that traditional authorities do have to pay some attention to the land needs of the least influential. Traditional authorities spend considerable time solving disputes, and in some cases, persuading people to manage land properly. Their practices are however often criticised as being corrupt and mercenary.

In the past, traditional authorities and the traditional tenure system provided affordable access to land for a large number of people and a simple and enduring system for administering it. However, within the new socio-political system, account needs to be taken of popular experience and feelings towards the traditional authority system. Attitudes concerning the overall role which should be played by the traditional leaders appear to vary geographically and socially. In many parts of the country, chiefs and headmen have lost legitimacy through a combination of abuse of power, complicity with Apartheid policies and failure to deliver even elementary support services.

At the same time, tolerance of and support for traditional authorities endure even under conditions of adverse experience. This is clearly evident in the diverse conditions of the Northern Province, North West, Mpumalanga, Free State, KwaZulu-Natal and the Eastern Cape.

Within the context of all these differing viewpoints, Government will have to ensure that all people enjoy the same levels of access to the processes of law, equality and all other fundamental human rights enshrined in the Constitution. This will lead to the restructuring of tribal land administrations to the extent necessary in order to ensure that all aspects of it comply with fundamental human rights. The Department of Land Affairs is committed to a process of negotiation with the chiefs and other rural constituencies as to how this can be achieved.

6.3 WATER RIGHTS : THE EXISTING SITUATION

The existing law dealing with water rights incorporates and amends many of the historical developments in water law over a period of about 300 years. It is an amalgamation of some of the legal principles of Roman Dutch Law and English Law, supplemented by rules developed here for the specific conditions of South Africa. It is based on the riparian right doctrine of English Law, which is partially tempered by the re-introduction of the so-called *dominus fluminus* doctrine of Roman Dutch Law.

The existing law dealing with water rights is contained mainly in the Water Act, 1956 (Act 54 of 1956), as amended, and another about 33 other acts deal with rights to use water out of specific water schemes or works or within certain demarcated areas. The Water Act, 1956 is a continuation of the codification of the water law which already started in 1906. The Water Act, 1956 *inter alia* regulates the control, conservation and use of water. The power to exercise executive authority in terms of the Water Act, 1956 and the other 33 acts dealing with rights to use water, vests, according to the President's Minute No 40,dated 30 August 1994, in the Minister of Water Affairs and Forestry.

Water rights are not contained in the Water Act, 1956, as this Act only contains the mechanisms for determining and obtaining water rights. Water rights are contained in various documents, including notices in the *Government Gazette*, schedules for Government water schemes, schedules for irrigation boards, Water Court orders, purchase contracts, deeds of transfer, deeds of servitude, written permissions by the Minister of Water Affairs and Forestry and Acts dealing with specific water schemes, works or areas. For many properties such documents do not exist, so that the water rights should still be determined.

Except in certain parts of the area previously known as the Republic of Bophuthatswana, the provisions of the Water Act, 1956 dealing with water rights are based on two cornerstones:

(a) The first cornerstone is the distinction between two categories of water, namely private water, which for simplicity's sake includes groundwater, and public water: In addition, public water consists of normal flow and/or surplus water. This is mainly due to the influence which Roman and Roman Dutch Law had on the development of our water law.

The main distinction between public and private water is that public water is water flowing in a known and defined channel and is capable of irrigation on two or more pieces of land riparian to that stream, which are original grants. Private water on the other hand, is water that is not derived from a known and defined channel, or if that water is derived from a known and defined channel, then it is not capable of irrigation on two or more pieces of land which are original grants.

The normal flow of a public stream is limited to the maximum quantity of water available in a public stream for beneficial irrigation during peak demand, but without storage, and this is usually during the three to four months immediately preceding the rainy season. Surplus water, on the other hand, is water which can only be used for beneficial irrigation after it has been stored.

(See the Appendix for a more comprehensive distinction between the different categories of water.)

(b) The second cornerstone is a distinction in rights: The right to use groundwater and public water is determined differently for an area which is not declared as a Government water control area and an area which **is** declared as such. There are furthermore no property rights to public water, but only a right for certain persons to use the water subject to certain conditions.

In an area which is not declared as a Government water control area, all the owners of land held under original grants or deeds of transfer, and the sub-divisions of such land, next to a public stream, have common property rights to all the water in that stream and each of them has a right to a share in that water for irrigation and urban purposes. This is mainly due to the influence that English Law had on the development of our water law. However, these rights are restricted, as many mechanisms have been created to allow other persons to obtain rights to use a share of the water.

In an area declared as a Government water control area, the right to the use of groundwater and public water vests in the Minister of Water Affairs and Forestry, subject to the beneficial exercising of certain rights. This is due to the partial re-introduction into our water law of the Roman Dutch Law doctrine *dominus fluminus*.

The rights to private water on the other hand, excluding groundwater, cannot be effected by declaring an area as a Government water control area. An owner of land on which groundwater (in an area which is not declared as a Government water control area) or private water is found, has the sole and exclusive use and enjoyment of such water. It can therefore be argued that there are limited property rights to these waters. This is mainly due to the influence that English Law had on the development of our water law.

(See the Appendix for more comprehensive details on the rights to use the different categories of water.)

A process is under way to review the existing water law and it is envisaged that the new law will come into operation during 1997. As part of this process a document entitled "Discussion Document: Water Law Principles" was released in April 1996. If the principles contained in the document are adopted, then, according to media releases, the riparian system, linking the right to use water to a specific land, will be terminated and the uncontrolled use of groundwater will also cease. The following will apply in place of the existing system:

- All water, wherever it occurs in the water cycle, is a resource common to all, the use of which should be subject to national control. All water should have a consistent status in the law, irrespective of where it occurs.

- There should be no ownership of water but only a right to its use.

- The location of the water resource in relation to land should not in itself confer preferential rights to usage.

- The development, apportionment and management of water resources should be carried out using the criteria of public interest, sustainability, equity and efficiency of use in a manner which reflects the value of water to society while ensuring that basic domestic needs, the requirements of the environment and international obligations are met. Although this does not form part of the principle, the discussion document mentions that "in order that water may be allocated to its most economic use, it may be necessary to be able to transfer water allocations between users. The water law should provide a framework which makes it possible."

- Rights to the use of water should be allocated in good time and in a manner which is clear, secure and predictable with respect to the assurance of availability, extent and duration of use. The purpose for which water may be used should not be arbitrarily restricted. Although not part of the principle, the discussiondocument mentions that "there may be reasons to place restrictions on the time for which a right may be exercised, in other words, rights may not necessarily be in perpetuity."

- Lawful existing water rights should be protected, subject to the public interest requirement to provide for the Reserve. The water required to meet people's basic domestic needs and the needs of the environment should be identified as the Reserve and should enjoy priority of use. Where existing rights are reduced or taken away, compensation should be paid wherever such compensation is necessary to strike an equitable balance between the interests of the affected persons and the public. An existing right should not include a right which remains unquantified and unexercised at the time of the first publication of these principles.

It is not clear as yet what approaches and methods will be followed to implement these principles. Will it for example include the speedy quantification of as yet undetermined water rights and the proper registration of all water rights?

Further, depending on the implementation options, it is possible that there may be no security of tenure of water rights, except possibly for recognised existing rights. This will have an effect on the value of land as water rights are capitalised in the price of land; lack of security of tenure in rights is likely to be detrimental to the economy in general and the irrigated agriculture sector in particular.

Because the new water law will have an effect on existing water rights, it is justified to reconsider all aspects regarding these rights. The existing law dealing with water rights will still be applicable for the forseeable future. It will in the first instance take time to implement a new system and there should secondly be a gradual move away from the old to the new to ensure security: Clarity and predictability of some of these rights should also be protected due to the property clause of the Constitution.

