WATER CONSERVATION AND DEMAND MANAGEMENT STRATEGY FOR THE AGRICULTURAL SECTOR

Final Draft

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ACRONYMS

ARC	Agricultural Research Council
BMPs	Best Management Practices
CMA	Catchment Management Agency
CMS	Catchment Management Strategy
DSE	Diverse Sideline Enterprise
DWAF	Department of Water Affairs and Forestry
IRP	Integrated Resource Planning
IWMI	International Water Management Institute
IWRM	Integrated Water Resource Management
FAO	Food and Agriculture Organisation
NDA	National Department of Agriculture
NWA	National Water Act (Act 36 of 1998)
NWCDMS	National Water Conservation and Demand Management Strategy
NWCSF	National Water Conservation Strategy Framework
NWRS	National Water Resource Strategy
PDA	Provincial Department of agriculture
SAII	South African Irrigation Institute
WC/DM	Water Conservation and Demand Management
WMP	Water Management Plan
WRC	Water Research Commission
WUA	Water User Association

EXECUTIVE SUMMARY

1 INTRODUCTION

1.1 Background

South Africa is a semi-arid country where water is of critical strategic importance to all development, in any sector of the economy. Recognising the potential limiting effect that water could have on future economic expansion in this country, it is of utmost importance that this resource be optimally utilised to the benefit of all current and future users.

The National Water Act (Act 36 of 1998) (NWA) provides for water to be protected, utilised, developed, conserved, managed and controlled, in a sustainable and equitable manner.

1.2 Definitions of water conservation and demand management

Water conservation is defined as the minimisation of loss or waste, care and protection of water resources and the efficient and effective use of water.

Water demand management is defined as the adaptation and implementation of a strategy (policies and initiatives) by a water institution to influence the water demand and usage of water in order to meet any of the following objectives: economic efficiency, social development, social equity, environmental protection, sustainability of water supply and services, and political acceptability.

1.3 Integrated Resource Planning (IRP).

The IRP process is a comprehensive form of planning that encompasses least-cost analyses of demand-side and supply-side management options. It also encompasses the following:

- An open and participatory decision-making process;
- The development of water resource alternatives that incorporate consideration of a community's quality of life and environmental issues which may be impacted upon by the ultimate decisions taken; and
- The recognition of the multiple institutions concerned with water resources and the competing policy goals amongst them.

The IRP process identifies opportunities to achieve societal and environmental benefits through joint utility programmes. Examples include: energy and water partnerships that conserve both energy and water; water conservation and waste water treatment and reuse programmes, where both water supply development and waste water treatment plant capacity expansion costs are saved, and, the reallocation of existing water supply resources among competing users.

1.4 The Integrated Water Resource Management (IWRM).

The IWRM is the idea that instead of the usual sectoral approach to developing and managing water resources, it is necessary to recognise that river basins are complex systems, in which use of water for one purpose has important implications for other uses.

Focusing attention on water basins (a term that includes the upper and lower areas of the basin as well as the groundwater) enables a systematic approach, considering the socio-economic, and human dimensions as well as the physical. Classical efficiency considers water flowing into drains as a "loss." But because of reuse, from a basin perspective one person's wasted drainage water is another's vital source. While efficiencies at field level may be low, in the same basin the overall effective efficiency of a basin may be quite high, and the "real" opportunities to save water by improving "efficiency" may therefore be limited.

This will be particularly so in the case of "closed" water systems. As population and economic growth increase the demand for water basins evolve from being "open" (where unused water is still available for additional uses) to being "closed" (where all useable flows are captured and distributed). Most water basins in arid areas and many basins even in non-arid areas are becoming closed basins. This has very important policy implications, as noted. For example, as upstream uses reduce the quality or quantity of flows downstream, different users become increasingly interdependent.

Managing this interdependency is an important public function, which few developing countries are equipped to do. It is very difficult to develop effective institutional mechanisms to manage water systems, particularly were political or administrative boundaries do not coincide with watershed boundaries, or where competing partisan interests are powerful and entrenched.

In South Africa, the following factors aggravates the problems, which must be overcome, in planning for the future:

- The typical climate is semi-desert and the average rainfall for the country is just over half of the world average of 900 mm / annum.
- Rainfall is variable and droughts followed by floods are common occurrences.
- The distribution of rainfall varies significantly and the availability of water resources is very uneven, with approximately 60% of river flow arising from only 20% of the land area.
- South Africa has limited groundwater, which can be used for irrigation.
- Some of the metropolitan and industrial growth centres have developed around mineral deposits and are situated far from major water resources.
- South Africa's average evaporation rate exceeds its precipitation rate. Irrigation is therefore vital to stabilize and increase the production of food and fibre.
- South Africa has a population growth rate of between 2 and 3 percent.
- South Africa is a developing country with a growing economy.
- The life style of South Africans is changing corresponding to an increase in per capita consumption.
- There is a large backlog of housing and basic services.
- Non-uniform payment for services in all water user sectors.

