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WATER USE EFFICIENCY AND WATER PRODUCTIVITY IN MALTA

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SUMMARY – This paper is focused on the water use efficiency and water productivity of agricultural sector in Malta. Irrigation water demand is discussed in the view of limited water resources. The presents status of agricultural water use is presented pointing out the main factors of inefficiency in the use of irrigation water such as: a) losses in the storage reservoirs; b) losses in the conveyance of irrigation water; c) low efficient on-farm irrigation methods, d) inefficiency related to the irrigation systems setup and e) losses due to inadequate irrigation practices. Water productivity is analyzed from an economic point of view through a study on economic considerations regarding markets for water in the Maltese Islands. Two scenarios (wet and dry season) are elaborated by means of crop water requirements, costs and income of agricultural production. The cultivation of crops which have low crop water requirements but have a high economic return should be encouraged together with an extensive use of treated sewage water for agriculture.

Key words: water use efficiency, water productivity, economics, Malta.

INTRODUCTION

Agricultural activity accounts for 3% of Malta's Gross National Product and contributes to 2% employment. The total territory of the Maltese Islands encompasses 315 km2, of which approximately one-third is available for cultivation. The 10-11,000 hectares are shared by some 15,000 producers, mostly part-timers. Agricultural land census (2000) indicates that about 8-11 % of the whole agricultural land is irrigated whereas the rest is rain fed. The average annual rainfall is approximately 550mm and the effective precipitation is 300mm per year. Taking into consideration that the rainy season extends from September till March, vegetables and summer crops cannot be grown unless supplementary irrigation water is available. In a region where the availability of water is normally less than the water demand, aspects in water management such as use efficiency and productivity play a major role. The paper will address the current situation in the use of water efficiently and its productivity in Malta with special reference to agriculture.

PRESENT STATUS

Irrigation demand vs water availability

Mild wet winters and hot dry summers typifies a normal climate scenario in Malta. The unpredictable patterns of rainfall distribution and intensity make it difficult to forecast. With the bulk of precipitation falling during the month of October, water abundance is present when demand is relatively low, (germination stage). On the other hand, during peek growth and maturation natural moisture is almost completely absent. Irrigation is a must to ensure decent crop performance and yields. Summer crop are totally dependant on the availability of irrigation water. Mitschoff (1990) carried out an extensive report on water requirements of most crops cultivated in Malta. Using evapotranspiration and effective rainfall data at the time, he established that the total annual water requirements based on 30% cropping intensity was 12,319 m^3 per hectare of land. Thus, the total annual irrigation demand amounts to approximately 123 Mm^3. On a national level, assuming that 4.5 Mm^3 come from the sewage treatment plant, about 30Mm3 from rain water, about 89Mm3 must be coming from private groundwater extraction.

Water Use Efficiency

In theory, agriculture competes with other water users and this competition should induce the agriculture sector to enhance water use efficiency and productivity. Since water used for irrigation is still very affordable and does not carry a realistic price, water use in agriculture is used in a very careless manner. The main use of water in agriculture is without any doubt for irrigation. Sources of irrigation water range from rainwater to groundwater to treated sewage effluent (all three sources carry negligible costs to the farmer). The indiscriminate use of such waters has put an appreciable stress on the economy of Malta as all types of irrigation water have, to different extent, a monetary factor attached to it. Unfortunately to-date, irrigation methods are not so efficient. Several factors lead to inefficiency in the use of irrigation water. These include:

1) Inefficiencies in the storage of irrigation water.