All these rights can theoretically be transferred to other properties or persons. Structures and procedures have been created to facilitate such transfers and also to protect the rights of others. Applications can for example be and are made to water courts for public water in areas which have not been declared as Government water control areas, and to the Minister for private water as well as public and groundwater in areas declared as Government water

control areas. Costs and technical and administrative problems are however often experienced. An effective framework should be created to address these problems, which should be market-related and based on a willing-buyer - willing-seller arrangement. The State should play only a facilitating role and should ensure that the rights of other persons are protected. Such a framework will lead to water conservation and mutual beneficial exchange from lower-valued to higher-valued users and uses. Agricultural production can then be maintained at lower levels of water utilisation, i.e. increased efficiency, while rights to water are reallocated to alternative applications, i.e. improved equity.

The provisions dealing with water rights contain elements of both private and public law. **Private law** regulates the legal relationship between persons who act on an equal footing. The outstanding feature is therefore that the different parties compete on an equal footing. **Public law** on the other hand, includes among others the legal rules that control the relationship between on the one hand, government bodies and government subjects on the other hand, in situations where these bodies act authoritatively. Its outstanding feature is that the body which acts, stands in an authoritative position in opposition to the other party.

Rights to groundwater, to the use of public water in an area not declared as a Government water control area and to private water, all fall within the ambit of private law. On the other hand rights to use public water and groundwater in an area declared as a Government water control area fall within the ambit of public law. The Minister, who has the power to declare any area a Government water control area, or to amend or repeal such a declaration, can therefore force the determination and granting of water rights into the field of private law or of public law.

In the area previously known as the Republic of Bophuthatswana, the provisions of the water law dealing with water rights are based on the doctrine *dominus fluminus*. In general a person needs the permission of the State to use any water, except a certain limited amount of water for domestic purposes.

6.4 DETERMINATION OF QUANTITY OF WATER USAGE, NEEDS AND REQUIREMENTS

Determination of water utilisation, needs and requirements takes place at various levels, for example at international, national, regional, catchment, project and user levels, by various organisations and often by more than one organisation at a specific level. Different rules apply and are contained in different documents for each level. The law does not, except under certain specified circumstances, spell out who should perform this function and how it should be performed. It is mainly a matter of policy and should be done to the best advantage of the Republic's inhabitants, with the allowance for the available water resources and the law dealing with water rights.

For example, determination of the overall water usage, needs and requirements for all the different water users in all catchments at the international and national level is a function performed by the Department of Water Affairs and Forestry. The law does not spell out that the Department has to perform this function and how it should perform it, although it can be read into or derived from various provisions of the Water Act, 1956.

On the other hand, determining the water usage, needs and requirements for a specific user is usually not a function performed by the Department of Water Affairs and Forestry, although the Department can play a role in it or influence the outcome thereof. For example, it is a legislative function of the Minister to determine irrigation quotas for a certain scheme or area, but this is usually done with extensive input from all stakeholders.

6.5 RENDERING WATER SUPPLY SERVICES

Various organisations who are involved in the supply of irrigation water, for example:

- Private irrigators who supply private or public water to their farms, each with its own water works, and at their own cost. Private irrigators can be natural or juristic persons.

- A small group of private irrigators can together supply water to their farms from one or more commonly used and owned water works. This is usually done by way of an agreement that sets out the operational rules for the works and the recovery of costs for operating the works.

- Irrigation boards who supply public water to individual private irrigators within their areas of jurisdiction. In such cases, water works belong to the irrigation boards. Some private irrigators may possibly also have water works in the areas of jurisdiction of irrigation boards.

  An irrigation board may assess rates on the land which is scheduled and assess charges for water supplied or distributed from a water works belonging to the board.

- The Department of Water Affairs and Forestry supplies public water to irrigation boards or private irrigators. In such cases, the Minister constructs Government water works, the water is supplied and distributed from each water works by way of canals or pipelines or by way of releases from a dam into the river. Rules may be made relating to the manner of regulating the flow of water into the river, the abstracting or distribution of water from the river, and the use of water in or from the works.

  The Minister may assess rates on the land which is supplied with water and assess charges for water abstracted, supplied or distributed.

- Water could also be supplied to irrigators from the water works belonging to water boards, water supply and sanitation committees and private water supply companies.

  Rates and charges may be assessed for the water supplied.

(See the Appendix for details regarding the legal framework involved.)

6.6 STEPS TO PREVENT WATER RIGHTS FROM BEING EXCEEDED

The necessary steps should be taken to ensure that a user does not exceed his or her water rights. These steps could also assist in reconciling the water demand and supply strategies. The Water Act, 1956 contains various control measures, tactical options and legal structures to ensure this. Although there are certain shortcomings, these could form the basis of the development of better measures and options.

The legal control measures centre mainly around the following:

- The quantification of the right to use a certain portion of a water resource. (See paragraph 6.3 and the Appendix for the legal framework dealing with the rights to use water.)

- The granting of permission to a person to construct, alter, enlarge or use a water works to enable him to exercise his right to use a certain portion of a water resource. (See the Appendix for the legal framework dealing with the construction, alteration, enlargement or usage of water works.)

The tactical options on the other hand, centre mainly around the following:

- Impoundment control, which consists of limiting and monitoring dam capacities. This option is used among others to protect the run-off to a lower-lying dam or to ensure that the available water is distributed fairly proportionally within a river reach.

- Flow rate control, which consists of limiting and monitoring the yield of water works. This option aims to ensure that under normal circumstances, every user will probably not use more than his legitimate portion of the water available within a river reach.

- Abstraction time control, which consists of limiting or prohibiting and monitoring the time of abstraction. This option aims to ensure that the available water is distributed proportionally within a river reach so that each user will probably not use more than his

legitimate portion of the available water.

- Volumetric control, which consists of installation, regular testing and reading water meters. This option aims to ensure that the water available within a river reach is volumetrically distributed proportionally.

- Irrigated area control, which consists of limiting and monitoring areas which may be irrigated. This option aims to ensure that under normal circumstances every user will probably not use more than his legitimate portion of the water available within a river reach.

The Water Court has the jurisdiction to implement some of these measures and options as far as public water is concerned, but it may only do so on the initiative of the water users concerned. On the other hand, the Minister has the prerogative to implement all these measures and options as far as public water is concerned and almost all of these measures and options as far as groundwater is concerned. This can only be done if it is deemed to be in the public interest or if public water is supplied from a Government water works. The Minister has the discretion as to which criteria are to be used as long as they are uniform for a certain area and recognise water rights that are lawfully exercised. He uses investigations, surveys, electricity usage, flow meters, aerial photography, administrative notices, etc. to implement these options.

As far as private water is concerned, the Minister has the discretion to implement the control measures and tactical options that deal with water works. This may only be done if the Minister is of the opinion that the construction of a water works will result in a reduction in the availability of water in any public stream in an area which is declared as a Government water control area.

An irrigation board or a subterranean water control board may also be established to help with the implementation of the measures and options. (See the Appendix for the legal framework dealing with irrigation boards and subterranean water control boards.)

The State therefore has, subject to the beneficial exercising of certain rights, extensive control over the utilization of public water and also fairly strict control over the utilization of private water. In practice however, problems are experienced in enforcing these measures and options, mainly because of manpower and financial constraints. These issues will have to be addressed, perhaps by using different procedures, e.g. a market process instead of administrative controls.

6.7 LEGISLATIVE PRESCRIPTIONS TO PREVENT LAND DEGRADATION AND WATER POLLUTION

Irrigators should comply with the following control measures in terms of the Conservation of Agricultural Resources Act, 1983 (Act 43 of 1983):

- Virgin soil or land with a slope of more than 20 per cent may be cultivated only with the written permission of the Department of Agriculture.

- Cultivated land should be protected against excessive soil loss as a result of erosion through the action of water and wind.

- Irrigated land should be protected effectively against waterlogging and salination.

- Vleis, marshes and water sponges may be drained or cultivated only with the written permission of the Department of Agriculture.