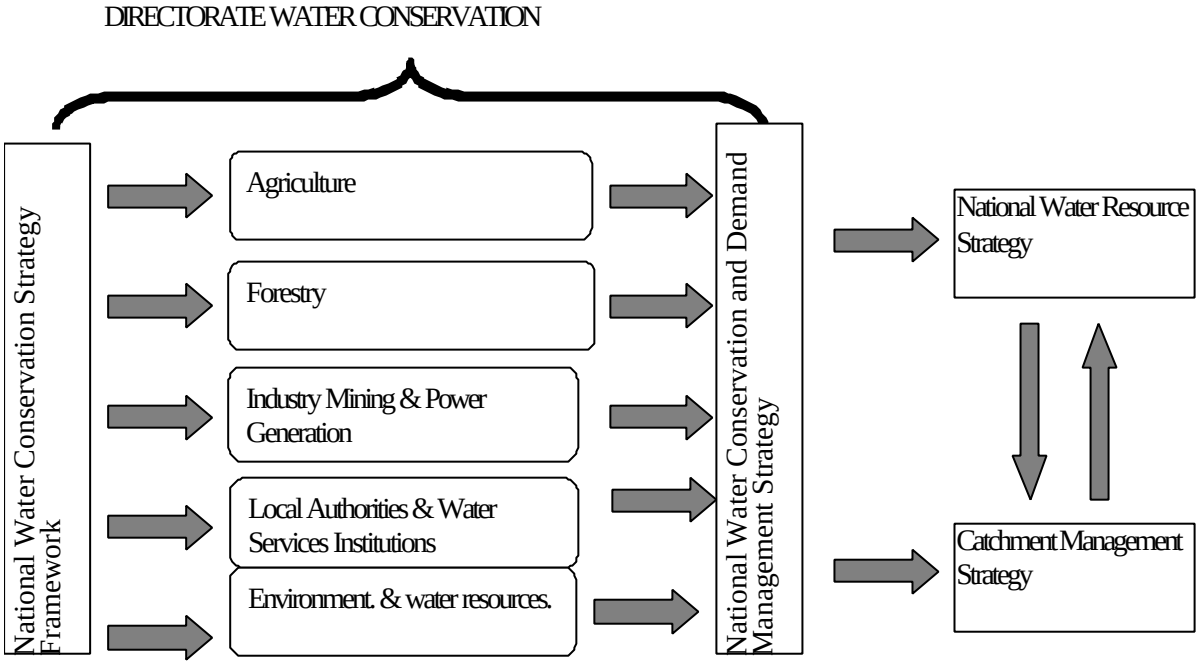
1.3 Overview of the development of water conservation and demand management in South Africa

In May 1999 DWAF developed the National Water Conservation Strategy Framework (NWCSF) document, which was widely published for comments. This framework document provided a solid foundation for the development of the five Water Conservation and Demand Management (WC/DM) sectoral strategies viz.:

- Agriculture,
- Forestry,

- Industry, Mining and Power Generation,
- Local Authorities and Services Institutions, and
- Environment and Water Resources.

The sectoral strategies will also exist as stand alone documents. The key elements of each sectoral strategy will be synthesised to produce the National Water Conservation and Demand Management Strategy (NWCDMS) The latter document will be contributed to the National Water Resource Strategy (NWRS). The key elements contained in the NWCDMS will also serve as the directorate water conservation's input to the development of Catchment Management Strategy (CMS) guidelines. The processes outlined above are depicted diagrammatically below.



2 WC / DM POTENTIAL IN THE SECTOR

The greatest potential impact of WC/DM in the agricultural sector can be achieved by addressing wastage due to conveyance losses and the inefficient application of water. Water wastage is classified as water, intended to perform a specific task, but not used for that purpose due to losses in transit. Seepage from irrigation canals which causes water-logging of adjacent land, is lost because of percolation, evaporates from land surfaces, or becomes degraded in quality of return flows, etc. are good examples of wastage. Similar wastages can also be seen in stock-watering systems, but as stock watering accounts for less that 1.5% of all water usage in the country, more emphasis is placed on preventing irrigation water wastage.

In South Africa, large volumes of water must be transported over large distances from the water-rich eastern areas to water-poor western areas. Water is of high value and the prevention of losses and optimal application of water is a high priority. Water losses occur in shared rivers, communal irrigation canals, and on-farm furrows and in irrigation fields.

The agricultural sector accounts for in excess of 50% of water utilisation in South Africa and experience water losses of between 30 and 40%. Clearly, therefore, the efforts and resources of water conservation and demand management measures should feature.

Irrigation losses are often quite significant and it is estimated that less than 60% of water abstracted from water resources is correctly placed in the root systems of plants. Approximately 35 % of irrigation system losses return to the river systems by overland flow and return seepage. This return water can be nutrient enriched and polluted with herbicides, pesticides and other pollutants in certain areas that could affect the water quality of rivers and streams.

Irrigation methods, irrigation scheduling, soil type, soil preparation, crop selection and evaporation all have a significant impact on the efficient usage of water.

The role of WC/DM in ensuring security of supply can be divided into short-term functions during droughts and sustainable long-term functions. During droughts emergency water conservation measures such as water restrictions and punitive rates may need to be adopted.

A strategy is required to promote the equitable and efficient use of water in the agricultural sector, to increase productivity, and to reduce income inequalities among people supported by the agricultural sector. Provide a regulatory support and incentive framework to improve irrigation efficiency. This strategy will therefore aim to:

- influence optimal use of water within the sector and release some of the water for use by aspirant and emerging farmers.

- provide for the user -management of irrigation schemes.

3 CHALLENGES TO APPLYING WATER CONSERVATION AND DEMAND MANAGEMENT

Water scarcity is more than the decreasing availability of this resource. The International Water Management Institute (IWMI) research as quoted in the 1998 Annual report pinpoints the rise of pollution and salinity in water as other pressing issues-with no evident solutions. This contamination makes plentiful water supplies unfit for drinking, agricultural, or environmental purposes. Given the scarce water resources in South Africa, it is essential that the available water is optimally allocated and used. The WC/DM strategy addresses this problem of water losses through leaking canals, evaporation, uneven distribution and poor scheduling.

Rapid groundwater depletion is a consequence of the explosive spread of small pump irrigation throughout the developing world. Ironically, it is precisely this low-tech, high efficiency irrigation that is sucking aquifers dry today in many highly productive agricultural regions.

The increased energy costs for deeper pump irrigation, reduces the freshwater supply to villages and causes lakes and rivers to dry up.

Problems of over-abstraction of groundwater sources in South Africa, for example in Dendron, springbok flats, Coetzersdam, are associated with irrigation use. These problems must be addressed through licensing and water conservation and demand management measures. The licensing process should actively support the water conservation and demand management measures. In the arid parts of South Africa, not even small-scale irrigation should be practised. Attempts by Non-Governmental Organisations (NGO's) in Namaqualand to irrigate using groundwater have failed because of our limited aquifer storage, very irregular recharge and lack of water for flushing salt accumulation in the soil

The application of WC/DM principles in the irrigation and farming sectors will have a significant effect on the availability of water to other sectors and the protection of water resources and the environment.

Improved WC/DM will require changes in the approach of all water users and regulatory bodies. It is widely recognized that evolutionary changes to the way in which farmers manage and operate irrigation systems will occur naturally. Economic constraints will automatically encourage farmers to improve the efficiency of irrigation to save on both water and energy costs.

