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HARMONIZATION AND INTEGRATION OF WATER SAVING OPTIONS IN CYPRUS

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SUMMARY- For Cyprus, water is the most important resource and a prerequisite for progress. Its scarcity has acted as a limiting constraint for the development of agriculture and for other economic activities such as tourism. Irrigated land, accounts 35.100 hectares or 16,2% of the total area enumerated and 57% of the annual amount of water for irrigation purposes is provided mainly from Government Irrigation Schemes. In the Government schemes the sources of water used are surface water, groundwater and reclaimed water. As a rule, the water demand in the non- Government schemes is satisfied by groundwater. The scarcity of water together with the high cost associated with collecting and using the limited surface rain water for irrigation, has become real constraints for our irrigated agriculture. Because of this, particular emphasis is placed on the water use efficiency and modern irrigation technology. Modern irrigation systems have been used in Cyprus agriculture for the last 40 years. It is estimated that currently over 95% of the total irrigated land of the country is being served by modern irrigation methods. Recently, particular emphasis was laid on protected cultivation and more specific on cultivation of vegetables and flowers on substrates and soilless cultures (closed systems and open with minimum drainage). At the Agricultural Research Institute, the use of local materials i.e. perlite, mixtures of perlite with pomace, almond shells, pine bark etc. have been tried successfully. In this paper, results of the application of modern techniques, hydroponic cultures, re-circulation of irrigation water and nutrient solution in closed systems and control of the climatic conditions in the greenhouse are discussed. In making the supply meet the demand the Government policy has encouraged and adopted management measures as water rationing, increase of public awareness for water conservation measures and water pricing for improvements in the water use efficiencies. The main measures, as well as the new Government water policies, are discussed in this paper.

Keywords: water saving, water management, irrigation water, irrigation methods, water supply, water demand, water policies.

IRRIGATED AGRICULTURE

Cyprus is the third-largest island in the Mediterranean with an area of 9251 km^2 (925000 ha). Presently the agricultural land consists of 216000 ha. The irrigated land amounts to 35100 ha (16.2% of the total agricultural land - Agricultural Statistics 2002) with provision to be expanded. The irrigated agriculture in semi arid countries like Cyprus demands large amounts of water and faces the serious challenge to increase or at least sustain agricultural production while coping with less and/or lower quality water.

There is an increasing concern about the effective and efficient utilization of water for agriculture and water conservation in general. The promotion of effective water use and on farm water management, were identified as important contributions to the management strategy (Chimonides, 1995), needed to address problems of water scarcity and practicing intensive agriculture on environmentally sound grounds. Improving the water use efficiency at farmers level is the major contributor to increase food production and reverse the degradation of the environment or avoid irreversible environmental damage and allowed for sustainable irrigated agriculture (Papadopoulos, 1996). The overall target is to maximize positive impacts of irrigation and minimize potential environmental hazards. The interaction between agricultural production and the environment should be complementary rather than competitive for balanced development of both. In the same line, in scheduling irrigation it is also important to identify the critical periods (stages) during which plant water stress has the most pronounced effect on growth and yield of crops, since this is also directly related to the nutrients requirement by the crop (Chimonidou, 1996).

In the view of the above, Government decided to improve the situation by creating and strengthening with personnel and equipment the Water Use Section of the Department of Agriculture in 1960 and by applying the water Use Improvement Project in 1965 and water supply (Special measures) Low No. 35 of 1965. With the creation of the Agricultural Research Institute in 1965 experiments were carried out on basic concepts of soil-water plant relationships (Chimonides, 1995).

Irrigated crops (permanent, annual)

The percentage of water demand for permanent and annual crop is 59% and 41%, respectively. This accounts 95,8 MCM/year and 65,5 MCM/year.

From 35.100 hectares of irrigated crops, 19.100 refer to temporary crops, while 16.000 refer to permanent crops. The main irrigated temporary crops are vegetable and melons with 27,6%, followed by fodder crops with 12,8% and cereals with 11,4%. The main irrigated permanent crops are citrus with 15,3% followed by fresh fruits with 10,2%, olives and carobs with 9,4% and Vines with 7,1% (Agricultural Statistics, 2002).