- Land within the flood area of a water course or within 10 metres horizontally outside the flood area of a water course may be cultivated only with the written permission of the Department of Agriculture.

- Run-off water may be diverted from one water course to another only with the written permission of the Department of Agriculture.

In terms of the Conservation of Agricultural Resources Act, 1983, control measures may be prescribed relating to the irrigation of land and the protection of the water resources against negative effects arising from activities.

In terms of the Water Act, 1956 it is an offence to pollute water in such a way as to render it less fit for the purpose for which it is ordinarily used by others, for the propagation of fish or other aquatic life or for recreational or other legitimate purposes.

The Fertilizers, Farm Feeds, Agricultural Remedies and Stock Remedies Act, 1947 (Act 36 of 1947), *inter alia* regulates or prohibits the importation, sale, acquisition, disposal or use of certain fertilizers, farm feeds, agricultural remedies and stock remedies. The Act does not regulate the usage of these products.

The efficacy of these measures is sometimes regarded as doubtful.

6.8 UPSTREAM AGRICULTURAL AND FORESTRY ACTIVITIES THAT IMPACT NEGATIVELY ON DOWNSTREAM WATER AVAILABILITY

6.8.1 Activities affecting stream flow

Some intensive to semi-intensive agricultural and forestry activities can have profound effects on stream flow and the availability of water downstream for irrigation, domestic, industrial and conservation purposes. This problem is larger (in terms of water quantities) than has been accepted traditionally. The traditional water law approaches have furthermore not given much attention to such water usage, since it represents water which has not yet reached streams or subterranean aquifers. In legal terms, it is private water.

It has however become clear that large consumption use of water upstream can seriously damage the interests and livelihood of downstream users.

The main agricultural and related activities that can have such effects are the following:

- Farm storage dams, water of which is used largely for limited irrigation or for livestock.
- Rainfed production of crops requiring and using large quantities of water.
- Commercial afforestation with forestry species requiring and using considerably more water than would be used by natural vegetation.

While the water-reducing influence of farm storage dams does not appear to be of particular significance, it could, if expanded considerably, pose problems. The cost of constructing enough such dams as to pose serious problems may however act as an impediment to its becoming a serious problem in South Africa.

Rainfed crop production appears to have been a more serious flow-reducing activity than farm storage dams. With present knowledge, however, it appears doubtful whether many dryland crops would have a serious influence: Their total vegetative mass and leaf surface appear to be too small, and their duration of evapotranspirative water use per year too short, to exercise a serious problem per unit of area. This includes South Africa's major grain, oilseed and legume field crops.

The situation is different with respect to sugar-cane, which is widely grown under dryland conditions in KwaZulu-Natal and in a part of Mpumalanga. Sugar-cane is a perennial crop, usually with a dense plant population and large leaf surfaces. Depending on rainfall, its water consumption appears to vary around 7 500 m^3 per hectare. This can obviously have considerable detrimental effects in terms of reduced river stream flow and reduced availability of water for downstream users.

Afforestation has increased considerably over the past few decades, and has been accused of reducing stream flows considerably. Empirical examples are presented in the Appendix.

One main difference between land uses is that discussions involving water rights and legislation have been rather discriminatory with regard to forestry in comparison to rainfed field crop water usage, including sugar-cane. No special legislation has been drawn up with respect to water usage by rainfed crops while forestry has been the subject of some special attention.

6.8.2 Legal aspects concerned with forestry water usage

Commercial afforestation has since 1972 been subject to the Afforestation Permit System (APS). The relevant legislation was an amendment to the Forest Act 1968 (Act 72 of 1968) and has since been incorporated in the Forest Act, 1984 (Act 122 of 1984) (Kentridge, 1995).

Kentridge (1995) notes that: "The Water Act No 54 of 1956 is concerned, *inter alia*, with the 'control, conservation and use of water for domestic, agricultural, urban and industrial purposes'. The provisions of the Act apply to foresters as they also do to other water users. It should be noted, however, that no water supply infrastructure is required for afforestation. Forestry plantations tend to be located in the upper regions of catchments where they intercept rainfall and draw on soil and groundwater. It is precisely because they have the natural ability to make preferential use of existing water supplies that nearby forestry plantations are often the focus of the resentment of other water users. The impact of afforestation on water supply is dealt with in the Forestry Act rather than in the Water Act. It is strongly arguable that any new system of water resources control affecting foresters should be located in the Water Act, and should apply equally to other water users."

The APS presents some problems of its own. Initially permits were granted for five years and these could be renewed thereafter. In practice renewals were almost automatic (without new investigations) and rarely refused. Lately however, renewals have been granted only upon application, and inspection is required. The time span of permits has been reduced to 3 years. Kentridge (1995) further notes that: "The cycle set in motion by the inception of new afforestation outlasts by many years the period of the permit. The very minimum period in the life cycle of a forest plantation is 8-10 years. Long-term cropping extends over a period of 20-25 years. Over such a period of time, changes to environmental factors, in

particular the water table, can be dramatic. Moreover, the effect of such a plantation will be determined in large measure by the kind of tree which is planted. Hence it is necessary that the Government should have the power to remove trees if the exigencies of water conservation or distribution demand this. Of course, such a power has an enormous impact on the forester in question. The economic implications of ordering the removal of a timber plantation, or even of certain strips of trees can be dramatic."

"It is preferable that planting should not be undertaken in the first place rather than be removed at a later stage. Priority should therefore be given to reviewing existing licences and scrutinising all new applications for afforestation permits".

"The scientific understanding of the impact of afforestation on run-off has increased significantly since 1972. It is now understood that run-off figures may be affected by the type of tree that is planted, as well as the methods of cultivation which are employed. It has also become clear that the effect of afforestation on available water resources cannot be appreciated without taking into account the effect of afforestation on river flow regimes".

Decisions regarding forestry permits and thus water use by forestry are administrative decisions, made by bureaucratic entities. In South Africa, water is a scarce resource. Its optimum use requires equivalent marginal returns and utilities in forestry, agriculture, urban and all other uses in an intertemporal space. Research on such optimal allocations will be both very complicated and rather speculative. If maximum welfare is the goal, another approach has to be explored. Water rights markets present themselves as a possible solution.

6.8.3 A principle for consideration

While the attention given to the streamflow-reducing, consumptive water use of forestry is certainly not unwarranted, the legal and other distinctions between forestry and other agricultural activities with similar effects are certainly not justifiable. It should be remembered that these water uses, as all others, consume a scarce resource - water. Ways must be sought to equalise the basis on which all water users, both up- and downstream are treated. Upstream and downstream users compete for rights to the same water.

6.9 ALLOCATION OF WATER AND WATER RIGHTS: THE POTENTIAL ROLE OF THE MARKET PROCESS

6.9.1 The potential usefulness of water markets

South Africa is a country with limited water resources and very few opportunities of enhancing water supplies economically by building new water works. Such development will also be very costly. However, there is substantial opportunity to ease the pressure of water scarcity by eliminating waste and improving the efficiency of water use.

The theory is clear and fairly simple: wherever water is used, it should be done efficiently and without waste. Water should be allocated in such a manner that the marginal value or utility of the last unit of water is equal for all uses at all places. However, attainment of the optimum is in practice much more complicated than in theory.

Water allocation can be done by either of two institutions (Cummings & Nercessiantz, 1994):

- A decentralized institution wherein all users obtain the resource in a competitive market. Competitive forces result in a market price that reflects the relative scarcity of the resource. Barring market failure, this process is expected to equalize marginal values and utilities.

- The second possibility is a centralized institution wherein the resource is controlled by a central manager who knows the scarcity value of the resource, as well as its marginal values and utilities, and distributes water in such a way that total utility is maximized. In theory, if the manager has perfect knowledge and insight, the ultimate allocation of resources will be identical under the two institutions, with the latter probably costing much more.