A change in the water use patterns is essential and water users face considerable challenges in ensuring sustainable water resources for the future. The Food and Agriculture Organisation (FAO) World Food Summit in November 1996 defined sustainable agriculture and rural development as the following:

"The management and conservation of the natural resource base, and the orientation of the technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations. Such sustainable development conserves land, water, plant and animal genetic resources, is environmentally non-degrading, technically appropriate, economically viable and socially acceptable" (John Hagaman; Global Crop Protection Federation: IWMI page 164).

One of the key thrusts of the new approach to managing water in South Africa is the entrenchment of and insistence on efficient water management and use. It has been possible to give strong emphasis to this concept both in legislation as well as through key demonstration water conservation and demand management projects.

3.1 Why some WUAs fail or do not perform?

In a review article published in IWMI, Juan A Sargardoy noted that sharing of responsibilities in the management of irrigation water is becoming a worldwide trend. There is an overall satisfaction with the results obtained by these programmes but there are also some cases where the performances of the newly established associations are less satisfactory than expected. The paper identified the causes of such failures and the kind of support needed to avoid or reduce them. WUAs are established to achieve a large number of objectives (explicit or implicit) and what often happens is that some objectives are achieved but others not. Certainly there may be other few cases where the WUAs become totally non-operative although they may be formally established, mostly because farmers refuse to accept the transfer of responsibilities. Sargadov distinguished two categories of constraints for the effective operation of WUAs:

3.1.1 Challenges associated with the formation of the WUAs

The WUAs may exist on paper but not functioning at all in practice due to reasons enumerated below:

- Economical un-sustainability of the irrigation system.

There are numerous examples of schemes worldwide constructed under political regimes that favoured certain developments no matter how much they cost. Such irrigation schemes will never be able to return the investment made but even for the operational costs they depend on the government subsidies to exist. Many pumping schemes with high lifts dedicated to cereal production or some industrial crops are examples of such systems. The only way out is that the government continues to subsidise part of the expenditures and under these circumstances the farmers may accept the transfers. Often the solution is to mask the subsidy via other contributions that compensate for the excessive expenditures. The lesson here is that irrigation transfer management programmes need to pay considerable attention to operation and maintenance expenditures and the farmer's capacity to pay them without loosing a considerable part of his/her earnings.

- No social or economic advantages for WUA.

For WUAs to perform satisfactorily, they need certain degrees of social satisfaction or some tangible benefits. Without these, farmers will lose their motivation and active participation will decrease rapidly and the WUAs may become non-operative. This situation tends to develop easily in cases where the functions of WUAs are so limited that they become simple instruments of decentralising some of the functions of the government responsibilities, but without giving to the WUAs any important responsibility in the management of the scheme.

- Rehabilitation needs exceeds the financial capacity of the farmers.

Many irrigation schemes require rehabilitation works. Their transfer to WUAs means in practice that the government is passing on to the WUAs a burden that would be taken care of in some other way by the government. The WUAs will have to spend resources that they may not have available or operate the system in a way that would be unsatisfactory to the farmers. Either way would lead to a management crisis that may eventually result in the collapse of the functioning of the WUAs. Rehabilitation needs should be carefully assessed and discussed with the farmers before transfer is affected and, where possible, agreements reached on mutual responsibilities for rehabilitation works. Once this is done, further preventative maintenance should be the responsibility of the WUAs.

- Insufficient financial autonomy

This in all probability is the common cause of failure. WUAs are institutions, which are not supposed to make profits, but income and expenditure (which must include the building of a reserve fund to cater for unforeseen repairs and damages) should be approximately equal. Small differences between both should be corrected with appropriate financial measures, but when the expenditures are continuously or generally greater than the income, the financial collapse of the users organisation will arrive. Good managers/ leaders with vision will soon identify the risk of such situations and take the necessary actions to avoid them. Nevertheless, financial viability remains the most important constraint to the viability of the WUAs and therefore a large number of ideas have emerged to deal with this sensitive issue namely:

- The government must recognise that this is the weakest point in dealing with the transfer programmes and to cope with it must be prepared to provide some financial or institutional incentives that will contribute to enhance the financial autonomy of the WUAs.

- The most common type of financial incentive is the transfer of the machinery that the government agency utilised for the operation and maintenance of the system to the WUAs. The machinery may not be in good condition but the WUAs may manage to put them into practical use. Together with the machinery also some related facilities are also transferred such as offices, stores and minor equipment.

- In addition, the use of some subsidies for the power (Electric & fuel) necessary to run pumping units is also frequent when costs are beyond farmer's capacity. This is sometimes the only solution to keep running the schemes that were not conceived with the relevant economic analysis, as earlier mentioned.

- The case of the "starter projects" is also a case of a financial incentive that a WUA should receive from the project. The amount that the government gives must be matched by an equivalent contribution from the WUA in terms of labour or materials. The joint resources are supposed to be invested in the improvement of the irrigation systems. Very often the contributions by the farmers may exceed by several times the contributions by the project.

- The example of Mexico (part of its policy) of providing special credit facilities to buy equipment for the maintenance of the irrigation system but also for the improvement of the canal systems are worth serious consideration by the government. The programme is financed through a World Bank loan and the contribution of the Mexican Government and covers 400 000 hectares in its first stage. The programme is of great interest to the WUAs and the demand for purchasing of machinery is much higher than the capacity of the government to supply it.

- An interesting example of incentives comes from china (Xuerren Chen, 1994). In 1985 the State Council issued a special regulation for the development of Diverse Sideline Enterprise (DSE) in the water sector. For this purpose some tax exemptions subsidies and loans were made available from the National Finance Department for the WUAs that would present a relevant project for such enterprises e.g.:

- Fish production in canals and ponds
- Production of bricks for construction
- Power generation at suitable places in canals or reservoirs
- Milk processing units.
- Storage of grains and other agricultural production.
- Drying units of rice.
- Recreation and tourism and many others.

The development of DSE in irrigation districts provided benefits for the entire society, additional employment and increased the income of the WUAs.

- WUAs may need to be empowered with the use of water for any purpose and often they may wish to sell part of the available water for towns and villages for drinking purposes or undertake power generation and sell the energy. These additional incomes are important contributions to the expenditures of the WUAs and could help to reduce the fees /tariffs paid by the farmers.