Origin of irrigation water

A percentage of 57% of the annual amount of water for irrigation purposes is provided mainly from Government Irrigation Schemes. In the Government schemes the sources of water used are surface water, groundwater and reclaimed water. As a rule the water demand in the non- Government schemes is satisfied by groundwater.

- Surface Water: Although the capacity of all main dams is 273.6 MCM, the average annual amount of water available for use in 2006, is estimated to be about 112.5 MCM. During the dry year of 2005 the contribution to irrigation of all dams was 63 MCM while for 2006, is expected to be only 39.5 MCM. Out of the 112.5 MCM, 93 MCM are used within Government Projects, 14.5 MCM for domestic use (after treatment) and 5 MCM for ecological areas.
- Groundwater extraction is estimated to be about 127.4 MCM on an annual basis. Such figure does not mean the safe yield of the aquifers, which is much lower. From this amount, 100.4 MCM are used for agriculture (26 MCM are within the Government Irrigation Schemes and 74.4 MCM are outside the Government Schemes).
- Springs contribute very little, amounting to 3.5 MCM per year, for domestic use of the mountainous villages.
- Desalination units at present contribute up to 33.5 MCM per year.
- Treated sewage effluent: Presently, only about 3.5 MCM is used, from which 2 MCM for agriculture and the rest for landscape irrigation.

Methods of irrigation (surface, sprinkler, micro-irrigation)

Modern irrigation systems have been used in Cyprus agriculture for the last 30 years. Due to the relatively high installation cost the drip method was initially used for irrigation of high value crops, such as greenhouse vegetables and flowers. At a later stage the installation cost was reduced, and the use of drippers, minisprinklers and low capacity sprinklers was expanded for irrigating trees and field vegetables. Proper hydraulic design of the irrigation systems, offered free of charge by the Ministry, coupled by a subsidy of the installation cost, resulted in a rapid expansion of the new irrigation systems.

Farmers have extensively adopted modern irrigation systems. The new technology introduced is continuously being tested by the Agricultural Research Institute in order to evaluate the different systems under local conditions and select the appropriate irrigation method for each cultivation (Metochis and Eliades, 2002).

For densely spaced field vegetables like potatoes, carrots, beans, etc. the permanent low capacity sprinkler system is recommended for irrigation. In case, however, of limited financial resources the portable sprinkler system can be used instead, although it requires more labour.

Drip irrigation is the only applicable method for irrigation of row vegetables grown in greenhouses, low-tunnels and in the open field, spaced at a relatively great distance on the row and between rows. One nozzle is usually installed to deliver water to each plant. Among permanent plantations, drippers are mainly recommended for banana, grapes and several other crops, like aromatic plants. Generally, unless there is a particular problem, drippers with larger nozzle opening are preferred, because they are not easily blocked by impurities, therefore, they require less filtering and they are characterized by higher uniformity in flow.

For irrigation of permanent tree plantations both drippers and minisprinklers can be successfully used. No differences have been observed concerning crop development and production; therefore, the choice of the irrigation method depends on several other factors. Minisprinklers are generally preferred and are more widely used for irrigation of trees, mainly due to lower installation cost. Moreover, as nozzle opening is relatively large they are not easily blocked by impurities present in the irrigation water.

The introduction of modern irrigation systems in Cyprus resulted in the expansion of irrigated agriculture, increase of water use efficiency and production, and improvement of yield quality. Continuous testing of new technology and instrumentation is always required, however, for further improvement of the design and management of the systems.

It is estimated that currently over 95% of the total irrigated land of the country is being served by modern irrigation methods. With the improved irrigation systems and the scheduling of irrigation based on experimental work of the Agricultural Research Institute, the overall water use efficiency at farmers level is above 80%.

PROTECTED CULTIVATION

In most Mediterranean countries the problem of an adequate water supply to meet the present and future demands of irrigated agriculture is very important. Water supply must be used in the most efficient way especially in countries where water is scarce, of high cost and in most cases of poor quality.