The main problem with a centralized institution is that if it has to achieve an optimal or near optimal situation, it requires giant allocative models that have not been successfully developed anywhere in the world. Such a model can hardly be constructed satisfactorily -

it will by necessity (or rather conveniently) contain too many subjective elements. In addition, decisions to change allocations or to increase water tariffs are often likely to spur on resistance and agitation, with the result that decisions may become vehicles of political patronage and convenience rather than efforts to maximize the public welfare.

Water markets are an institution in which water rights are exchanged between willing sellers and willing buyers. Such markets can be formal or informal. Two major strengths are claimed for water markets (Cummings & Nercessiantz, 1994):

- Under ideal conditions unfettered markets will result in allocation of water rights that are economically efficient, resulting in water being placed in its highest value uses.

- Water markets can eliminate shortages, lead to efficient pricing and limit distributional conflicts.

Even where water markets exist the State must be involved in a regulatory capacity. Firstly, private transactions in water or water rights hardly take place under conditions of pure or perfect competition. There are possibilities of monopolization and/or coercion, and these have to be regulated by the State. Secondly, the State has a duty to see to it that the poor get water for their needs and enjoyment.

The answer may be a market for water rights, subject to government control and regulation.

6.9.2. Prerequisites for successful water markets

Certain prerequisites must be met for water markets to be successful. A brief list, some taken from Simpson (1994), follows:

(1) **Water rights.** There must be a clear title to the water to be traded. The title must be readily understood, in measurable units and recorded in such a way that there can be no dispute concerning ownership and the nature of ownership. (The Appendix gives examples of some types of rights that can exist.)

(2) **Quantification.** Water must be quantified in some term or other, e.g. cubic metres or rate of flow for a set period. The measurement system must be fair and readily comprehensible to all interested parties.

(3) **Institutional requirements**. Rights and titles must be secure, enabling Government or preferably courts to have jurisdiction over transactions. This requires fair administration and proper description of rights, e.g. in deeds offices. In most areas with free water markets, water rights are still administered by government agencies.

(4) **Infrastructure.** Water markets can be instituted only in areas where water can be delivered, thus either where the water occurs naturally, e.g. in catchment areas, or where the necessary infrastructure e.g. dams and canals exists.

(5) **Third-party effects.** Third parties may be influenced by water transactions, and the necessary structures therefore have to be in place to handle complaints efficiently and fairly. Three mechanisms are possible, and may operate alongside each other, namely judicial review (eg. water courts), government intervention and voluntary resolution.

(6) **Regulation of unfair practices.** This is a normal government duty in economic and social life and it should also be part and parcel of water markets. Monopolistic practices will in particular have to be guarded against.

6.9.3. International experience with water marketing

Water markets have successfully operated, sometimes in different shapes, in a number of countries. Some of these are described by Deiniger (1994).

In the Huerta of Anlance in Spain, water is delivered and paid for by volume. The allocative mechanism is a weekly auction, in which tickets for the right to take a fixed flow from canals for a certain amount of time are auctioned.

Water trading is quite widespread in California. Farmers contract to buy a certain quantity of water before the crop season, and are obliged to pay for their full purchase, irrespective of whether they use it or not. Irrigation districts, in turn, contract to buy water, based on their members' demands.

In the Punjab/Haryana region in Northern India, farmers found it inefficient to depend on scheduled water deliveries. They have solved this problem by trading turns to obtain water in an informal market.

Chile has probably moved furthest in the direction of water marketing. This was part of a movement away from the highly controlled, centrally managed and very inefficient economy which had characterized Chile by 1970.

Chile's goals with water policy are certainly not unique, but what is unusual is that it was decided to solve allocation problems by a market mechanism. Chilean water law now ensures secure water rights that are both transferable and tradeable. The most common form of these rights consists of rights (shares) to a variable flow or quantity. An owner has a right to a limited number of shares at a certain location. These rights are traded, while third parties are protected by law.

There are various types of rights: While water is a public goods, individuals can have private rights, which are categorized into a few groups.

- Consumptive or non-consumptive rights;
- Permanent, contingent or discontinuous rights; and
- Alternating rights.

Urban water use rights have been transferred to companies which have the national, regional, and municipal governments as shareholders together with private persons, with the State playing a regulatory role to prevent monopolistic practices such as have lately been witnessed in Britain.

Transfer of water rights need not be of a permanent nature; as with land, leasing or renting is a distinct possibility. In Chile, the most frequent water transaction is a form of renting in which the owner rents a portion or all of his or her water, usually for a fairly brief period, possibly only hours. This can take place between farmers in the case of a short-term water crisis and this often happens without any formal legal arrangements (Gazmuri, 1994; Le Moigne *et al*, 1995).

6.9.4. Relative advantages of water markets and administrative water allocations

Water markets and administrative allocations can be compared with each other in terms of a few criteria (Howe *et al*, 1986; Le Moigne *et al*, 1995 Winpenny, 1994), namely flexibility, security of tenure, whether real opportunity costs are considered by users, predictability, equity, political and public acceptability, efficacy and administrative feasibility. These will be briefly reviewed.

6.9.4.1 Flexibility

Flexibility in the allocation of existing supplies refers to the ability to shift the resource between uses, places and users and changes in demand. This is necessary to equate marginal values and ulilities. Water markets are superior to administrative decision-making in this respect.

6.9.4.2 Security of tenure

Security of tenure for established users is important to draw the desired type of farmers, and also to provide farmers with an incentive to make the necessary investments and to take the necessary measures to use water efficiently.

In this respect, water markets are superior to administrative decision-making: Irrigators certainly do not wish to feel constantly threatened by the possibility of reduced rights.

6.9.4.3 *Real opportunity cost*

Users should consider the real opportunity cost of a resource in order that it may become possible to also cope with other demands and externality effects (eg. environmental uses). This will also direct employment of the water resource to its highest alternative values. Le Moigne *et al.* (1995), after reviewing practices in a number of countries, concluded that water markets outperform administrative decisions in this respect. The administrative option often leads to large-scale subsidization, often not of those in need, but rather of those wielding political power. This has happened over time in South Africa (Backeberg, 1994).

6.9.4.4 *Predictability*

It is necessary to be able to predict the outcome of the allocation process in order to minimize uncertainty and therefore also transaction costs. Water markets are superior in this sense.

6.9.4.5 *Equity*

The allocation process should be perceived as providing equal opportunities for all prospective water users. Administrative allocations are superior to water markets in this respect.

6.9.4.6 *Political and public acceptability*

Political and public acceptability will differ among countries. In South Africa, administrative decision-making presently appears to be politically more acceptable, mainly because of considerations of equity, mainly resulting from a discriminatory past, and because of lack of experience with water markets.

6.9.4.7 *Efficacy*

Efficacy refers to the ability of water allocation to change existing situations and to drive

towards policy goals. Administrative allocations are more conducive to efficacy than water markets.

6.9.4.8 Administrative feasibility and sustainability

Administrative feasibility and sustainability refer to the ability to implement and administer allocations and to institute the necessary changes. It also refers to administrative costs. In this respect, water markets do better than administrative allocations.

6.9.5 Benefits summarized

The relative benefits of water markets and administrative allocations are summarized in Table 6.1.

Table 6.1: Relative benefits of administrative water allocations and water markets

Criterion	Water markets	Administrative allocations
Flexibility	ü	
Security of tenure	ü	
Real opportunity cost	ü	
Predictability	ü	
Efficiency	ü	
Equity		ü
Political and public acceptability		ü
Efficacy		ü
Administrative feasibility and sustainability	ü	

ü = superior performance

6.9.6 The best choice. The best of two worlds

South Africa can potentially have the best of two worlds by adopting a policy that combines the merits of water marketing and administrative allocations while avoiding the deficiencies of both.

Water markets can be introduced on a catchment area basis, both for surface and groundwater. This should also be done in terms of the use of water in such a manner that stream flow is diminished.

The first step will be the compilation of an inventory of existing water use, potential water use and water needs.