3.1.2 Challenges associated with the effectiveness of the WUAs

- WUA leaders do not perform their duties adequately

It is not unusual that next to a small irrigation scheme adequately managed by a WUA one finds another scheme with similar physical characteristics where the organization does not function properly. If an analysis for the reasons for the malfunctioning is made, often one finds that the elected or "nominated" leaders do not have the competence or the ability to lead the group. This is often a transient problem in the sense that the WUAs should be able to have the capacity to replace their leaders with more capable people. However, social groups are very complex and influenced by different behavioural patterns and it is not always feasible to select the best people for a given job There is an inherent risk for any kind of social organization and certain number of cases such as this can be expected due to the same reason. However, certain measures may help to reduce the risk for example, some managerial training for leaders, devising effective selection processes, economic incentives for leaders and others.

- WUA's operating rules are not clear to farmers.

Many WUAs are established under some general organisational rules but without dedicating the necessary time and resources to explain to the farmers what is their new role. The result is often the low participation in the activities of the association and lack of commitment in its affairs. This does not necessarily lead to a collapse of the organization but it will certainly reduce its effective functioning.

- Low farmer's educational level.

There is no doubt that certain tasks within the WUAs have certain complexity either technically (as may be the case of the water distribution system) or financially as keeping the accounting), that are facilitated if the leaders and the members of the associations and the farmers have relatively high levels of education. This is a daunting task in South Africa due to the past government's discriminatory policies that created a pool of illiteracy; the same stakeholders are now among the emerging farmers that the present democratic government and farming community must take aboard. It has been noticed that when low levels of education are predominant, considerable training inputs and long periods of development are required to become effective WUAs. An effective way of bypassing this problem is by contracting technical staff capable of performing these tasks in an adequate manner.

- Lack of appropriate legislation.

WUAs need appropriate legislation to regulate their duties, responsibilities and contracting capacity. On the other hand a very restrictive legislation is a shortcoming to undertake some activities that can be helpful to improve the financial autonomy of the associations. Legislators must be careful in developing the relevant legislation by providing an element of regulation but avoiding a too narrow framework that might become an obstacle for their future development. In South Africa the National Water Act provides adequate provisions for most of the latter requirements.

3.1.3 Support services needed to enhance the effectiveness of WUAs.

The first question to deal with is whether WUAs need supporting services generally provided by the government and other agencies? Experience is proving that the more autonomous the WUAs are, the less they need support services from the government and the opposite also applies. In this respect, Mexico is an interesting case. When the transfer programmes were initiated, the government of Mexico foresaw a number of support services in terms of training and, at special prices, provision of machinery and other facilities. However the programme of transfer has been proceeding much faster than those of the supporting services. In consequence, many WUAs have had to face the situation of having to perform functions for which they have neither the training nor the financial support. Nevertheless, they solved their problems by going to the private sector for assistance and to the farmers asking for the extra financial support. In many cases this has permitted them to go ahead and solve the problems. However, in others –where the farmers and the elected leaders had less managerial and financial capabilities, the situation had remained unresolved. The conclusion that can be drawn from this is that support services are important to facilitate the autonomy of WUAs, particularly those that have less financial autonomy and managerial capacity.

The second question is what kind of supporting services may be more efficient or more needed? Three categories may be distinguished viz.:

- Capacity building.
- Financial support.
- Technical support.

4 INSTITUTIONAL ARRANGEMENTS

The NWA provides for the establishment of Catchment Management Agencies (CMAs) and Water User Associations (WUAs). The CMA will act as Basin water authorities to manage, develop and protect water resources within defined water management areas. WUAs are voluntary organizations of water users, which can be established along the guidelines developed by DWAF. The WUAs will then manage water on behalf of the end users. New management models will evolve and new relationships between the state and the locality will develop, especially on the allocation of the increasingly scarce water resources and the government funds for the water sector.

Clearly, basic institutional change (as provided for in the NWA) is needed to transcend this vicious cycle of government-induced dependency of farmers on the state and their consequent under-investment in the maintenance of irrigation infrastructure. Such reforms must create the right combination of incentives to induce an optimal mix of state and local investment to achieve sustainable infrastructure maintenance. The following is a list of what the International Water Management Institute (IWMI) hypothesizes is the essential set of incentives, which should be inherent in such a reform. The reform should:

- Unify decision-making about both short and long-term investments in irrigation infrastructure into the same decision-making body,
- Give the users the incentive to maximise efficiency of the total investment in infrastructure,
- Give the government the incentive to maximise the efficiency of its investment in infrastructure,
- Ensure that government intervention stimulates rather than discourage, local investment in infrastructure,
- Give users the incentive and confidence to make long-term investments.

5 ROLES OF CMAs, WUAs AND FARMERS IN WC / DM

5.1 The role of CMAs in WC/DM.

The demand for water resources and the current land use practises in each Water Management Area (WMA) must be the first step in any attempt to implement WC/DM principles by a CMA. The strategic assessment of water resources by a CMA will reveal whatever action is needed to address each situation in a WMA. It is essential to know:

- what the water resource in a WMA comprises, their yield and their current sustainability.
- the extend of the demand for and actual use of the water resources.
- the existence of conflicting demands for water.

- the nature of all land use practises in a WMA. To what extend does such practises adversely or beneficially affect the sustainability and the quality of the water supply / or resource.

It may well be that factors in specific catchments could reduce or increase the need for WC/DM. It should however, be borne in mind that even if in a particular catchment water is plentiful, WC/DM principles must still be applied in order to protect the environment, water resources and the delicate aquatic ecosystem.

As a regional water authority a CMA will also be responsible for the following aspects:

- The CMAs in collaboration with WUAs should introduce programmes for the creation of public awareness of the vital need for WC/DM and the training of their members to deliver effective services in the exercise of their functions.

- The CMAs in collaboration with WUAs should put in place programmes to overcome any limiting constraints.

- The CMA should look into the introduction of incentives so as to maximise the efficiency of water use.

- Determine the need for and the economic viability of water works that could enhance the sustainability of water resources.

- The CMAs should ensure that the guidelines and regulations developed by DWAF are implemented and complied with in order to:

    - prevent deleterious land use practises and

    - encourage practises that will conserve natural resources.

- The CMAs should assess and address financial and economic constraints in order to ensure that effective investment in irrigation infrastructure by WUAs occurs.