The irrigated area by crop, the percentage of water use by crop as well as the value of production for the irrigated crops (producer's price), are presented in Figures 1,2 and 3. The area under protected cultivation represents only the 1% of the total area, uses the minimum quantity of water and gives the highest return/income compared to the rest of the irrigated cultivations. The greenhouse cultivations represent the most profitable crops per volume of water (m^3). This is a very important consideration in countries of the Mediterranean region since water is the limiting factor in agricultural production (Chimonidou, 2000).

The scarcity of water, together with the high cost associated with collecting and using the limited rain water for irrigation, has become a real constraint for our irrigated agriculture. Because of this, alternative water resources, innovative approaches and new technologies are sought to help solve the problem. Development of more efficient irrigation methods to save water, better utilization of marginal quality water, and the turn to intensive irrigated agriculture, protected cultivation and soilless culture are promising alternative and innovative approaches (Chimonidou, 2000).

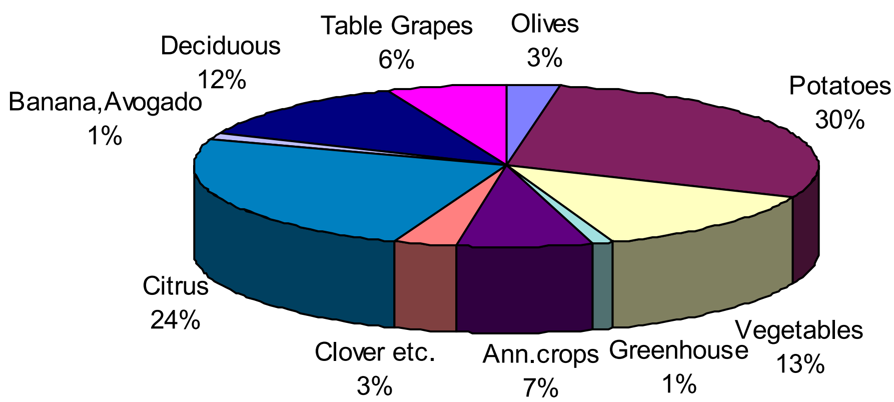

Fig.1: Irrigated area by Crop (35100 ha)