The next step will be specification of water rights, including specification of who can hold water rights, eg. individuals or firms in the case of agriculture and forestry, municipalities (rather than individuals) or utility companies in the case of urban uses, and in some areas, communities rather than individuals.

The next step will have to be an administrative allocation decision among uses and users. This has to be done at the highest level with full knowledge of the Minister of Water Affairs and Forestry, since this will partially be a political decision for which he or she will eventually bear the responsibility. At this stage considerations such as equitable access to water, restitution and considerations of future development ought to be addressed once and for all. This step is bound to be time-consuming, and difficult decisions, some of a subjective nature, will perforce have to be made. Thus will the weaknesses of water markets concerning equity, efficacy, and administrative feasibility and sustainability be addressed.

A following stage, after the allocation stage, will be registration of water rights, possibly in deeds offices.

At this stage, the Government will have to lay down the rules regarding how trading is to be done, and what limits it prefers to place on such trading. There may, for example, be limitations on the sale of poor communities' water rights, while still allowing lease. There should be safeguards against monopolization. Measurements should be specified which may be volumetric or in some cases, eg. forestry, based on area and species of tree.

The best alternative appears to be a water market subject to a limited but well-specified degree of government regulation.

6.10 WATER SUPPLY PRICING

6.10.1 *Water pricing and capital values of land and water rights*

The subsidization of agricultural inputs, including water, has been a world-wide phenomenon. In a survey of 13 developing and five developed countries, Tsur & Dinar (1995) found that water pricing did not fully recover operation and maintenance (0 & M) costs in any of these countries; in some countries, eg. Egypt and Indonesia, cost recovery contributed nothing to O & M costs. Water cost recovery contributed towards capital costs in all five developed countries and in only three of the developing countries. South Africa has also for long followed the policy of subsidizing water to both commercial and subsistence agriculture (Backeberg, 1994).

The effects of subsidization on capital values should always be kept in mind. It has been convincingly shown that subsidization of inputs such as interest, capital goods, fertilizers, transport and water becomes capitalized in land values, and that such subsidization did, particularly in the 1960s and 1970s completely distort the agricultural land market in South Africa (Van Schalkwyk, 1995).

The higher the rate of subsidization of water delivery rates, (thus the lower the price charged for water use), the higher is the degree of capitalization in capital values consisting of land and water rights. This means that a landfall profit, consisting of capital values, lands in the lap of the present owner. This represents a welfare transfer from the rest of the economy, and in particular the taxpayer, to the recipient. However, since future farmer generations have to acquire the land on which to use *inter alia*, water resources, this also represents an extremely inequitable cost to these future generations. If they do not inherit such overvalued capital assets, they have to purchase the land at overvalued prices. It therefore also represents inequitable distributions within the same farmer generation.

In South Africa water rights have long been linked to land: One has to possess a certain tract of land to be entitled to a certain share of the available water. This has created the anomaly that although water resources are scarcer than land, subsidies and scarcity values have

become capitalized prices of land, and not of water (Backeberg, 1996).

Separation of the title and registration of land and water rights will cause the total capital value to the divided between land and water rights. Water rights will assume a value of their own, and land values will decline by approximately the value that is linked to water rights. This will enhance the opportunity (a) to compare the value of water rights to present use, and (b) to transfer water rights from low-value to high-value uses (Backeberg, 1994 & 1996; Tregarthen, 1977; Anderson, 1983; Saliba & Busch, 1987; Paterson, 1989). Individual decision-makers will also be able to exchange water rights voluntarily, legally and efficiently (with the lowest possible transaction costs) through negotiated transactions between willing parties.

Thus, if water pricing is to be optimal, water delivery tariffs must at least cover O & M costs while water rights have to be divorced from land ownership.

Pricing of water at below O & M costs conveys the market signal that water is a cheap and abundant resource. This does not stimulate efficiency. Should the State decide to finance the capital works entirely or partially, it can be regarded as a once-and-for-all welfare subsidy which needs not impinge an efficiency.

6.10.2 Water prices and optimal efficiency

The use of water is optimized when the marginal value product resulting from its use equals marginal delivery costs, provided that they are above O & M costs. The theory of production economics clearly indicates that the supply of water at rates below O & M variable costs involves irrational economic behaviour and wastage.

If existing schemes are meant to become self financing in the future, tariffs will have to include not only O & M costs, but also prospective future replacement and rehabilitation costs. If the Government intends that all capital costs be fully recovered, it should avoid one mistake which is often made, and which has been recorded in the literature in South Africa (Backeberg, 1994) namely that in the case of government schemes, no cognisance is taken

of the fact that the Government invariably receives part of its expenditure back in the form of taxes (income tax, V.A.T., etc.) generated by economic activities stimulated by such development. It is erroneous to ignore this factor in cost recoupment calculations (Backeberg, 1994; Backeberg & Groenewald, 1995; Goedhart, 1975; Randall, 1981; Gittinger, 1982).

The above implies that water tariffs have to differ from place to place, depending on local circumstances. It has been shown that even under such conditions, centralized agency decisions do not succeed in promoting efficiency of water use (Cummings & Nercessiantz, 1994). This once again leads one to water markets. They have been more successful in achieving efficiency than administrative, political or bureaucratic decision-making. There may however be problems regarding equity (Cummings & Nercessiantz, 1994).

6.10.3 Pricing practices, efficiency and equity

Existing water pricing methods include (Rhodes & Sampath, 1988; Sampath, 1992, quoted by Tsur & Dinar, 1995):

- **Volumetric pricing:** Water charges are based on direct measurement of the volume of water consumed. This can also be indirectly measured in terms of time of use.

- **Output pricing:** Irrigators pay a certain water fee for each unit of output of product.

- **Input pricing:** Water is charged on the basis of the quantity of some other input(s) used, e.g. fertilizer.

- **Per unit of area pricing**: This sometimes depends on the type of crop, the irrigation method and the time of year.

- **Tiered pricing** involves a multi-rate volumetric unit; water rates increase when the amount of water consumed exceeds certain threshold values.

- **Two-part tariffs:** Irrigators pay a fixed amount per year for the right to use water, plus a constant marginal rate per unit of water purchased.

- **Betterment levies:** Water fees are charged per unit of area, depending on the increase in land value accruing from the provision of irrigation.

An important distinction between these methods is that in some cases, water is paid for in proportion to the volume used: Tiered pricing and two-part tariffs are merely variants of volumetric pricing. Others which are tied to output or other inputs (eg. land or fertilizer) do not relate directly to the volume of water used.

An analysis comparing volumetric water pricing to pricing per area of land, kilograms of fertilizer used, or output, clearly showed that with volumetric pricing, water use efficiencies were superior to those obtained with the other pricing methods (Tsur & Dinar, 1995). No water-pricing method appeared to be superior in terms of equity.

Another analysis also found volumetric pricing to be superior to all other methods in terms of efficiency, with area pricing faring better than output taxation, and input taxation clearly being inferior to the remaining methods (Rhodes & Sampath, 1988). This analysis, like the other, could provide little insight into the equity objective of water pricing. However, since smaller units tend to have more capital invested per unit of land, area pricing may discriminate against farmers on small units (Rhodes & Sampath, 1988).

These results strengthen the conclusion by Seagraves & Easter (1983) that water pricing is a poor means of reducing income inequity; it is therefore an ineffective tool for income redistribution policies.

Taking the above into consideration, it appears logical that water supply pricing should be done according to the following guidelines:

- Prices must cover at least O & M costs. O & M costs will certainly differ between schemes, or in a wider framework, between catchment areas. This obviously implies

different prices at different places.

- In general, volumetric pricing should be practised wherever practicable. Water rights should therefore be clearly specified and water use measured as accurately as possible by direct or indirect metering. Where volumetric pricing is impracticable, area pricing is preferable.