- The CMAs in collaboration with WUAs should ensure that maintenance and upgrading of irrigation infrastructure is regularly conducted..

- The CMAs in allocating the scarce water resources, must address on an equitable basis the social and economic requirements of all water users within a WMA.

- The CMAs must encourage the development of enterprises within their WMAs.

- The CMAs should apply contingency or emergency measures in times of floods, drought and water scarcity.

- The CMAs should garner, update and apply such technological information for the benefit of all water user sectors. In instances where some functions of CMAs are delegated to WUAs, an enabling environment for WUAs to manage, develop, monitor and control water resources should be created. The WUAs should be empowered to husband and improve the sustainability and quality of such water.

- The CMAs should strive for the best use and allocation of available water for the different water user sectors and to ensure specifically that the water users in the agricultural sector do not just waste water , but also use it as efficiently as reasonably possible with a view to improve the productivity of their farming operations.

- The CMAs in collaboration with WUAs should ensure that all water used or conveyed to water users is measured accurately and reliably in order that losses may be quantified and remedied.

- CMAs will also develop catchment specific strategies for WC/DM as part of the overall Catchment Management Strategy.

- Use of the water licensing procedure as a tool to regulate water use and prevent unlawful withdrawal of water.

- CMAs must use the Raw Water Pricing Strategy as a powerful tool to reduce water demand and increase water use efficiency.

- CMAs must encourage the attainment of the necessary WC/DM skills and technologies by the WUAs and water users.

- Co-operation with neighbouring CMAs, neighbouring countries and DWAF in all WC/DM matters.

- There are a large number of schemes that belong to the previously disadvantaged and emerging farmers that will require special attention with regard to WC/DM. The WC/DM strategy and its implementation through the pilot studies should have a much greater focus on the small farmer and the small projects. This is essential in terms of our physical, socio-economic and political situation. It is accepted that small projects can contribute greatly to water conservation and to reduce environmental impacts. However, such projects have different support requirements and should try to incorporate traditional knowledge and techniques. Different approaches to credits, extension services and other services are required. Both in the strategy and the operational parts, the utilization of the water savings should be addressed upfront. In our south African situation they are probably crucial to achieve greater equity. CMAs will be required to investigate appropriate policies and strategies relevant to their WMAs based on the guidelines developed jointly by DWAF and the Department of agriculture that will assist emerging farmers grow their businesses sustainably and allow them to progress from emerging to established commercial farmers

5.2 The role of the Water User Associations (WUAs) in WC/DM

The WUAs role in WC/DM will largely depend on the functional role that the WUA has in the provision of the water services to the water users. In the instances where a WUA acts as water service provider the role will be both administrative and managerial or only administrative where the irrigation water is supplied directly to the water user. As an institution that represents water user's interests the role of a WUA with regard to WC/DM may be some or all of the following:

- Control of raw water storage and conveyance infrastructure at the local level with the aim of limiting water losses. Many of the irrigation schemes are reaching a stage where major reconstruction and redevelopment is required to maintain operational functionality and efficiency. Neglected schemes might face serious economic and physical consequences. It is therefore very important that due attention is given to a proper preventative maintenance programme, in order to postpone major reconstruction.

- WUAs should ensure that all water used or conveyed to water users is measured accurately and reliably in order that losses may be quantified and remedied. Water measurements at all levels present a major challenge to WC/DM efforts. In order to determine accurate water balances there is a need to install accurate and reliable measuring devices to quantify the losses in the water conveyance systems and to ascertain the volume of water delivered to the end-users. If the latter is not done, how then will water suppliers quantify the losses experienced throughout the distribution systems? For WUAs or CMAs to effectively

measure and bill end-users where an option of charging end-users on a volumetric basis, the latter action is imperative.

- The Act stipulates that the use of water for irrigation or commercial purpose is linked to the acquisition of a valid water use license. Monitoring of water usage including prevention of illegal water withdrawal from rivers, ground water and other surface sources must be prohibited.

- A positive approach with respect to WC/DM by end-users is pivotal to a successful implementation of the principles of WC/DM in the sector. Irrigation water users might, sometimes, require encouragement to participate in WC/DM efforts. This encouragement should be by means of incentive schemes offered to the water users.

- Monitoring and prevention of unlawful water pollution or degradation of water quality.

- Development and implementation of the WC/DM Water Management Plans.

- Ensure timeous delivery of irrigation water to fields and reliability of irrigation supplies. Water Delivery Scheduling in long canals where water takes a considerable time to travel the length of the canal, special attention must be given to the operation of the canal in order to avoid water spillages. The most challenging situation, however, is when water is released into a major river to supply irrigation activities downstream.

- Support farmers by giving them advice on the latest irrigation technology that is water efficient.

- Scheme management information required by farmers and WUAs is not readily available currently. There is a serious shortage of information on irrigation and irrigation farming taking place in South Africa, on the crops that are grown, where they are grown, how much water each crop requires in various localities and the quality of water they need, etc. This information shortage will have to be adequately addressed by the WUAs in collaboration with CMAs, DWAF and National Department of Agriculture

5.3 The role of the water user in WC/DM.

The strategy focuses mainly on the scheme (WUA) and the individual end-of-pipe level due to the fact that its implementation is designed to be through the development and implementation of Water Management Plans by WUAs. However, the irrigator as the largest user of water should also contribute to the preservation and protection of water resources and the optimisation of the utilizable component of the hydrological cycle. Especially for small projects, where the individual creates his own source, the water resource conservation issue needs to be strongly addressed. The agricultural water user will be responsible for the implementation of all WC/DM strategies and plans that he had accepted through the licensing process and, if applicable, through the rules and regulations of the appropriate CMA and WUA. Regardless of any regulatory obligations the water users will always be encouraged and supported by both the WUA and the CMA.

In order to gain more productivity from the water used, the farmers will need to be encouraged to:

- Consider changing the crops to higher-yielding varieties, ones with lower-water needs, or switching to crops with higher economic returns per unit of water consumed.

- Improving farming practises, for instance through-improved fertilisation and soil management.

- Using water-saving irrigation techniques. Wherever possible, new proven and innovative technologies should be used to improve water utilisation and maximise crop production.