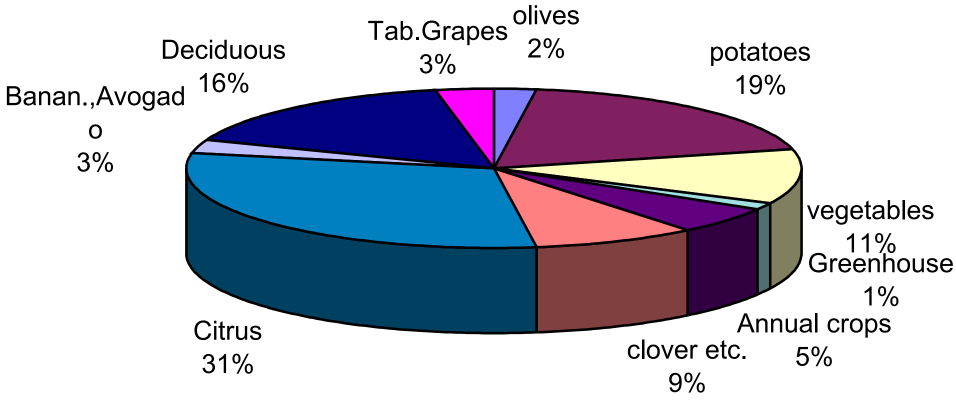

Fig.2: Water use by Crop

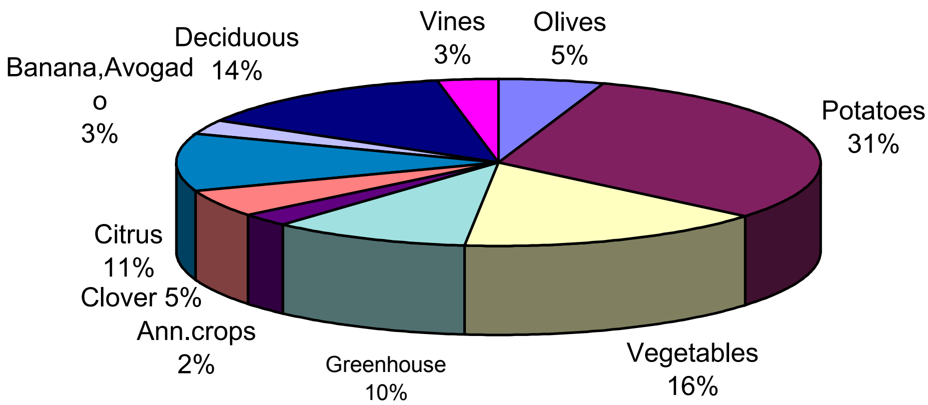

Fig.3: Value of Production for irrigated Crops (Producer's price)

SOILLESS CULTURE

Recently, particular attention was given in soilless cultivation and the area under soilless culture is rapidly expanding. There are various reasons for changing from soil growth to soilless cultivation:

- Higher water use efficiency.
- Increase of yields. For fruit (i.e. strawberries) and vegetable on substrate, yields can be increased by 10-15% and for flowers by more than 30-40%.
- Disinfecting. The use of methyl-bromide is harmful to the environment and restricted by the government. Steaming the soil is expensive. By using substrates disinfecting is avoided. Steaming and reusing the substrate is also less expensive than steaming the soil.
- Energy-saving. For warming up the root system less energy is needed when growing on substrate, compared to growing in the soil. There is also less risk of too high relative humidity

when warming up the root system in a greenhouse where screens are used. The energy used per unit of product is also less, because the yields per m^2 of area increase. Moreover, decreasing the number of working paths, results in a better use of space.

- Growth control. Growth of crops on substrates can be controlled better. This not only improves the quantity, but also the quality of the product.
- Improving labor conditions. The change to soilless culture opens the possibility to bring the crop to the workers, instead of the workers having to go to the crop. Hence, the position of the crop can be adapted to be comfortable to work with.
- Avoiding hazardous amounts of harmful compound in vegetables. The risk of contaminating land with undesirable elements has increased considerably in recent years. By applying soilless culture, vegetables will not contain these elements in high concentrations and risk for man of taking harmful amounts of these elements is avoided.
- Avoiding of soil born diseases and better aeration of the roots especially in countries like Cyprus with heavy clay soil conditions.
- Avoiding cultural practices (i.e. digging, weed control, etc).
- Saving of water and fertilizers from deep penetration and surface flow out.
- Use of areas that the soil conditions are not suitable for cultivation.

Experimental work at ARI

Cultivation of Roses on substrates

A joint programme between the Agricultural University of Athens - Greece and the Agricultural Research Institute of Nicosia - Cyprus (2001-2004), aimed at studying the development and photosynthetic activity of roses cultivated in four different substrates and two irrigation regimes.

Roses cv "Eurored" were cultivated on four different substrates in a heated greenhouse at the ARI using local materials i.e. perlite 100%, mixtures of perlite 50% with pomace 50%, perlite 50% with almond shells 50% and almond shells 50% with pine bark 50%. The two irrigation regimes applied, were 800ml (6 times/day X 2 min) and 530ml (4 times/day X 2 min). The pH and the EC were kept constant at the levels of 6,5 and 1,7-1,8 DS/m respectively. Drainage for both cases was only 5%. The photosynthetic rate, stomatal conductance, CO2 concentration and transpiration rate of the rose plants were measured, as well as the total productivity and quality characteristics (stem length, fresh weight) of the roses produced.

Results on the relation between the stomatal conductance and the % of moisture of the substrate showed that when the percentage of moisture of the substrate reached the lower price of 2,7%, the stomatal conductance reached the maximum value of 8 sec/cm. The minimum value of stomatal conductance (3,8 sec/cm) was obtained when the value of moisture content was 11,5%.