- Since water is a scarce resource, efficiency in its use is very important. This renders tiered pricing preferable, with price increasing progressively after a certain threshold of e.g. O & M costs, has been reached. However, it must be borne in mind that O & M is often performed by a monopolist - a branch of a state department, such as the Department of Water Affairs and Forestry in South Africa - which is world-wide accompanied by the ineffectiveness and inefficiency that characterizes a monopoly. It is in such a case unfair and also counterproductive to let irrigators foot the bill for a monopolist's incompetence (Jones, 1994).

- Capital not recovered through general taxes can be recovered from beneficiaries through betterment charges. This will involve a two-part tariff consisting of a fixed annual charge (the betterment levy) and a volumetric charge on water actually used.

- It should however be kept in mind that a considerable number of potential irrigators have been historically disadvantaged and thus can not compete with existing farmers, although they may have the same latent abilities. Proposals concerning their settlement have been made earlier in this document. (See chapter 5, paragraph 5.6.)

  These new irrigation farmers will need special dispensations in terms of research, extension, training and also in water pricing. They have to have the opportunity to settle and improve their own efficiency. Two approaches should be considered.

  (i) Subsidies on a sliding scale, whereby the price subsidy is gradually and automatically reduced until it disappears after a certain period, say 10 or 15 years. This should, in the event of a tiered system, be valid only for quantities up to

threshold level.

(ii) A voucher system can be employed. New irrigators can receive vouchers which may be handed in in lieu of payment for water accounts. Systematic and automatic reduction of vouchers in time is once again recommended.

6.11 DECENTRALIZATION OF ADMINISTRATION AND CONTROL THROUGH LOCAL COMMUNITY PARTICIPATION

It has been found internationally that O & M is often done ineffectively, inefficiently and at high costs, frequently because it is monopolised by a state entity under central direction and control (Jones, 1994). India perhaps represents the classic example. Until early this century, India had evidently not experienced water problems. It is however now beset with problems of water supply and serious, ever-increasing conflicts over water, although only approximately 15 percent of water resources are tapped: The rest flows down to the sea. India's centralized, state-controlled water distribution system is constantly breaking down. The establishment of the Water Works Department a century ago marked a major shift away from traditional ways towards centralization and has continually failed to meet the demands of India's growing population (Kishore, 1995). Some traditional water management systems still exist, juxtaposed to this failing centralized system, particularly in India's more arid regions. Where this is found, the organizational structure is completely decentralized, as had generally been the case before centralization. Under the traditional structure, whole communities have been involved in the construction, repair and maintenance of water works. This system is low-cost, effective, sustainable and eco-friendly, with very few disputes and with jobs being created within the community itself (Kishore, 1995).

It will be naive, taking into account the size and complexity of many water systems and the necessity to coordinate activities over total catchment units, to expect to achieve desired results by a completely decentralized structure. But at the same time, effectivity, efficiency, and equitability dictate a need to decentralize functions to a local level and to involve the affected communities.

In Chile, different types of water user associations (WUAs) have been formed for this purpose (Schleyer, 1994; Easter and Hearne, 1995). The general function of these associations is to distribute water according to rights, and to collect fees for administration, distribution, maintenance and amortisation of infrastructure. They have the power to withhold water from those who default on payment of user fees or from those who exceed their entitled water rights. It is compulsory for any entity who holds water rights to join a WUA or more than one, depending on circumstances. The WUAs are indispensable for the implementation of water-exchanges.

Many other governments have also come to rely more heavily on WUAs, financially autonomous entities and private firms to provide the services involved in water distribution. Many smaller public irrigation systems in the Philippines and Indonesia have been turned over to farmers (Small & Carruthers, 1991, quoted by Easter & Hearne, 1995). In Argentina, small WUAs have combined to form larger ones in order to capitalize on the economies of scale that are perceived to be possible with water development and the use of professional management. The result has been reduced operating costs and a 10 percent improvement in efficiency (Chambouleyon, 1989, quoted by Easter & Hearne, 1995).

Water user associations can certainly play an important role in minimising both market and government failure to deliver water on irrigation schemes.

The impression gained from international experience as reported in the literature can be summarised as follows:

- User participation increases the likelihood that irrigation works will be well maintained: WUAs improve the management of water systems.
- User participation results in reduced financial and management burdens on Government.
- They reduce the likelihood of conflict among users and between users and Government, and provide a mechanism to solve conflicts.
- They contribute to community development.
- WUAs reduce dependencies on government agencies, they contribute to self-financing and promote independence of communities.

PRIORITIES

- Removal of legislative attenuation of water rights.
- Clear definition of water rights in terms of:
  - quantity;
  - variability;
  - preference.
- Implementation of regulatory procedures to enforce water rights and administrative procedures that will enable legal transfers of water rights. This would require the establishment of water rights markets and a water rights register. The State will have to control and regulate the water markets.
- Provision of supporting services to reduce transaction costs and to facilitate voluntary trade, i.e. mutually beneficial transactions based on negotiated agreements between parties.
- Introduction of some regulatory measures that will prevent injudicious alienation of the water rights of disadvantaged communities.
- Implementation of inspection services to measure return flow, water quality changes and instream flow requirements in order to protect the environmental balance and third-party interests.
- Phasing out of subsidies and increase in water tariffs to cover operating and maintenance costs with increasing block or peak-related tariffs for above-normal water requirements.
- Recovery of capital for refurbishment or rehabilitation of irrigation schemes through betterment charges, following execution of feasibility studies to quantify the financial, fiscal and economic impact.
- Recognition of the water consumptive role of some upstream water usages, e.g. sugarcane and forestry, and treatment of these in similar fashion as downstream users.
- Establishment of Water User Associations representing irrigation farmers abstracting water from rivers or below dams on schemes and building capacity for local management of water resources.
- Introduction of appropriate payment systems to address the problem of poverty on specifically smallholder irrigation schemes in rural areas, without subsidisation of water services and distortion of scarcity values of water rights.

CHAPTER 7

POLICY PROPOSALS

7.1 POLICY OBJECTIVES

Policy in general, including among many others also water, agricultural and specifically irrigation policies, should be directed at promoting a happy, prosperous and just society. "The objectives of all specific public policies and programmes should be subservient to the broad goals toward which society as a whole is striving; all goals should converge toward one end - the improvement of general economic and social welfare" (Schikele, 1950).

The objective of promoting a happy, prosperous and just society really consists of three master goals:

(1) Maximising social product in time;
(2) optimising the distribution of income and benefits among people; and
(3) optimising this distribution among the present and all future generations.

The above implies that income and opportunities should be distributed in such a manner that everyone could (1) enjoy at least minimum standards of health, nutrition, clothing, shelter and education (the subsistence norm); and (2) have the opportunity of personality differentiation, of developing and utilising his/her own individual abilities and satisfying a large variety of wants according to his/her own selection (Schikele, 1950).

Turning specifically to water and irrigation, this will require recognition of the scarcity of the water resource and formulation of a specific objective to obtain such allocation of this resource, both among agricultural and various other uses as to render optimal contribution to the objectives stated above. It will involve a degree of use intensity and of practices that will maximise the long-run social product value derived from water resources. It will certainly also mean constraining short-run private profit motives to exploit resources in favour of the long-run social welfare motive, to conserve, develop and improve our water

resources. Conservation and non-use are not synonymous concepts, but conservation implies that certain standards should be adhered to in the use of the water resource. Those who at present have access to water resources have an ethical duty towards other living persons and towards future generations.

Various instruments are available for water policy, including legal prescription, economic pricing administrative or bureaucratic control, education and persuasion. The challenge is to recognise the basic principles, the potential contribution of each, and the optimal balance and direction of the various instruments. It will be argued in this chapter, as has been done in previous chapters, that an optimum policy system can be created only if each of these instruments plays its appropriate role. If the importance of any one of these is ignored, attainment of the optimum will not be possible.