- *Irrigation scheduling is commonly defined as determining when to irrigate and how much water to apply.* Irrigation scheduling can conserve water. Methods of irrigation scheduling are based upon either soil and / or crop monitoring or soil water balance computations. In the case of soil monitoring, soil water content is generally measured at several places in the field to decide when to irrigate. Using tensiometers is one method of measuring soil water content. One tensiometer is placed at the depth where most roots occur. This tensiometer is used to indicate whether enough water was applied to wet the total root depth. If this tensiometer reading does not rise between irrigation cycles it also serves as an indication that the lower part of the root zone is too wet and that the interval between irrigation cycles should be increased. Careful preparation, installation and regular maintenance of tensiometers will ensure reliable soil water monitoring.

  One of the simplest water balance techniques is the checkbook method. The irrigator needs to measure rainfall and irrigation water applied and knows the daily crop water use. A daily soil water balance is kept and when a certain deficit is reached, irrigation water is applied to fill the soil reservoir. Crop water use must be determined for the local region for different crops in order to use this method.

  Deficit irrigation is another method of conserving water. The fundamental goal is to increase water use efficiency. Management of deficit irrigation is much more different from conventional irrigation management. Rather than working to minimize crop water deficits, the irrigation manager must decide what level of deficit should occur. Irrigation scheduling is much more difficult with deficit irrigation.

- Proper irrigation system selection is a key factor in efforts by farmers to utilise the scarce resources optimally. Appropriate advice should be sought in order to select irrigation systems that are designed to suit the crop, scheme, water supply regime and farming practices. The aim of the replacement of an old inefficient irrigation system should not only be to replace it with the same type of system, but with a more efficient system. Methods, in line with other policy documents, to assist the farmer to replace his current ineffective system when replacement is due with a more effective system should be investigated and developed. Preventative maintenance should be used to extend the usable life span of irrigation equipment.

- More attention should be given to the maintenance of irrigation equipment and distribution systems. Wear and tear on pumps, valves, sprinklers and other mechanical equipment have an adverse effect on the overall efficiency of on-farm irrigation.

- Runoff from lands and agricultural return flows could affect water quality. Return flows can originate from canal losses, over-irrigation, canal overflows, drainage, or even effluent from animal waste slurry dams. While the quality of water in these returns will vary greatly, some degree of eutrophication of rivers can occur. These inflows will normally be distributed over a wide area, have widely varying water quality and will have to be measured and controlled.

  Soils must have sufficient internal drainage capacity to allow excess water to leave the root zone. A water logged root zone will not support most crops. In addition, sufficient drainage capacity is needed to prevent the formation of a perched water table or a rising of the water table to a level that affects the root zone. If the water table is too close, water from the water table will replenish the soil surface water lost to evaporation by capillary rise. Salt present in this water will accumulate in the surface soil and salinization may occur rapidly. In soils with insufficient natural drainage, a drainage tile and a proper water conveyance system will need to be built to facilitate movement of return flows out of the irrigation project. (Brian J Wienhold, USDA-ARS-SWCRU).

Water quality of return flows must be considered in planning an irrigation project. Water leaving an irrigated area will likely have accumulated additional salt. If the irrigated soils have saline sub-soils or fossil soils present, the increase in salinity of the return flows may be substantial. In addition, other chemicals such as fertilizers, pesticides and soluble minerals (selenium) may be present in the return flows. The quality of the return flow water may affect downstream users such as other irrigation projects and municipalities and may make the water unsuitable for recreational uses and wildlife.

Over-irrigation coupled to poor drainage causes salinity and the eventual destruction of the irrigable lands. Water quality suffers when the same channel is utilised for water supply and drainage.

As irrigation water is applied and lost via evapotranspiration, salts accumulate. These accumulated salts must be periodically leached from the root zone. In some semi-arid regions precipitation during the non-growing season may be sufficient to maintain the salinity at a sufficiently low level (Wienhold and Trooien, 1995). In most cases excess irrigation water must occasionally be applied to leach excess salt out of the root zone.

- Growing more food with less water**.**

> *"A particularly difficult challenge will be to improve the efficiency of agricultural water use to, maintain crop yields and output growth while at the same time allowing reallocation of water from agriculture to rapidly growing urban and industrial uses. How this will be managed could determine the world's ability to feed itself" (Mark Rosegrant, 1997).*

Rising populations and increased competition for water will create dual burdens on agriculture. First, a large population will need more food and fibre. Second, agriculture will have a less reliable supply of irrigation water to meet these rising demands. The central challenge for agriculture is how to grow more food with less water (Mark Rosegrant, 1997).

Improving how water is delivered to farms and put to use in fields, will enhance food security and human nutrition. Inefficiencies in global irrigation methods are numerous, difficult to manage and massive. The magnitude of the problems, however, creates vast opportunities, for change and economic growth.

Some environmental problems internationally have been attributed to irrigation. Overuse of water can cause shortages in river basins, or deplete an underground water supply. Water-saturated soils can be loaded with salt, damaging the productive capacity of the land. Crop chemicals can leach into the groundwater or pollute the surface water.

Irrigation agriculture faces many challenges. However, with modern irrigation management, advanced agronomic practices and more refined decision-making systems, countries facing these challenges can create a more productive and profitable agricultural base. Societies and farmers that capitalise on these opportunities will be more competitive in the global marketplace. *To grow more food, the water we use must be managed more carefully.* The following are some of the options open to South African irrigators:

- Mechanized irrigation uses less water and labour than flood irrigation. These efficiencies with water and human resources help farmers to increase yields, farm more land and raise the total production. This form of irrigation can also help solve other problems, such as waterlogged soils, salinity and water contamination. Mechanized irrigation is an excellent place to begin as countries begin to grow more food and with less water and human toil.

- Modernization of the irrigation equipment contributes towards achieving water conservation and demand management goals. Well-managed Centre pivots and linear systems provide a sensible alternative to inefficient forms of water application, such as flood irrigation. However, the latter with laser levelling can achieve irrigation efficiencies of up to 70%. Water use in irrigation can be lowered dramatically without the loss in food production. Well-managed Centre pivots and linear irrigation efficiencies range from 75-98% in specially designed sprinkler systems. Exact quantities of water are delivered to crops, and with proper design, runoff and evaporation losses are nearly eliminated.