Effect of irrigation and substrates on the production

Concerning the interaction between substrate and irrigation level, higher production was recorded with the roses growing on the substrate of pine bark 50% and almond shells 50% irrigated with the reduced irrigation level followed by the substrate of perlite 50% and pomace 50% irrespective of irrigation level. However, no significant differences were recorded concerning the quality characteristics and the roses produced under all treatments were marketable with mean stem length between 75-97 cm.

Irrigation level irrespective of substrate did not have any significant effect on the quality or quantity of the roses produced. On the contrary, the effect of the substrate was pronounced and higher productivity was recorded in the substrate of pine bark 50% and almond shells 50%, followed by the substrate of perlite 50% and pomace 50%. Significant differences were observed also on the weight of the flower stems of the roses produced on the substrate of pine bark 50% and almond shells 50%.

Physiological Activities

No significant differences were observed concerning the photosynthetic rate, the stomatal conductance, the CO2 concentration and the transpiration rate under the four substrates and the two level of irrigation. Differences on the value of the parameter Fv/Fm under the different treatments were not statistically significant and under the obtained values, plants did not suffer from dysfunction of their photosynthesis centers and photosynthesis ability of the leaves.

During the three years duration of the programme, result of rose cultivation for intensity of luminous radiation PAR 500 μmol m^{-2} s^{-1} but also for lower intensity of luminous radiation, PAR 75-90 μmol m^{-2} s^{-1}, showed that the photosynthesis rate, the stomatal conductance, the CO_2 concentration in the intercellular spaces and the transpiration rate, did not show statistically significant differences between substrate and irrigation level. It seems that the lower irrigation level did not create conditions of water stress and did not affect negatively the physiological activities of the rose plants. Concluding remarks showed that the local substrates could be used successfully as substrates for the rose cultivation in the region.

Cultivation of Lysianthus (Eustoma grandiflorum) in substrates

Experiments on Lysianthus were conducted during the 2001-2004 at the Agricultural Research Institute and at Zygi Experimental Station, aiming at higher productivity and year-round production.

The productivity and quality characteristics of *Eustoma grandiflorum* on two substrates and under two irrigation regimes were evaluated. The substrates used were perlite 70% plus coco 30% and perlite 50% plus pomace 50%. The irrigation was performed using drippers of 4l/h and the irrigation intervals were: 6 times x 2 min (800 ml/ day) and 4 times x 2 min (530ml/ day = reduction 33%). The pH and the EC were kept constant at the levels of 6,5 and 1,7-1,8 DS/m respectively. Drainage for both cases was only 5%. Results showed that no significant differences existed between the different substrates or the stressed and not stressed plants with respect to total productivity (number of stems) or the quality characteristics (number of flower buds, stem length and fresh weight) of *Lysianthus*. Vase life of the plants was not affected by the cultivation in different substrates. On the contrary, the plants under the low level of irrigation lasted more days in vase with or without preservative (Chimonidou et al., 2003).

Modern Irrigation Technology

Modern irrigation technology has moved very rapidly from an experimental technique to a commercially significant method of irrigation. The ability to carefully control water application not only offers improved efficiency in the use of an increasingly scarce natural resource for agriculture, but also opens the door to new and more efficient ways to manage fertilizers and other agricultural chemicals.

Recent innovations designed to adapt drip irrigation to different conditions include moving units, simplified bubbler systems, and the promotion of spitters or micro sprinklers rather than drippers. Perhaps the most significant trend has been towards greater control and automation of the frequency and amount of water application, using programmable computer-based systems and including such devices as sequential metering valves and sensors to monitor weather and soil moisture variables. More recently, new drip-irrigation systems have been introduced for use with wastewater in both agricultural and garden settings. The rubber tubes of these pipes have a labyrinth “toothed” water passage, which facilitates superior filtration. Chemigation and particularly fertigation are yet other developments of major importance (Papadopoulos, 1996).

HYDROPONIC SYSTEMS

The open system for soilless culture is at present the most favoured commercially in Cyprus due to its simplicity, mainly in managing the nutrient solution.