The proposals in this chapter will be aimed at directing South African water institutions towards the attainment of contributions that will benefit society optimally. All change must recognise the inviolability of the fundamental rights as entrenched in the Constitution of the Republic of South Africa.

The basic premise is that water institutions must be such as to enable irrigators to create wealth by using their own initiative; this must apply equally to existing, emerging and future irrigators. Wide-spread rural poverty will also require support programmes aimed at alleviating of immediate hardships.

7.2 GENERAL POLICY RECOMMENDATIONS

- Water legislation and institutional reforms should be formulated and implemented in conjunction with water policies. Legislation should address water rights, customary legal values and practices, water allocation, transferability of water rights, security of land tenure, water pricing, water pollution control and the organisation of water user associations.

- Appropriate pricing and charging systems reflecting opportunity costs for reliable water supplies need to be established in order to encourage decentralised decision-making.

7.3 WATER-SOIL-CROP RELATIONSHIPS

- South Africa has since the 1980s entered the mature stage of water resource development, with water availability becoming scarce relative to the felt needs, and with water works construction becoming increasingly expensive relative to the volume of water involved. Water is certainly scarce relative to irrigable soils. Thus, **it should be accepted as an important policy principle that better soils - only Classes 1 and 2 (see 4.1.2) - should receive priority in water allocation**. Only then can irrigation make an optimum contribution to welfare.

- It has furthermore been pointed out that irrigation often leads to deterioration in soil properties and or pollution of water further downstream (see 4.1.4). **It is imperative for future welfare to limit such environmental damage by employing sustainable irrigation practices**. These practices must consist of irrigation systems and technologies that are adapted to resource requirements.

- It is furthermore necessary, both for purposes of water economy and environmental conservation, that **irrigation scheduling techniques be used that ensure both high water-use efficiency and sustenance of soil and water quality**.

- The above implies the development of **ecological and social responsibility among irrigation farmers**. Individual farmers and farming communities must be made responsible for the maintenance of natural resources and for efficient water use. Education, extension and development of community spirit are needed for this purpose.

- Water-use efficiency must be further enhanced by **moving water use from crops with low economic and physical water-use efficiencies to those with better performances**. Water tariffs must be high enough to discourage inefficient water usage.

7.4 COMMERCIAL IRRIGATION FARMING AND MODERNISATION

- Modernisation of present non-commercial and emerging financial farming must be stimulated together with stabilisation and where necessary, revitalisation of existing commercial irrigation farming. Modernisation implies that **more irrigators will move from subsistence and near-subsistence irrigation farming towards fully commercial agriculture using appropriate technology - i.e. technology that will absorb labour, economise on water and capital and be economically, socially and ecologically sustainable**. Such technology will in many ways differ vastly from much of the present technology that was developed for the regions in which it was appropriate, viz. the capital-rich and labour-scarce economies of North America and Western Europe. **Research and extension should concentrate on discovering, developing and disseminating such technology that will be appropriate for South African conditions.**

- **Irrigation farms must be large enough to be economically and financially viable**: This is a prerequisite also for social and ecological viability. **Successful irrigators, being the more able managers, should be able to expand operations once they have accumulated sufficient profits.**

- **Educational and extension services should be designed specifically for irrigation** (see 5.1.5).

- **New irrigation development should**, if soil and water supply and quality allow it, **preferably occur in areas with a favourable economic location**, i.e. areas within reasonable distance from markets and which are served by transport, communication and other infrastructures which are vital for successful irrigation farming. **In many areas, particularly some former "homelands", such infrastructures should be developed by Government or with government assistance in order to improve the economic location.**

- **Subsidies should, where they exist, be limited to a minimum, with a definite time scale** according to which they will be phased out. Subsidies on water and capital,

together with artificially set high product prices have proven to be counter-productive in the long run, being capitalised into artificially high prices for land. If anything is to be subsidised, preference should be given to new farmer settlement and labour absorption (see 5.5).

- **Rehabilitation of existing schemes should receive priority over new water works development as candidates for public funds.**

- **Expenditure of public funds on new developments should occur only if thorough financial, economic, fiscal, social and ecological benefit-cost and impact studies have shown conclusively that they will be viable and sustainable on all these scores.**

7.5 SMALL-SCALE FARMER IRRIGATION SCHEMES

With a few notable exceptions, the overall evaluation of small-scale farmer irrigation schemes presents a gloomy picture, with many irrigation projects, large and small,lacking effective operation and management (see Chapter 5). Certain preconditions are required to revitalise present irrigation schemes and to develop new schemes. This is a responsibility for both national and provincial agricultural departments and the Department of Water Affairs and Forestry:

- **The Department of Water Affairs and Forestry, in co-operation with provincial agricultural departments and corporations should set up multi-disciplinary task teams to undertake appropriate diagnostic analyses to pinpoint major constraints and problems and to make innovative changes in the design, concept, management and thinking both of project management and farmers.** Project performance must be improved on an economic basis. This would involve development of a **training and extension programme** to strengthen management, extension workers and farmers. To assess the potential benefits and the prerequisites needed to make existing irrigation schemes sustainable, it is necessary to compare "with" and "without maintenance and rehabilitation" scenarios.

- **National water resources development and irrigation policies and strategies must be reviewed and reformed** to meet the objectives of food security and sustainable agricultural development in the small-scale farming sector.

- "Top down" and autocratic administration and control of many small-scale farmer irrigation projects have led to inefficiency and have placed heavy burdens on Government expenditure. This should be remedied by **the devolution of responsibility** to local autonomous institutions.

- **Increasing responsibility should be vested in rural communities** through water user associations (WUAs) or similar organisations, using existing functional groupings where possible. User participation will promote sustainability by ensuring that design choices and operational practices are consistent with local crop requirements and farmer capacity, and will furthermore result in more effective operation and maintenance of irrigation schemes, provided it is accompanied by education and training. **Government can play an important role in fostering the formation of WUAs** by providing technical and management training for WUAs and other local organisations. Sound social engineering is as necessary as good technical engineering for the design and creation of irrigation schemes that are both technically and socially (as well as economically) viable.

- **Extension agents need to act as catalysts in bringing farmers together for WUAs,** without imposing a particular structure or type of leadership on the groups. Trained agents can also be useful for strengthening existing farmer organisations on projects. Decisions regarding the role of WUAs should be left to the farmers as far as possible.

- The larger the scheme, the more difficult it is for farmers to organise. **Field level groups of 20 to 30 members would seem to be near the optimum. On large schemes it is easiest to form groups on a federated model** built up from canal or "block" organisations.

- WUAs are likely to require **institutional support for management for the initial period (perhaps the first three years of operation).** Initially it may be necessary for

Government to provide a **management subsidy and maintenance for WUAs.** These subsidies should however be phased out systematically according to definite time scales. In order to be successful, farmer participants need to perceive a benefit to themselves, for example, improved water supply or reduced costs.

- WUAs are most likely to succeed if the **organisations have legal powers and status,** and farmers are secure in their tenure. WUAs should be accountable to their members. Leaders should be selected by the farmers, and should not be appointed by the managing agency. **It is recommended that a task group be set up to make recommendations on the organisational structure, powers, functions, accountability and funding of WUAs.**

- **Infrastructure** should be developed and maintained to ensure the economic and social viability of irrigation projects. This implies that irrigation should not develop in isolation, but **should be part of area development programmes.** At scheme level, Government should be responsible for the construction and maintenance of water storage and main reticulation systems, while water users associations or the private sector should be responsible for maintaining and operating "in-field" distribution systems. New innovative ways to finance irrigation development need to be developed.

- **Other social and economic infrastructure** are vital for the economic and social sustainability of irrigation schemes, e.g. proper roads schools, health clinics and communication. Where these are lacking, they should receive a high priority. Construction, operation and maintenance are all tasks that should be undertaken by a combination of national, provincial and local government as well as by local communities.