The problem with flood irrigation (without laser levelling) is lack of uniform application, which is a key cause of reduced crop quality and yields.

Well-managed centre pivot or linear system can apply water at 88 - 95 % uniformity, compared to 40 - 70 % (with laser levelling) uniformity with flood irrigation.

The following proper handling and application practises by the farmers can help prevent groundwater contamination:

- Integrated Pest Management (IPM) assures that pesticides are applied only when needed. The goal of IPM being to reduce pesticide use to the minimum level to produce high quality food. Improper pesticide handling can lead to groundwater contamination.

- Nitrogen in the form of nitrate can be leached from the soil to groundwater. Nitrates are the major concerns in groundwater contamination by nutrients. Nutrient management is the key to reducing nitrate leaching. Good record keeping is an essential part of a nutrient management programme.

6 OBJECTIVES OF THE WC/DM STRATEGY

The overall objective of the WC/DM strategy for the agricultural sector is to ensure that WC/DM principles are applied by the agricultural sector in order to release some water for use within the sector, to open up irrigation opportunities for emerging farmers, to release more water to cater for the needs of competing water users and to protect the environment.

In support of the overall objective a number of specific objectives and action plans are outlined below:

OBJECTIVE 1: TO ENSURE THAT APPROPRIATE MEASURES TO INFLUENCE THE REDUCTION IN WATER WASTAGE ARE IMPLEMENTED

ACTION 1: Conduct and support ongoing research necessary for the refinement of the pricing strategy to facilitate the implementation of stepped water tariffs.

ROLE PLAYERS: DWAF, WRC

ACTION 2: Install suitable measuring devices in all irrigation schemes to facilitate volumetric water charges to end-user. Implement progressive stepped water tariffs to reduce water demand and encourage water user to relate water use to cost.

ROLE PLAYERS: DWAF, CMA, WUA

ACTION 3: Promote the use of more water efficient irrigation equipment in order to conserve water. Discourage the use of flood irrigation especially when laser levelling is not continually done to increase the efficiency.

ROLE PLAYERS: CMA, WUA

OBJECTIVE 2: TO ENSURE THAT THE WUAS AND END USERS UNDERSTAND AND APPRECIATE THE NEED TO PROGRESSIVELY MODERNIZE THEIR WATER CONVEYANCE SYSTEMS AND IRRIGATION EQUIPMENT.

ACTION 1: Support ongoing research and development of new crop varieties that are water efficient, high yielding and high valued to enable the farmers to be competitive in the global marketplace

ROLE PLAYERS: DWAF, NDA, PDA, WRC, CMA, WUA

ACTION 2: Conduct research to develop, validate and evaluate irrigation technology.

ROLE PLAYERS: DWAF, NDA, PDA, WRC, CMA, WUA

ACTION 3: Use the latest water conveyance and irrigation technology that prevents unnecessary water wastage and minimizes water losses

ROLE PLAYERS: CMA, WUA, and Farmer

ACTION 4: Develop models to assist in water management, crop water requirements, equipment selection and design

ROLE PLAYERS: DWAF, NDA, PDA, WRC, CMA, WUA

ACTION 5: Practice irrigation scheduling based on crop water requirements to avoid under- and over-irrigation and the associated problems of salinization and destruction of irrigable land.

ROLE PLAYERS: Farmer

ACTION 6: Select the irrigation system to suit the crops that are grown, scheme, water supply regime and farming practices

ROLE PLAYERS: WUA, Farmer

ACTION 7: Minimise seepage losses in irrigation canals and irrigation ditches

ROLE PLAYERS: WUA, Farmer

ACTION 8: Ensure that the pesticides, herbicides and fertilizers are applied optimally and when needed to produce high quality food and avoid contamination of surface and groundwater resources. Ensure that the quality of the return flows from irrigation area do not adversely affect the irrigators and other consumers downstream.

ROLE PLAYERS: WUA, Farmer

OBJECTIVE 3: TO ENSURE THAT WATER ALLOCATIONS PROMOTE EQUITABLE AND OPTIMAL UTILISATION OF WATER BY ALL SECTORS IN A WATER MANAGEMENT AREA.

ACTION 1: Use water allocation process to promote WC/DM principles

ROLE PLAYERS: DWAF, CMA

OBJECTIVE 4: TO ENSURE THAT PREVENTATIVE MAINTENANCE PROGRAMMES ARE PUT IN PLACE ORDER TO POSTPONE MAJOR REHABILITATION, REPLACEMENT AND RECONSTRUCTION

ACTION1: Conduct regular preventative maintenance programmes of the raw water distribution and conveyance systems to detect and fix leaks.

ROLE PLAYERS: DWAF, CMA, WUA

ACTION 2: Provide appropriate support services where these are needed in planning, development of new irrigation schemes and rehabilitation of existing schemes.

ROLE PLAYERS: DWAF, CMA, NDA

ACTION 3 Implement appropriate preventative maintenance programmes on canals and other raw water infrastructure.

ROLE PLAYERS: CMA, WUA

ACTION 4 Implement appropriate preventative maintenance programmes on irrigation equipment

ROLE PLAYERS: Farmer

OBJECTIVE 5: TO ENSURE THAT SUFFICIENT IRRIGATION INFORMATION IS GENERATED AND ACCESSIBLE TO ALL STAKEHOLDERS

ACTION 1 Develop irrigation databases and make this information widely available

ROLE PLAYERS: DWAF, CMA, WUA, NDA

ACTION 2 Encourage the use of the printed and electronic media to disseminate information to all stakeholders

ROLE PLAYERS: DWAF, CMA

ACTION 3 Contribute regular articles to local irrigation journals and agricultural publications to promote the concepts of WC/DM

ROLE PLAYERS: DWAF, CMA, NDA, PDA, WUA, ARC, SAII.

OBJECTIVE 6: TO ENSURE THAT THE CONCEPTS OF ENVIRONMENTAL AWARENESS AND PROTECTION ARE PROMOTED AND ACCEPTED BY ALL STAKEHOLDERS

ACTION 1 Minimise return flows from irrigated fields. Minimize the pollution and degradation of surface and groundwater by the optimal application of pesticides, herbicides and fertilizers.

ROLE PLAYERS: Farmers

ACTION 2 Monitor and measure water quality upstream and downstream of the irrigation areas to protect the aquatic ecosystem and the downstream users. Apply the ***polluter pay principle*** to encourage compliance with the regulations / rules.