There are three main ways in which irrigation water is stored for eventual use. The method of construction and operation of these water-bearing structures have led to water loss and hence resulted in an ineffective utilization of this rare resource.

a) Underground reservoirs and cisterns situated in fields and other rural areas:

The majority of these structures are excavated and constructed in bedrock. There are a good number of these are not sealed and/or partially plastered. Therefore water is lost slowly by infiltration into the rocks. Slow ground movements and expansion in concrete render those that are plastered liable to develop fissures and hence resulting in water loss. Silting results from heavy storms especially during the first storms of September and October. Unfortunately, the lack of maintenance of these reservoirs (re-sealing and cleaning from silt) mainly due to financial problems and lack of awareness for water conservation has led to reduction in the capacities of these reservoirs. Moreover, many reservoirs, especially cisterns situated in fields and other rural areas have been abandoned following the introduction of drilling boreholes and pumping groundwater directly from the aquifers.

b) Above ground reservoirs/soakpits (open top):

These are used mainly for the storage of water pumped from the aquifers, storage of water from the sewage treatment plant (in the South East area of Malta) and catching of runoff storm water. In general, these are kept in better condition since their maintenance is easier. Water loss from these reservoirs is mainly due to evaporation. (Figure 1).

Fig. 1. Above ground water storage reservoir in Malta

c) Dams:

Over the years, many dams have been constructed by the government in many valleys to trap run-off rainwater with the intention to retain soil as well as to store water for irrigation and for aquifer re-charge. A good number of these have never been maintained and/or cleaned since then, and today have silted up almost completely and therefore do not hold water. Others need extensive repairs especially on the sides from where water escapes downstream (Figure 2).

Fig. 2. Wied is-Sewda Dam in Malta

2) Inefficiencies in the conveyance of irrigation water.

a) Gravity systems:

Some gravity systems are still in use, especially where there are natural springs and in the South East area for the distribution of the treated effluent from the Sant'Antnin Sewage Treatment plant. Water is conveyed by means of open channels. These are constructed from a number of channel pieces, each one hewn out of stone or made from pre-cast concrete, placed end to end. Mortar or cement is used to bond the pieces of channels together. The mortar often gets broken due to subsidence of the channel support or by being accidentally hit, and water leaks out of the channels. Overflowing and evaporation is also responsible for a good percentage of the water losses (Fig. 3).

b) Pressurized systems:

Galvanized pipes and/or polyethylene (PE) pipes are normally used to convey irrigation water. The galvanised pipes are now rarely used. In general, the PE pipes used are of good quality and have a long life. Unless the pipes are corroded or punctured, the chances of water losses from these systems are lower when compared to gravity systems. On the other hand, if punctured, water losses could be high since the system would be under pressure. Generally leaks are observed near the joints and the connections between fittings.

3) Inefficiencies in the irrigation systems.

a) Furrow irrigation:

This method is still practiced in some places, but generally on small scale irrigation systems. Water use efficiency is considered medium to low, since a large volume of water is supplied in a relatively short time. This leads to considerable deep percolation and also evaporation.

b) Sprinkler irrigation:

This is the second most popular irrigation method used in Malta. It is mainly used for the irrigation of potatoes, fresh vegetables and fodder. The two main factors that make sprinkler irrigation not very suitable to Malta are the prevailing windy conditions and the fact that most of the fields are small and of irregular shape. This makes it very difficult to control the wetted area and this result in water losses due to it being thrown outside the field boundaries. Sometimes we observe that very powerful spray-guns are used. Apart from depositing part of the water outside the field, the soil is unable to absorb the water fast enough, and results in surface runoff. Irrigating with sprinklers around midday also results in large evapotranspiration losses.

c) Drip irrigation:

This is the most common irrigation system used in Malta. The water is used much more efficiently but we still observe over-irrigation in some places.

One can also note other problems associated with the setup of irrigation systems which eventually lead to water use inefficiencies.

4) Inefficiencies related to the irrigation system setup.

