INTRODUCTION

"Water is the elixir of life"
STUDIES ON WATER STRESS MANAGEMENT IN MULBERRY (MORUS SPP.) WITH RELEVANCE TO SILK PRODUCTION FOR SUSTAINABLE SERICULTURE UNDER TAMIL NADU CONDITIONS

CHAPTER - I
INTRODUCTION

Water is undoubtedly the elixir of life. Whether it be for irrigation, drinking, & sanitation or for the protection of natural ecosystems & providing goods and services for growing populations, without water, life on earth is just impossible and hence it is “lifeline”. India though occupies 2.4% of the world’s land area, it supports for 16.66% of world’s population with only 4% of world’s water resources. The long-term average annual rainfall for the country is 1160 mm, which is the highest anywhere in the world for a country of comparable size (Lal, 2001, Gupta and Deshpande 2004). However the annual rainfall in our country fluctuates widely and certain parts of the country especially the southern peninsular receive either poor or scanty rainfall results in drought. Central Water & Power Commission and Irrigation Commission have assessed our country’s water potential. The average annual surface flow is assessed as 1953 km$^3$ of which 690 km$^3$ is utilizable and the utilizable ground water potential assessed as 396 km$^3$ (Rakesh kumar et al., 2005). Hydrological Cycle of India presented in Fig. 01.

Massive shifting of irrigation from surface water to ground water from the level of about 33% during 1960’s to more than 50% in three decades reduced the ground water level and quality of irrigation water considerably (Swaminathan, 1994). The requirement of water in our country at present is estimated as 710 km$^3$ which is expected to increase to almost 1500 km$^3$ by 2030 against a projected availability of 744 km$^3$ and deficit of 50 percent, where as globally it increases to 6900 km$^3$ from the present level of 4500 km$^3$ with the availability of 4100 km$^3$ and 40 percent deficit is expected in the same period (Narasimhan, 2010). Thus water is
likely to become critically scarce in the coming decades, continuous increase in its demands due to rapid increase in population and expanding economy in India (Ramasamy Iyyar, 2010). Worldwide agriculture is the single biggest drain on water supplies, accounting for about 69% of all use, about 23% of water meets the demands of industry & energy and just 8% goes for the domestic and commercial use (Anonymous, 2002). In India, agriculture sector uses about 93% of water whereas industry and domestic & commercial sectors use 3 & 4% respectively (Rakesh kumar et al., 2005).

IRRIGATION SYSTEM - IN THE PAST, PRESENT AND FUTURE :
IRRIGATION SYSTEM IN THE PAST (AGE OLD SYSTEM):

Earliest records date the first use of irrigation by Egyptians along the Nile river was about 5000 BC (Anonymous, 1994). Sophisticated irrigation and storage systems were developed by the Indus Valley civilization in Pakistan and North India, including the reservoirs at Girnar during 3000 BC (Rodda and Ubertini Lucio, 2004). By 2100 BC elaborate irrigation systems were in use, one of them was a 19 km (12miles) channel that diverted Nile floodwaters to Lake Moeris. The Sumerian relied much on irrigation to water fields in Southern Mesopotomia (now southern Iraq) as early as 2400 BC. Peruvians built sophisticated systems before Christ and early Native Americans in the same era had more than 101000 ha. of irrigated land in the Salt River Valley. Among the early devices used for lifting water from streams to higher-lying fields was the Egyptian “shadoof”, which is a bucket set on one end of a counterweighed pole. The Persian Wheel, still in use in India today, is a partly submerged vertical wheel with buckets attached to the rim. As draft animals rotating a geared horizontal wheel turn the wheel, the buckets are filled and emptied into a trough above that carries the water to crop (Anonymous, 1994).

A method far less burdensome than lifting water was that of building permanent dams farther upstream, whereby water could be raised to a desired level
and then allowed to flow by gravity through canals to low-lying areas, where it was let out over gently sloping fields. This method had been practiced on a large scale by early civilizations, using simple earthwork structures, was essentially the same principle as that of modern irrigation, using masonry dams.

IRRIGATION SYSTEM AT PRESENT:

Increase in demand for food, cloth, shelter etc., due to increase in population necessitated expansion of agriculture and other activities over the years. Advancement in research and technology in the field of agriculture though brought green revolution in agriculture production and improvement on unit area productivity, the major inputs like land, water, fertilizer and labour became scarce in agriculture sector. Over exploitation of water from all sources not only resulted in lowering of ground water level but also declined the quality of water to a greater extent especially different levels of total salt concentrations in different water sources necessitated the need for standard ratings for quality of water for both irrigation and drinking (Paliwal, 1971) and acute shortage of water in some areas. Attention of world agriculture scientists during the middle of 19th century was focused on water management studies for judicious use of water and enhance efficiency of the same in agriculture with the common objective of “More crop for drops” invented the novel “Micro-irrigation” system.