Pollution of the environment (underground water), waste of fertilizers and water are though only some of the problems faced in open hydroponic systems. The leachate is usually collected in a reservoir and is used for the fertigation of open cultures or greenhouse cultivations in the soil. This results in approximately 30 % loss of fertilizers and water from the system.

For this reason ARI started a research program in order to develop a locally adopted closed hydroponic system, using locally available inert substrates, like crashed gravel produced in a copper mine in Cyprus. The leachate from the substrates is collected in a tank and is recirculated after being sterilized passing through a UV lamp. The EC and pH of the water are regulated using an automatic fertilizer-mixing unit as by the open system. The water consumption of a good managed closed system is reduced to the evapotranspiration level of the plants. The system requires water of very good quality that is difficult to find in Cyprus. At the coastal areas where greenhouse cultivation has developed due to the favourable climatic conditions, the ground water salinity ranges from 1.5 to 4 dS/m, whilst the salinity of water coming from dams is around 1 dS/m. The fresh water supplied to the closed system can be therefore rainwater collected from the greenhouses or water treated by a small reverse osmosis unit. Thus the need for replacing the nutrient solution due to the increasing concentration of chlorides and sodium is minimized. The experiments are carried out at the ARI research station at Zygi on tomato cultivation (Polycarpou and Hadjiantonis 2004).

In addition, an open system using a mixture of locally available organic materials with perlite or peat moss as substrate is being studied in floriculture. In this "zero loss" system, the nutrient solution is supplied to the plants, planted in big boxes (substrate volume 15 liters/plant), in such a quantity that leaching just starts. In this way the water and fertilizer loss from the system is minimal. The salts are pushed by the irrigation water away from the root zone and are accumulated in the outer volume of the substrate not affecting the growth of the plants.

In designing and operating such a closed hydroponic system the following main parameters are to be considered:

- Crop related matters such as the life span of the crop, the water and nutrient requirements (recipe),
- and the cultural practices needed.
-
- Method for fertilizer mixing and supply of irrigation water (Using simple volumetric fertilizer injectors or automatic fertilizer mixing units).
- Use of locally available inert substrates like perlite, coarse sand, crashed gravel vs. imported inert materials like rock wool.
- Climate Control in Greenhouses, like monitoring the aerial climate requirements (temperature, relative humidity, light, CO_2, etc), the root zone requirements (root temperature and O_2 supply in the root zone) and improving the PAR transmission of covering materials and lowering their NIR transmission.

Due to the advantages of the closed hydroponic system compared to the open one, ARI is investing a lot of effort in optimizing its parameters, simplifying its operation and training the growers in its effective management and utilization (Polycarpou and Hadjiantonis 2004).

WATER RESOURCES ASSESSMENT AND WATER POLICY

Water Supply

The maximum quantity of water, for calculating its availability for planning purposes, is the mean annual long term precipitation that is 513 mm (1987-2000) times the area that is 9250 Km^2. It corresponds for the whole island to approximately 4600 million cubic meters (MCM) of water per year. More than 80% of this returns to the atmosphere through evapotranspiration. Only the remaining 20% i.e., about 900 MCM can be considered as the actual water available for use. From this, 600 MCM is surface water and the rest i.e., 300 MCM, flows into the aquifers. The above are estimates of 1970 and refer to the whole island. They are based on rainfall-runoff and groundwater hydrology relationships of past years. Since then, rainfall has decreased considerably, more than 13%. Consequently there is a marked decline of the surface and groundwater sources. It is estimated, that the reduction may be as high as 30 to 40%. A reassessment of both the surface and subsurface hydrology is urgently needed, for meaningful planning and management of the water resources of the island (Socratous 2003).