This is mainly the result of lack of technical information.

a) Lack of proper design of the irrigation system, mainly to undue consideration of pressure losses along the pipes, leading to problems in uniformity distribution. Not very acute in Malta since most fields are small and flat.

b) Improper layout of the irrigation system, especially sprinklers, which can also lead to uneven uniformity distribution and water losses out of the field boundaries (very common since fields in Malta are small and of irregular shape).

c) Omission of certain accessories from the system due to lack of know how or due to financial restrictions affecting the overall performance of the system, e.g., leaving out or using an improper filter from a drip irrigation system (because groundwater looks clean!), resulting in clogging of the drippers. Pressure gauges are usually installed the first time, but then neglected.

d) Not using the proper irrigation system and equipment suitable to the size of the field, type of crop and type of soil. E.g. using powerful spray guns in small fields.

e) Using cheap material or excessive recycling of certain items. Here again, the main cause is the financial aspect. E.g. re-using drip tape over and over again, even though many emitters had been clogged.

f) Lack of maintenance of the system, e.g. cleaning of filters and repairing leaks.

5) Inefficiencies due to improper irrigation practices.

This is mainly the result of lack of information on crop-water characteristics, soil moisture and evapotranspiration. The following are the main causes for these inefficiencies:

a) High or low application rates due to lack of know-how on the infiltration characteristics of the soil, resulting in surface ponding and runoff. This is especially true when high capacity drippers are used on clay soils and on the other extreme, deep percolation if low capacity drippers are used on sandy soils for a long time.

b) Lack of soil moisture monitoring and/or irrigation scheduling. Very few use sensors to check the state of moisture in the soil and to decide when and how much to irrigate. Irrigation scheduling among the farmers is still very primitive, usually based on past experience and by intuition.

c) Losses due to over irrigation during the early stages of growth when the crop uptake is low and the root zone depth is shallow, resulting in excessive evaporation from the wetted soil and deep percolation. Evaporation can be reduced by the use of mulching, but deep percolation cannot be stopped.

d) Missing water metering. Most farmers irrigate on a time base rather than on water volume needs.

e) Improper selection of crops according to water availability and water salinity.

Water Productivity

Water is a scarce resource that has a marked effect on the economics in any line of production and economic sector. However, its use and eventual possible re-use is constrained by economic, technological, physical, spatial and temporal conditions. Controlling its use will affect outputs and therefore on revenue.

The concept of economic efficiency when applied to agriculture can be termed as water productivity in agriculture. This is defined as the return obtained from one m^3 of water expressed in terms of added value of agricultural production. This is a result of the currently accepted concept that water has an economic value and as such any end user making use of water must perform in order to effectively compete for water.

In the study Economic Considerations regarding markets for water in the Maltese Islands, by Delia (2004), the share of water cost in the total production was obtained. The study was based on billed consumption only. It transpired that even if one excludes the cost of water for irrigation (14.5 million m^3) from secondary sources, the biggest consumer of water for production purposes remained agriculture with 2.4 % of the total input value. Electricity and the service and tourist industry come after with 1.63 % and 1.46 % . (Table 1)

Table 1. Water requirements per LM100 of output (Source: National Statistics Office, National Accounts of the Maltese Islands, Input Output Tables

	Water requirements per Lm100 of output	
Industry	**3-year average output in Lm'000s**	**3-year average water requirements per Lm100 of output**
Agriculture	1097	2.4
Mining and quarrying	14	0.37
Food	118	0.43
Beverages	183	0.78
Tobacco	1	0.19
Textiles	22	0.32
Footwear	2	0.17
Wearing Apparel	25	0.19
Furniture/Fitting	22	0.19
Printing	18	0.14
Leather	13	0.44
Chemicals	30	0.2
Non-metallic Minerals	45	0.15
Metals	14	0.18
Machinery	60	0.05
Rubber/Transport & Shipyards	110	0.4
Miscellaneous	73	0.32
Construction	82	0.3
Gas	5	0.36
Electricity	507	1.63
Services and Tourism	3076	1.46
Other production and trade	3539	0.79
Other industries	/	0.2

However, though water is an essential input, when one comes to decide what to produce, other issues must be considered. Infrastructure, labour and marketing risks must also be considered. Farmers need not only to consider the volume of water used to grow their crops but also should take into account the net benefit they eventually get from the crops. Needless to say, this line of action can be extended to the other water competitors.