Sprinkler and drip (trickle) irrigation are the two popular methods of micro-irrigation system being adopted in agriculture worldwide. The basic principle of the micro irrigation system is to supply adequate water to growing plants i.e., to avoid excess standing water and to prevent exposure to water shortage. Though pressurized irrigation with sprinklers, introduced about 50 years ago contributed much for modernizing agriculture and increasing water use efficiency (WUE), drip irrigation system based on its suitability in arid and semi arid regions became popular with much efficiency in agriculture. The drip irrigation was first developed
in Israel and introduced in agriculture less than 35 years ago. Since then it has been disseminated all over the world with great success. Studies show that WUE under surface irrigation, sprinkler and drip irrigation are 45, 75 and 95% respectively.

While countries like Israel, Germany, Austria, Lithuania, Czech Republic, Great Britain and Slovak Republic have brought the entire irrigated area under micro-irrigation facility, several other countries yet to adopt the system fully, a list of some member countries of ICID and its irrigated area status are given in Annexure : 1 (Anonymous, 2010). Despite this development, its relatively high capital costs have been major constraints in developing countries like India, which has been estimated to be 10.5 mha potential for drip irrigation. However only about 2.0 mha area covered under drip irrigation which is less than 2% of total irrigated area. in our country. Studies on drip micro irrigation in India revealed 30-79% water savings; yield increase of 2-98% over conventional irrigation systems and is practical for both small & large farms and for hilly tracts, coastal sands and arid zones of southern & western parts of the country (Sivanappan, 1994).

A simplified low cost drip system developed at a capital costs to $250 / ha. tested in Nepal showed encouraging results where in all farmers at least doubled their irrigated area and reduced the labour by half and in India with water often pumped from deep tube wells the introduction of the low cost drip system showed promising results. After adaptation of the system in meeting the needs of mulberry crop, an initiative was made to disseminate the same to small mulberry farmers in the states like Andhra Pradesh., Karnataka and Tamil Nadu etc., (Polak et al., 1997).

As water is applied directly to the root zone of the plant in drip irrigation water loss due to evaporation, seepage, and soil erosion due to run-off is avoided. Water saving and additional area coverage with same amount of water used in conventional type of irrigation and increased WUE and good returns in a variety of crops are achieved through drip irrigation (Behera and Sahoo, 1998). Micro-
irrigation system saves irrigation water in different crops in different amounts, in field crops with surge 50%, drip 35-40% and sprinkler 24-30% and in vegetables, fruit crops with drip 50-70% are reported (Shekhawat and Singh, 1997).

**IRRIGATION SYSTEM FOR FUTURE:**

In addition to the wide popularization for expansion of the existing micro irrigation system in agriculture, further advancement in the system and introduction of Management Information System (MIS) on irrigation with the help of Computer Aided Design (CAD) / Geographic Information System (GIS) software packages for analysis and management as reported by Xanthoulis et al., (1998) in north Bali Indonesia is needed for all regions of agriculture intensive areas.

The MIS covering the information on ground water level, irrigation system planning, operation parameters, crop monitoring etc., Map with details of existing wells, ground water profile, salinity studies etc., for selection suitable drilling site, scheduling and preparation of calendar for irrigation for different crops for use by extension staff / farmers etc., on the line of study made by Panigrahi and Behera (1998) in Balipatna of Orissa - timing and amount of water for each irrigation for crops like cabbage, green gram, mustard, onion, tomato and maize. Use of remote sensing technology (Reginato, 1987) for measuring components of the energy balance at the earth’s surface shows great promise for managing farm water resources. Assess crop stress using reflected and emitted radiation measurements from vegetation areas, calculation of evapotranspiration and water budget procedure application to find out quantity of water required for irrigation are expected.

The Union Ministry of Water Resources reported at the International Conference on Plasticulture and Precision Farming held on 17-21 November 2005 at New Delhi that the government of India is programmed to irrigate an additional area of 10 million ha in next ten years. Off which 6.2 million ha would be through
drip and sprinkler (micro-irrigation) adding to the present level area of about 2.0 million ha under micro irrigation.

Successful implementation of System of Rice Intensification [SIR] in large scale areas > 1000 ha in states like Andhra Pradesh, Tamil Nadu, Karnataka, Kerala, Orissa and West Bengal to save water and other inputs > 50% in paddy cultivation is a novel proven new strategy introduced in agriculture sector pave way to allow similar ones to bridge the gap between WUE and crop productivity (Himanshu Thakar, 2007). As much as 90% of the total water is used for agriculture in our country. Hence, when one speaks of water management, the focus is only on agriculture. Even if 10% of water is saved, 14 m.ha. will benefit additionally. Existence of vast scope for saving water in drip irrigation, recycling of water for domestic uses and awareness among people on water conservation are the key for water management (Planisami, 2010).