- **It is recommended that the irrigation technology used on all schemes be evaluated by a multi-disciplinary task team** comprising irrigation specialists, crop scientists, agricultural economists and farmers themselves, with the object of assessing which technologies will be sustainable on small-scale farmer schemes.

- In addition to suitable technology, the success of irrigation depends on **economic factors and adequate back-up services.** Inadequate support in terms of extension inputs, credit, marketing, storage facilities and project management have all contributed to past failures. These constraints need to be eliminated by sound national and provincial agricultural policies to ensure the economic viability of projects.

- There is a **need to reactivate and reorientate project managers** to provide direction, training and contact with the community while encouraging and emphasising water users formation of groups and initiatives in systems management. If farmers are to assume a major role in managing irrigation systems, present scheme management must gradually reduce their involvement in accordance with the level of competence of WUA members. **Farmers' participation** should not be limited to certain sections, but **should be a primary consideration in replanning irrigation schemes.**

- The optimal approach in organisational development is **to build on a simple need** which is identified and to work from that. Participation in organisations improves when people have a clear sense of their rights and obligations, benefits and responsibilities, as well as a sense that irrigation infrastructure in reality belongs to them; also that they are active participants in managing the infrastructure.

- There is a **need for reform of government extension services** with new strengths in water, irrigation and crop production technologies and their management. There is a clear need to demonstrate economic gains from irrigated agriculture.

- **A multi-disciplinary approach should be adopted in the planning of any new irrigation schemes, including potential farmer participants.** Important issues include economic analyses, use of technology, institutional development, governance, social analyses, services and integrated rural development.

- **It is recommended that priority be given to settlement of projects where no settlement has yet taken place (see 5.3.5)** concurrently with a land reform programme, ensuring security of tenure.

- **Objective farmer selection should be done** in consultation with local authorities in settling new schemes and existing schemes still to be settled. Important criteria include technical experience, business acumen, foresight and trainability.

- It is not possible to make any recommendations on farm size, since it is necessary to make an estimate of potential income from irrigation, as well as supplementary activities such as livestock and dryland farming. There should, in addition, be room for competent irrigation farmers to expand their activities. Land reform should not only ensure security of tenure, but should also create opportunities for "commercial" farmers to acquire units large enough to make a living, as well as encourage family food plots for food security and to boost family income. **It is recommended that the Department of Water Affairs and Forestry, and the national and provincial agricultural departments, liaise with the Department of Land Affairs on irrigated land reform policy.**

7.6 THE LEGAL ENVIRONMENT

Water resource management should involve the effective allocation of water rights, the effective utilisation of these rights and the protection thereof. This could be achieved by adopting the following principles:

- **An effective institutional and regulatory management structure** should be in place, probably based on integrated catchment management. **Stakeholder participation should be incorporated in all the different decision-making processes** of such a structure.

- **Effective criteria, procedures and structures** should be used **to allocate the available water resources and the different water rights** fairly among all the different water users. Stakeholders should be incorporated into the structures to ensure that this is done fairly and justly.

- **Basic human needs to maintain a minimum standard of health, and the needs of the environment to sustain healthy aquatic ecosystems, should have priority.**

- **The rights and obligations contained in a water right should be clearly defined**. The definition should include the nature of the right and clear stipulation of whether it forms part of a group of rights or not. It should be possible to determine the economic value of such a right.

- **Existing water rights should be protected, although an initial once-and-for-all negotiated reallocation may be necessary**. Existing water rights should not be restricted to only those rights lawfully exercised at a certain date but should also include rights which had not been exercised.

- **The necessary appropriate procedures and administrative structures should be put in place to register these rights**, and this should also involve solutions to the existing legal and technical problems which are being experienced.

- **No activity which might have a significant impact on a water resource and might thereby change the nature of any water right should be allowed**, except if appropriate measures are taken to address the change in the nature of the water right sufficiently and fairly.

- **It should be possible to transfer a water right** or part or elements thereof, to any person at any time and for any period of time, and the nature of use of the transferred right should not be controlled by law, unless such a use will infringe on the rights of others. **The compensation involved should be as agreed between the parties involved. The necessary appropriate procedures and structures should be in place to create an effective market process** supported by a service to supply the necessary and appropriate information, to facilitate the transfers and to prevent impairment of third-party interests. The process of transferring the rights should be so structured as to render transaction costs as low as possible.

- **Expropriation of any water right should be permissible only for a higher priority or higher valued purpose and should be subject to the payment of an agreed-upon compensation**. By failing to reach such an agreement, a court of law should determine

a just and equitable compensation, striking an equitable balance between the interests of the affected persons and the public.

- **The legal system should have effective mechanisms to prevent water rights being exceeded.** Water user associations, government officials and courts can all be involved. It will be important to involve communities and not to rely only on the Government and courts. **It is also necessary to be able to measure water usage.**

- Some upstream uses of water often have negative effects on stream flow, and therefore on the interests of downstream users. **These uses and users should also be subject to water use measurements. As water use and water rights should preferably be handled on a catchment area or river basin basis, water rights of these users should be specified and treated in a similar fashion to those of the other users:** They compete for the same water. Their use can often be measured by means of area/species parameters.

7.7 INSTITUTIONAL CHOICES

- International experience increasingly indicates that use of water rights markets to allocate water rights is superior to administrative allocations in terms of flexibility, security of rights, opportunity costs, predictability, efficiency and administrative feasibility. Administrative allocations outperform water rights markets in terms of political and public acceptability, equity and efficacy (see 6.9). It should be possible to achieve the best of two worlds by combining the advantages of both institutional approaches. **The ideal situation will be well-established water rights markets subject to a limited but well-specified degree of government regulation.** Regulation should aim to prevent monopolisation of water rights, prevent abuses, and to protect the poor and weak.

- Certain poor communities should have additional **protection in the sense of a prohibition on permanent or long-term alienation of their water rights** until such time as their development has reached such a stage that such controls no longer have greater benefits than disadvantages.

- **It should be the goal to price water delivered by the State at levels which at least cover operation and maintenance (O & M) costs**, and contribute towards capital redemption through betterment levies. In the short run however, disadvantaged communities should receive subsidies that will be phased out gradually. Care should however be taken that this does not lead to wastage of water use.

- **Water supply pricing should, wherever practical, possibly occur on a volumetric basis and where this is not practical, preferably on the basis of area and species of crop.**

- Water use efficiency and optimal allocation of water and water rights require the **decoupling of water rights from land ownership**, either riparian land or land scheduled under water storage schemes.

- **The administration, control and management of water schemes must be made more effective through decentralisation and improved local community participation**. The ideal of community participation, which is an essential ingredient for successful policy and for economic and social development, can never be realised with centralised structures such as those which presently exist in South Africa and India (see 6.11). **The formation of water user associations should be encouraged and assisted and they should take on increasing responsibilities**.

7.8 INFORMATION

Information regarding irrigation farming practices, actual profitability and costs, the living standards of irrigation farmers' and their felt needs, is exceedingly scarce in South Africa. Formulating and executing aspects of policy will therefore become difficult. Policy may act in a vacuum, based on guesswork. It is therefore of paramount importance that a **comprehensive in-depth survey be carried out of agricultural practices, sociological conditions and economic circumstances.**

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APPENDICES

APPENDIX 1: Management and Returns to Size.

APPENDIX 2: Economic Location.

APPENDIX 3: Per Hectare Income Generation and Employment Absorption of Different Irrigated Crops.

APPENDIX 4: Small-scale Farmer Irrigation Schemes in South Africa.

APPENDIX 5: Land Tenure.

APPENDIX 6: Land Reform Programmes.

APPENDIX 7: Water Rights.

APPENDIX 8: Legal Framework Dealing with Irrigation and Subterranean Water Control Boards.

APPENDIX 9: Construction, Alteration, Enlargement or Usage of Water Works.

APPENDIX 10: Effects of Afforestation on Stream Water Flow.

APPENDIX 11: Water Markets.

NOTE

Appendices are available on request from the Water Research Commission.