In an exercise carried out by Borg Victor P.,1997, were evaluated the following considerations:

- absorption per crop throughout the year,
- the profitability per crop after accounting for prices fetched on the market, and
- total costs

It should be noted that in actual fact, the prices which could be obtained to-date for agricultural products were in a sheltered market environment i.e. quotas and tariffs are used to protect the local produce. Moreover, the relatively low cost of water used for irrigation has also a marked effect on the low total production costs.

In the above mentioned report by Borg, two water requirements scenarios were considered namely:

Scenario 1: during the wet season, when the evapotranspiration is lower than rainfall and most, if not all of the crop water requirements are met by rainfall (Fig. 4);

Scenario 2: during the hot and dry summer period when the evapotranspiration is higher than rainfall, rainfall meets, if any, little of the crop water requirements and hence, other sources of irrigation water are required (Fig. 5).

Data indicate that considering scenario 1, melons and watermelons would require the highest amount of water to grow whilst onions the lowest. However, under scenario 2, the broad beans consume more water than melons with onions still needing the least.

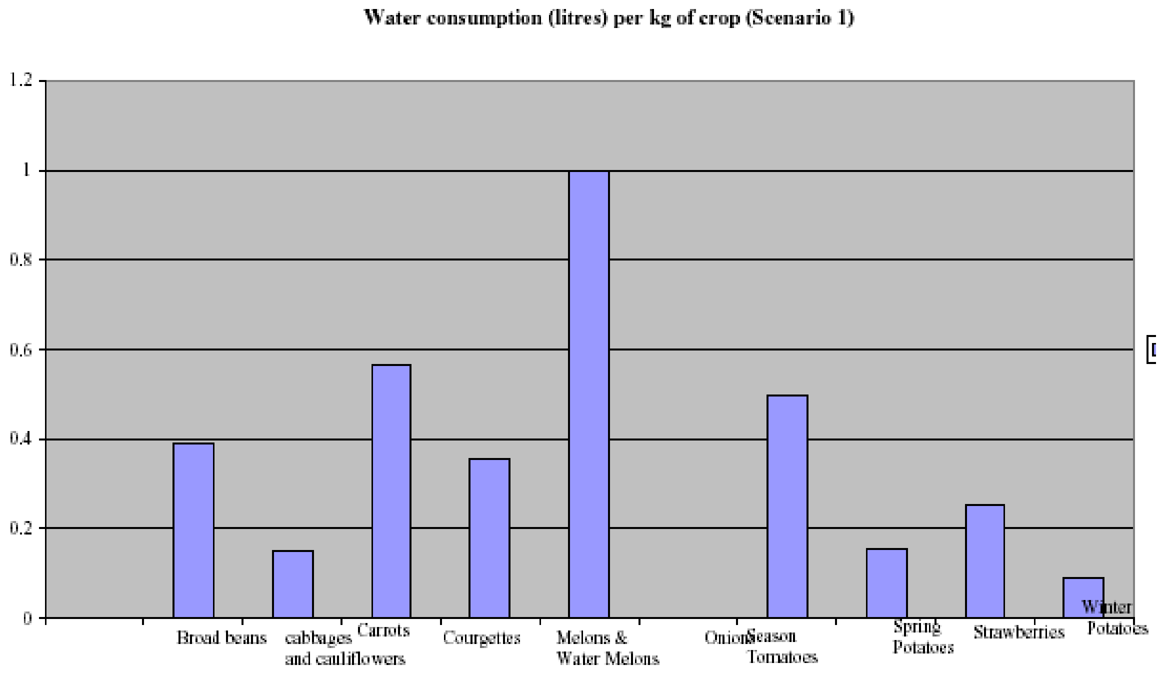

Fig. 4. Water consumption (in liters per kg of crop) according to Scenario 1

When considering costs and the net benefit per crop, under scenario 1, cauliflowers and onions yielded the better value for the efforts inputted in the growing of the crops (Fig. 6). Strawberries were seen to be grown at a loss. When the same analysis was made during the dry season (scenario 2), courgettes, melons and watermelons, onions and cabbages and cauliflowers gave the best values (Fig. 7).