ROLE PLAYERS: CMA, WUA

ACTION 3 Initiate awareness campaigns through workshops, discussion forums, and newsletters.

ROLE PLAYERS: DWAF, CMA, WUA, NDA

OBJECTIVE 7: TO ENSURE THAT ACCURATE WATER MANAGEMENT AND SERVICE PROVIDERS IMPLEMENT AUDITS FROM THE WATER SOURCE TO THE END USERS AND BEYOND

ACTION 1 Install accurate and reliable measuring devices to determine water balances.

ROLE PLAYERS: CMA, WUA, NDA

ACTION 2 Prevent unlawful withdrawal of surface and groundwater.

ROLE PLAYERS: CMA, WUA

OBJECTIVE 8: TO ENCOURAGE WATER MANAGEMENT AND SERVICES INSTITUTIONS TO USE THE LATEST TECHNOLOGY IN THE WATER RELEASES AND DISTRIBUTION SYSTEMS

ACTION 1 Train people who are involved in water releases.

ROLE PLAYER DWAF

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ACTION 2 Encourage the implementation and use of computerised operational systems in schemes and train WUA bailiffs in the use thereof

ROLE PLAYERS: DWAF

7 IMPLEMENTATION OF WC/DM IN THE SECTOR

Water User Associations will implement the strategy through the drawing up and submission of Water Management Plans In a Water Management Plan, a WUA describes its current irrigation water use and conservation measures and sets out how it plans to implement Best Management Practices (BMPs) to improve its irrigation water supply services and to achieve water conservation and water demand management.

To achieve the above-named objectives in the agricultural sector, the Directorate Water Conservation has developed a suite of tools comprising of Best Management Practises (BMPs), Water Audits, and Benchmarks, train the trainer programme and the training manual. The latter suite of tools will be tested and refined in case studies to be initiated by the third quarter of the year 2000.

Developing a Water Management Plan and reviewing it regularly is a major stimulus to efficiency, promotes co-ordinated action and facilitates negotiations with the CMA and other stakeholders. The process does not require expensive data gathering, but uses existing data for its initial implementation and then aims to improve the plan from year-to-year

In its Water Management Plan a WUA goes through the following steps:

- **Step 1**: Describe the WUA, its location and facilities, history, operating rules, etc. This dovetails neatly with WUAs current development of their constitutions to be transformed from Irrigation Boards

- **Step 2**: Identify and adopt appropriate Benchmarks for irrigation water use and water management in the WUA area.

- **Step 3**: Develop a Water Account of the WUA's water resources and uses for auditing purposes

- **Step 4**: Review progress and show plans for the implementation of BMPs for the WUA.

- **Step 5**: Motivate which "Secondary" BMPs the WUA should not have to implement, through an analysis of the impact of the BMPs on the environment, possible third parties and any indirect economic impacts on the farmers and others.

The focus of the Water Conservation and Demand Management Strategy is to establish an approach and a system in which there is a balance between centralised (top down) and decentralised (bottom up) water delivery management. For this bold "self-regulation" approach to succeed will require empowerment of all role players in irrigation.

Empowerment, in turn, implies capacity building and training. Therefore, an essential element of the strategy will be a systematic and long-term initiative of enabling irrigators and the various levels of regulatory authorities to improve water use efficiency. The main levels of intervention would be:

- Catchment Management Agency (CMA)

- Water User Association (WUA)

- Farmer (Irrigator)

- Technician and

- Farm workers

Furthermore new WUAs – particularly those involving emerging farmers – should receive special attention and support with respect to:

- Exposure to alternative types of irrigation

- Record keeping and financial management skills

- Making appropriate measuring devices available.
- Guidance in drawing up Water Management Plans and related best management practices (including repair and maintenance of infrastructure and equipment)

- Training in understanding the National Water Act

- Sharing of experience and knowledge with established, commercial WUAs

- Introduction of computerised water management systems such as "WAS" as soon as possible

- Establishment of multi-purpose Information Centres in communities which could be used by WUA for information transfer and communication

Training and motivation of government officials involved at "grass roots" will be an essential element of the overall strategy.

Training is a major complementary measure needed to improve performance of the WUAs in those cases where not enough time was allocated to prepare the farmers for the new institutional structures. However, training is not the only measure that can strengthen the newly established WUAs, sometimes additional financial and institutional incentives are required to provide the necessary autonomy

One common perception internationally held, of the training needs for WUAs is that they must learn the management of the system following the pattern that the irrigation agency has maintained for many years. No matter how well the staff of the irrigation agency has done this job. The WUAs members themselves should identify the training needs of the WUAs. However, they may often not have a clear perception of what the most urgent needs might be, and in what way training could help to solve their problems.

South Africa can learn from valuable experience gained elsewhere in the international community. The training programme to be tested in pilot studies will be divided into a series of sessions spread over a period of three-year period. A technical person that, through questions, can the attention of farmers to the problems that they may not have clearly understood should accompanied the consultant appointed to determine the training and capacity building needs of the stake holders. Nevertheless, at the end of the problem identification phase the farmers should prepare a water management action plan. Such a plan should include physical improvements of the system but also the training needs of the group must be identified. However, in order to provide training and technical support, the agricultural officers may need to be trained first as due to their strong professional orientation towards agriculture, their knowledge of water management could be insufficient. The benefits of this training and improvement programme may be substantial and could lead to increased production per hectare thereby raising farmer's incomes per hectare per year.

One form of capacity building that has proven extremely effective in this context is the exchange of experiences among the leaders of WUAs. Farmers tend to learn more from other farmers than from technicians or government officials. DWAF intends also to encourage the formation of discussion fora and information sessions where sharing of information and experiences takes place between different WUAs and farmers to ensure that valuable cross-fertilization occurs.

8 ACKNOWLEDGEMENTS

1 DEPARTMENT OF WATER AFFAIRS AND FORESTRY: *National Water Conservation and Demand Management Strategy Framework*, Draft May 1999

2 INTERNATIONAL WATER MANAGEMENT INTITUTUTE: *Sustainable Agriculture Solution*; the sustainable Agriculture Initiative Action Report. The Novello Press Ltd, London 1999.