Mulberry is a hardy perennial plant, cultivated by farmers for its leaves, the sole food for *Bombyx mori* L. silk worm for commercial production of silk. Next to China, India is the second largest silk producing country in the world with an annual raw silk production around 19000 MT and is unique in production of all known four varieties of natural silk namely mulberry, tasar, eri and muga. Mulberry silk is the most popular one contributing around 85% of the total raw silk production of the country. During 2009-'10 a total of 19690 MT raw silk production was achieved from 1.84 lakh ha mulberry plantation covering 8.18 lakh sericulture families from 50918 villages and employment opportunities for a total of 68.17 lakh persons have been provided by the sericulture industry. Apart from the above a sum of Rs. 2892.44 crores foreign exchange earned for the country through silk goods export (Anonymous, 2010). Of the total mulberry raw silk of 16322 MT produced in the country about 95 % is produced from five traditional sericulture states viz., Karnataka, Andhra Pradesh, West Bengal, Tamil Nadu and Jammu & Kashmir.
Out of total 1.84 lakh hectares area under mulberry cultivation in the country above 80% area is under irrigated condition which shows the importance of irrigation for the mulberry crop.

Silk industry has a long history and is a traditional occupation in Tamil Nadu. During late 1950’s mulberry area in the state was around 300 acres with very less raw silk production, mulberry cultivation and sericulture practice was restricted in the districts bordering Karnataka state. However the state has earned a prime status of being one of the major silk consuming states in the country since centuries, owing to the best branded design silk sarees production by traditional artisans from Kancheepuram, Arni, Kumbakonam and Salem with infrastructure facilities over 55000 handlooms and appreciable number of power looms with a total annual consumption of about 1200 MT raw silk. Further the state has emerged as one of the major silk producing state in India in the late seventies by occupying the fourth position. Now mulberry cultivation and sericulture is practiced in all 29 districts and during 2009-’10 a total of 1233 MT raw silk from 14220 ha mulberry area covering 22633 farmers have been achieved which account for 7.6% contribution of the national total mulberry raw silk and with a production of 351 MT bivoltine raw silk clinched 29.3% share of bivoltine raw silk production at the national level (Anonymous, 2010).

While average renditta of 6.97 during 2009-’10 achieved by the state which is 12.93% less than the national level renditta of 8 and major share on quality bivoltine raw silk production are the proven example for wide acceptance and dissemination of improved technologies in the field of sericulture at all levels coupled with rich potential silk weaving clusters in the state are considered as vital strength for the sericulture industry of the state on one side, but on the other side insufficient irrigation water availability for agriculture purpose in general and for mulberry cultivation in particular due to low rainfall or failure of monsoon and
frequent droughts is found to be the only major limiting factor which not only limits the vertical growth of the industry though the state possesses adequate cultivable land for expansion of mulberry area and many a times to struggle for even maintenance of the mulberry area and productivity at farmers level in the field and raw silk production at the state level.

**BACKGROUND FOR THE SELECTION OF THIS STUDY:**

**[PAINED ME MUCH AND INSPIRED ME VERY STRONGLY]**

National Silkworm Seed Organization (NSSO) (erstwhile National Silkworm Seed Project) of Central Silk Board (CSB) functioning under the control of the Ministry of Textiles, Govt. of India entrusted me to study the impact of severe drought prevailed during 2001-'02 to 2003-'04 in Tamil Nadu for submission of report to the Govt. The observations made by me while undertaking the task like people vacated their residence in groups from different villages after disposal of their domestic animals at very low price for want of fodder, people to take care and maintain same etc., and migrated towards urban areas like Tirupur, neighbouring state like Karnataka mainly to Bangalore for large construction works boon by the Information Technology Industry boom era, where several multistoried buildings / housing flats came in a big way in the sub-urban areas of Bangalore.

As the drought scenarios and the difficulties faced by the farmers pained me much and inspired me to do some thing to them beyond material help which should be unique and sustainable one for the entire farming community for whom I am dedicating my life over 25 years and the sericulture industry too which I am serving. Immediately after submission of the study report to the Director, NSSO., Central Silk Board, Bangalore, I set myself to undertake this studies. My desire when I submitted to the competent authority encouraged me at once and sanctioned me two years study leave to carry out the field experiments.
Initially a thorough scientific understanding on irrigation technology and crops was made by me through review of large volumes of literatures, earlier studies in the field of agriculture covering short-term and long-term crops including perennial crops and horticulture tree crops etc., its response to irrigation water in terms of water use efficiency and sustainable productivity without compromising the quality of the product, detailed discussions with water experts, irrigation engineers & scientists, agronomists, field specialists’ and statisticians were made before planning and preparation of experiments for this study keeping the concept “more crop for drops & sustainability”. And thus the present study was meticulously planned and carried out by me with due personal involvement, sincere efforts and full dedication with utmost care on every aspect of the study with the following main objectives.

**OBJECTIVES OF THE STUDY:**

- To study the impact of drought (2001-’02 to 2003-’04) on sericulture industry in Tamil Nadu state.

- To find out the minimum irrigation water requirement for mulberry crop for sustainable productivity under Tamil Nadu conditions without compromise on the quality of mulberry leaves and raw silk.

- To find out an appropriate irrigation system for mulberry cultivation with maximum water use efficiency (WUE) with sustainable productivity suitable for Tamil Nadu conditions.

- To draw a model irrigation calendar for mulberry crop for Tamil Nadu conditions for the benefit of sericulture farmers and field functionaries.