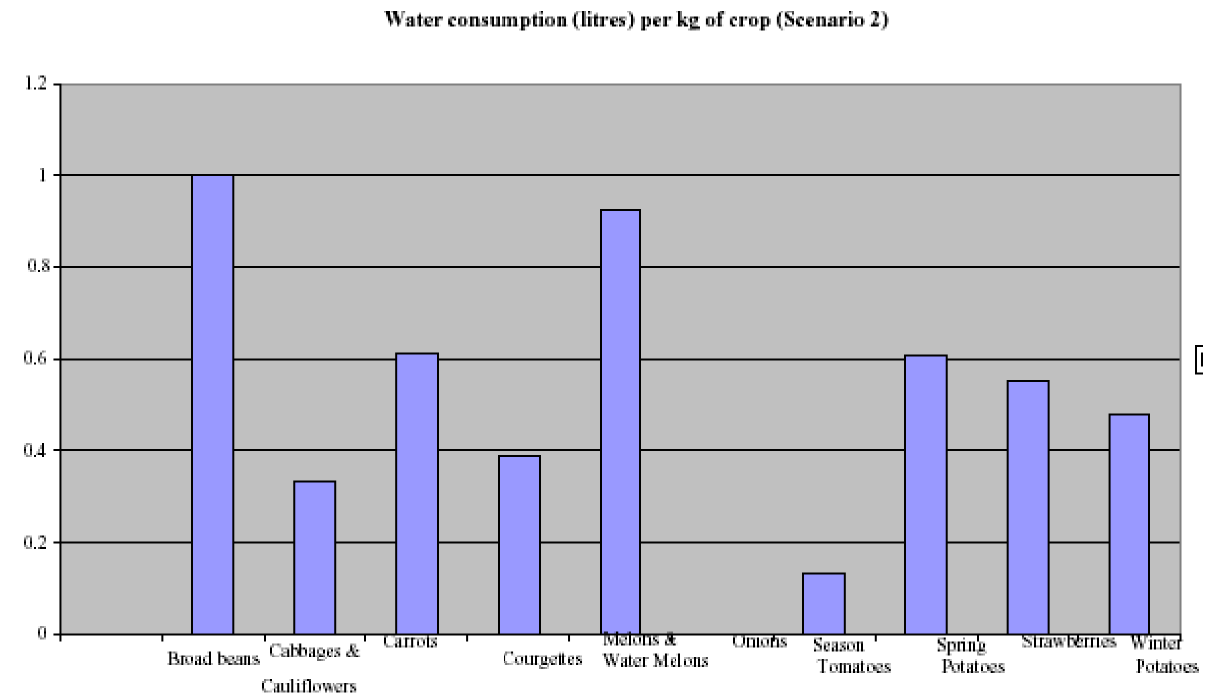

Fig. 5. Water consumption (in liters per kg of crop) according to Scenario 2

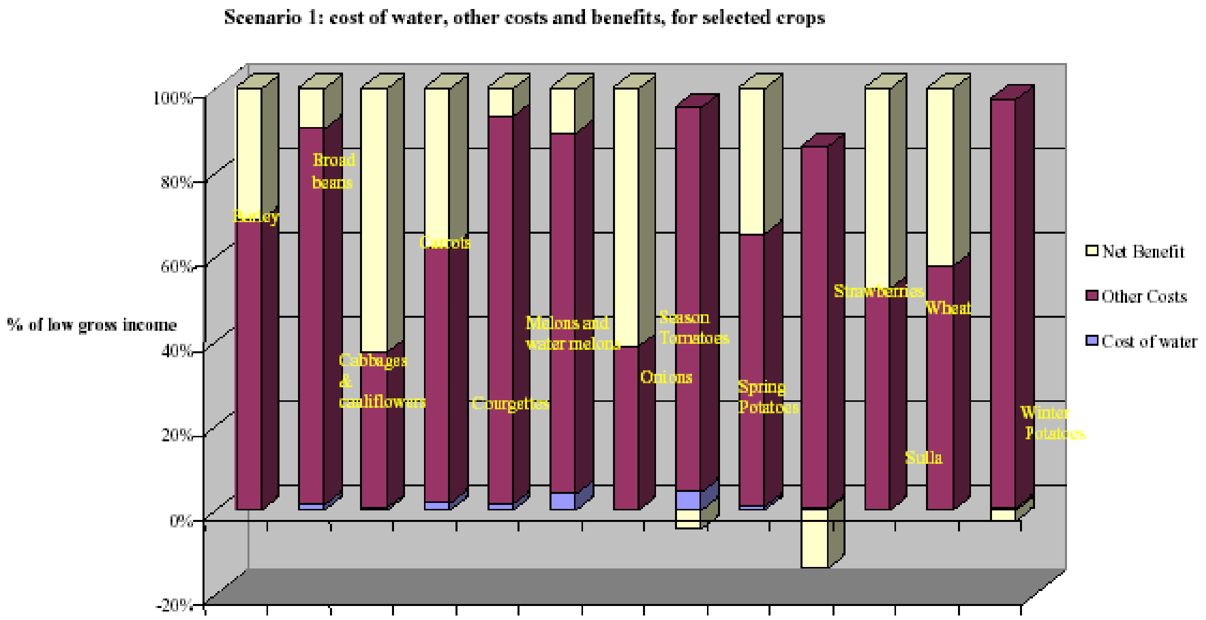

Fig. 6. Percentage of low gross income for Scenario 1

When the consumed water and the net benefit per crop were integrated, it became evident that in a low water requirement scenario (scenario 1 – Fig. 8), the crop with most net benefit was onions. However, when the water demand was high (scenario 2 – Fig. 9), courgettes is the crop with the higher net benefit.