The drastic reduction of the water supply couple with the concurrent increase of the demand for water have brought about the full utilization and even overuse of the available traditional water sources, i.e. groundwater and surface water. Groundwater is reliable, clean and cheap when compared to other sources. The result is that all aquifers in Cyprus are today exploited beyond their safe yield, which is estimated at 230 MCM per year. The excess pumping over natural recharge is in the order of 40 MCM per year. The result is sea intrusion into most of the coastal aquifers. The Government of Cyprus embarked in 1960, the first year of its independence, into an ambitious program of tapping the surface waters that used to be lost into the sea. This program was in essence a comprehensive water resources program that was produced in 1967 to 1970 with the technical help of the United Nations Development Programme. Thanks to this program the storage capacity of surface reservoirs has reached 304,5 MCM from a mere 6,1 MCM in 1960. The yield of these reservoirs is about 130-150 MCM/year. This value is now seldomly reached because of the decline in rainfall and hence of runoff (Socratous 2003).

Now, as the conventional water sources are reaching saturation in their development the Government is planning the use of treated sewage as the additional main source for water supply for agriculture and the use of desalination water for domestic purposes.

The first large sewage treatment plant in the Government controlled areas started operation in Limassol in summer of 1995. Sewage treatment plants are now under design or construction in all the major cities and sensitive mountain villages of Cyprus. All municipal sewage treatment plants have provisions for tertiary treatment. Projections estimate that the volume of reclaimed sewage effluent will increase to 25 MCM by the year 2020.

Desalination of seawater was first introduced in Cyprus on a large scale basis, on the 1st of April 1997, with the operation of the 20 000 m3/day reverse osmosis Dhekelia plant. Due to the drought prevailing at the time the plant was soon expanded to 40 000 m3/day. The plant operates on a Build, Own, Operate, Transfer (BOOT) basis and the desalinated water is presently sold to the Government, at source, at a varying unit price which is about £0,54/m3. A new seawater desalination plant, of 51 667 m3/day nominal capacity, has been constructed next to the Larnaca airport. It started normal operation in February 2001. This too, is a reverse osmosis BOOT type plant. The cost of the water from this plant is only £0,43/m3. However, the present tragic situation demands the construction of another 30 000 to 40 000 m3/day seawater desalination plants. In this way the domestic water demand for water will not any more be dependent on the vagaries of the weather.

Other, tertiary or exotic sources of water supply, such as, importation of water from abroad, artificial rainfall, undersea fresh water tapping, underground deep drilling and evaporation suppression from water surfaces are not economically justifiable and/or risky and unreliable (Socratous 2003).

Water Demand

Domestic use and irrigation are the two main sectors of water demand. The total water consumption in the Government controlled areas in 1994 a year having no appreciable water supply restrictions was 235 MCM, of which 55 MCM was for the domestic sector. The industrial and tourist demand were 6 and 11 percent respectively of the total domestic consumption. Gross and net consumption of water was 220 l.p.c.d. and 140 l.p.c.d. respectively. This compares well with consumption in most European countries. As the tourist industry seeks new forms of recreation e.g. golf facilities, the water demand for recreation will be increasing. It is conservatively estimated that the domestic water demand will rise to 100 MCM in 2020. Irrigation water use in 2005 in the Government controlled areas totalled to 182 MCM i.e., 77% of the total water demand. More than half of this amount was supplied from Government water works. The demand for irrigation water will increase to 225 MCM by 2015. Demand for irrigation water is expected to remain stable thereafter.

Water Management

In making the supply meet the demand the Government policy has encouraged and adopted such management measures as water rationing, increase of public awareness for water conservation measures and water pricing for improvements in the water use efficiencies.

Water rationing has been extensively applied in an attempt to curtail the demand in periods of drought. This has allowed the authorities in the last year to reduce the water by 20% of the normal demand for domestic purposes and by 67 percent for irrigation purposes. Water conservation measures include subsidies for use of inferior quality groundwater or the treatment of the gray water from households for the flashing of toilets and irrigation of house gardens in the cities. Furthermore the campaign for raising the “water awareness” of the public towards water conservation proved to be successful. Now, water pricing is an integral part of the Government policy on water. Water for municipal including industrial, commercial and tourist purposes is sold at full cost, while irrigation water is heavily subsidized by as much as 77 percent. The Governments´ policy towards agriculture is very generous and this has contributed to the selection of non-efficient cropping patterns and even to the wastage of water. It should be noted that in the last six years the water tariff for the domestic sector does not reflect the full cost as is formed with the recent introduction of the comparatively expensive desalinated water. The subsidy is as high as 34 percent. The present price of the water to agriculture and domestic sector is 6.5 c/m3 and 33,5 c/m3 respectively (Socratous 2003).