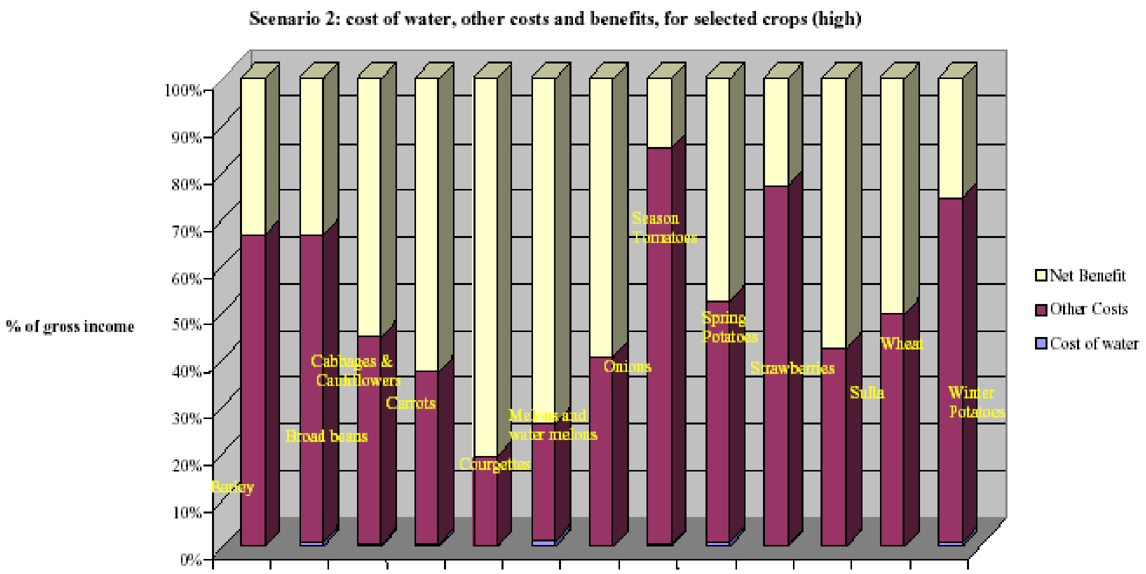

Fig. 7. Percentage of low gross income for Scenario 2

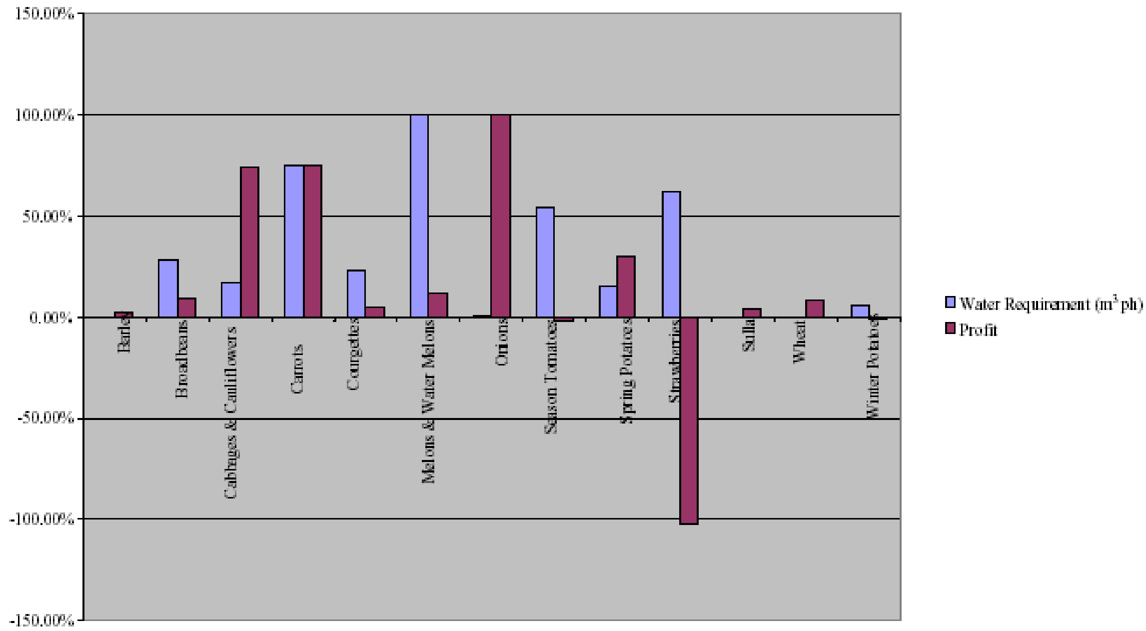

Fig. 8. Valuing irrigation water: water requirements and profit for Scenario 1

From these analyses, it was evident that prior to any water and agricultural management policies are formulated, other studies specific to different time periods need to be carried out on different commodities.

CONCLUSIVE REMARKS

The problems mentioned in this paper regarding the inefficiencies in the use of irrigation water must be dealt with both on the national as well as on the local level. With regards the local level, the farmers must start adopting irrigation practices which give more importance to water-use efficiencies and hence water savings. This would eventually add up to less stress on the country's need to provide more and more water. Hence, the National Economy will benefit.

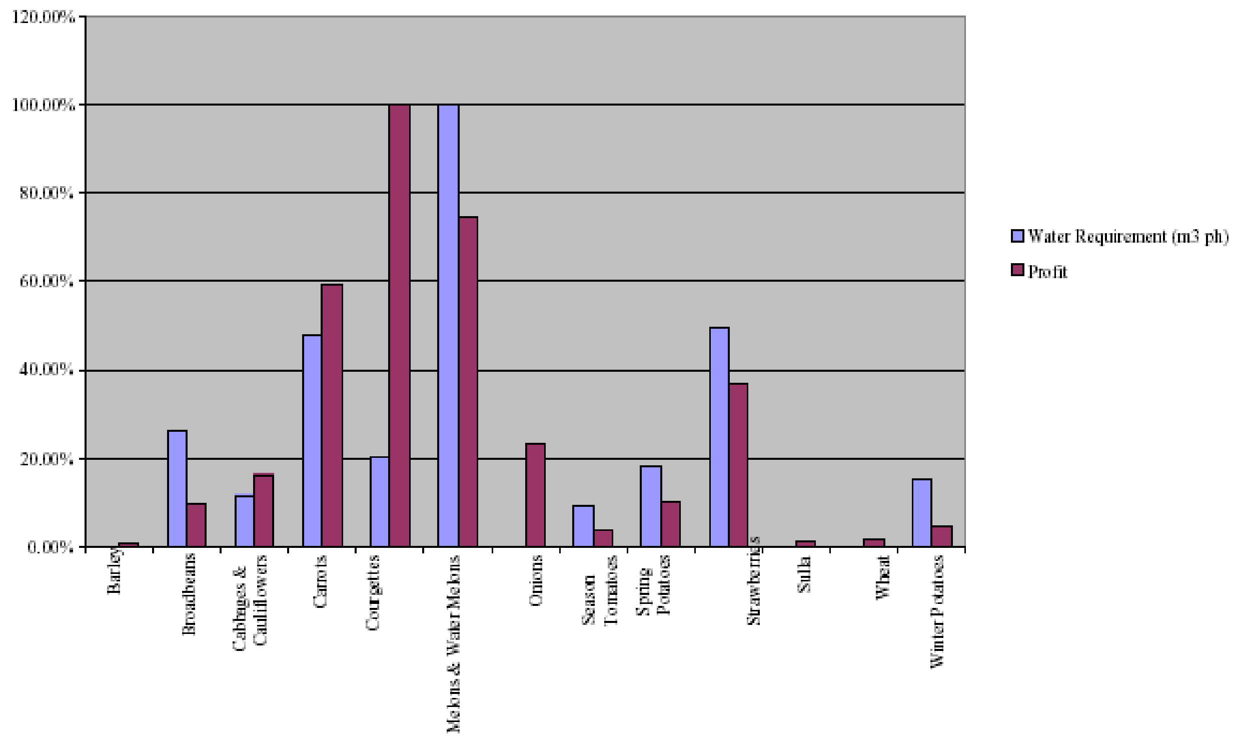

Fig. 9. Valuing irrigation water: water requirements and profit for Scenario 2

With the introduction of new and larger sewage treatment plants, more irrigation water will be made available. The locations of these plants do not necessarily match or coincide with the water requirements and proposing large distribution systems to meet all requirements is definitely not recommendable. Transporting treated sewage effluent via road water tankers (which already transport groundwater all over Malta and Gozo anyhow) would be a novel thing and definitely would render a three-fold benefit namely:

- involve the private sector in water distribution,
- eliminate the need to allocate large amounts of capital in a water distribution system as well as associated operating costs related to monitoring, pumping, water accounting, theft etc. and
- last but not least by so doing most if not all water tankers which presently are used to transport groundwater which is being extracted uncontrolled and illegally, will be used solely to transport irrigation water originating from the treatment plants.

With regards to water productivity in agriculture, in areas such as Malta where water is scarce but has a high economic value, the cultivation of crops which have low crop water requirements but have a high economic return, should be encouraged. It should be noted that in Malta, approximately 56% of the total water production for potable purposes is produced by very expensive desalination plants. It has been estimated that 80% of this ends up in the local sewers. This implies that artificial water available for irrigation has an even higher economic value. Moreover, as mentioned previously, the excessive extraction of groundwater for irrigation and hence increased salinities has exacerbated matters and the economic value of water is even higher. Thus, water productivity in agriculture is of utmost importance.

Producers have to be made aware so as optimal use of water is practiced and that utilizing water efficiently could be attractively be linked to profitable returns (value per unit output). Efforts should concentrate at channeling water to be used on crops that generate the highest value added. This could actually act as the incentive to eventually reduce water consumption and hence water production costs through increased water use efficiency and water productivity.

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