For 2006, Cyprus Government has decided to curtail the water supplied for irrigation both for permanent and annual crops as well as for glasshouses and clover. The above decision was taken, taking into consideration the needs for irrigation as well as to preserve water reserves in case of possible drought next year. The measures to be taken for summer 2006 are as follows:

- Water supply for covering 50% of permanent crops demands in order to keep them alive except for the district of Pafos where water reserves are enough to cover 75% of crop demands, keeping reserves for next year as well.

2) Water supply for covering 20% of seasonal crops demands in all regions, except the district of Pafos where water reserves are enough to cover 75% of crop demands. In addition, at Famagusta district, water will be supplied in order to cover water demands of subjected crops, as well as water demands of early potatoes.

3) Water supply for covering 50% of water demands of crops in greenhouses. Water will be enough to cover the demands of one crop instead of two, which is the usual method.

Tables 1, shows the water balance and water reserved in dams in 2005/06, after the application of the above measures.

In addition to the above, the Ministry of Agriculture, Natural Resources and Environment have announced measures for saving drinking water, such as subsidizing the excavation of private drills for irrigation and other domestic purposes, promote the installation of domestic water recycle systems and initiate campaigns for public awareness.

Table 1. Water Balance and Water Reserved in Dams for the years 2005/06

	Water Sources	MCM
Water reserves in dams on 1/1/2005		189.0
Plus	Water flow in dams	47.0
	Desalinization units	30.0
	Drills	16.0
	Recycled water	3.5
Less	Watering	-73.0
	Irrigation	-63.0
	Evaporation, losses, enrichment	-21.5
Water reserves in dams on 1/1/2006		128.2
Plus	Water flow in dams	16.3
	Desalinization units	25.5
	Drills	15.8
	Recycled water	3.5
Less	Watering	-73.0
	Irrigation	-39.5
	Evaporation, losses, enrichment	-16.3
Water reserves in dams on 1/1/2007		60.5

New Water Policy

It is apparent, by a simple comparison of the supply and demand, that the current water situation is not sustainable. The recent droughts of 1989/91 and 1995/2006 demonstrate quite convincingly how critical the water situation may become. A new water policy is warranted that will bring about sustainability. The new water policy should include the following specific measures.

a. Secure additional sources of supply
b. Ensure efficient use of available water
c. Modify the current irrigation water allocation matrix
d. Built up strategic water reserves
e. Maintain and enhance the quality of water

f. Introduce new effective/efficient management procedures through the establishment of a Water Entity

These measures should be holistically applied. Each measure compliments the other.

The basic water policy of the Government is the production of desalinised sea water, the use of non-conventional sources such as the use of recycled water for irrigation, recharge and amenity purposes, the desalting of brackish water, the efficient use of available water including the better use of pricing and water conservation measures, the harmonisation with the European acquis, the protection, preservation and improvement of the water quality, the introduction of new effective management procedures through the establishment of a Water Entity and the development of the remaining existing water resources with the construction of dams until 2015.

CONCLUSIONS

Water is by far the most precious resource in Cyprus. The quality of life and almost all economic activities depend upon the presence of an economic water supply. The present water situation is not sustainable in spite of the impressive development of the conventional surface water sources in the last four decades. Much has been done but still a lot remains to be done in the realm of water resources development and management. A new approach is presented that ensures sustainability of the water sector of the island.

The targets of this new plan are summarized below:

a. The relief of the domestic sector from the vagaries of the weather
b. The increase of water tariffs for all uses
c. The use of recycled water for amenity purposes and irrigation
d. The formation of underground strategic reserves
e. The reduction of horizontal expansion of irrigation
f. The changing of the cropping pattern to less water demanding crops
g. The preservation and further enhancement of the water quality
h. The formation of a Water Entity

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