<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Particulars</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Preface</td>
<td>vi - vii</td>
</tr>
<tr>
<td></td>
<td>Abbreviation</td>
<td>viii</td>
</tr>
<tr>
<td>I</td>
<td>Introduction</td>
<td>1 - 9</td>
</tr>
<tr>
<td></td>
<td>Irrigation in the Past, Present and future</td>
<td>2 - 9</td>
</tr>
<tr>
<td></td>
<td>Irrigation system in the Past (Age old system)</td>
<td>2 - 3</td>
</tr>
<tr>
<td></td>
<td>Irrigation system at Present</td>
<td>3 - 5</td>
</tr>
<tr>
<td></td>
<td>Irrigation system for Future and mulberry</td>
<td>5 - 8</td>
</tr>
<tr>
<td></td>
<td>(Pained me much and inspired me very strongly)</td>
<td>8 - 9</td>
</tr>
<tr>
<td></td>
<td>Background for the selection of the study</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Objectives of the study</td>
<td>9</td>
</tr>
<tr>
<td>II</td>
<td>Review of literature</td>
<td>10 - 30</td>
</tr>
<tr>
<td>2.1</td>
<td>Efficiency of irrigation methods &amp; levels in different crops</td>
<td>11 - 25</td>
</tr>
<tr>
<td>2.1.2</td>
<td>In cotton</td>
<td>11 - 12</td>
</tr>
<tr>
<td>2.1.3</td>
<td>In sugarcane</td>
<td>12 - 14</td>
</tr>
<tr>
<td>2.1.4</td>
<td>In wheat</td>
<td>14 - 15</td>
</tr>
<tr>
<td>2.1.5</td>
<td>Other agriculture crops</td>
<td>15 - 19</td>
</tr>
<tr>
<td>2.1.6</td>
<td>Other horticulture crops</td>
<td>19 - 25</td>
</tr>
<tr>
<td>2.2</td>
<td>Soil regime and mulberry growth</td>
<td>25 - 27</td>
</tr>
<tr>
<td>2.3</td>
<td>Mulberry leaf quality and silk production</td>
<td>27 - 28</td>
</tr>
<tr>
<td>2.4</td>
<td>Irrigation system in mulberry cultivation</td>
<td>29 - 30</td>
</tr>
<tr>
<td></td>
<td>Hydrological cycle in India (Fig. 1)</td>
<td>31</td>
</tr>
<tr>
<td>III</td>
<td>Materials and methods</td>
<td>32 - 66</td>
</tr>
<tr>
<td>Part-I</td>
<td>Studies on the impact of droughts on sericulture in Tamil Nadu (2001-'02 to 2003-'04) (Survey)</td>
<td>32 - 35</td>
</tr>
<tr>
<td>3.1</td>
<td>Materials</td>
<td>32 - 34</td>
</tr>
<tr>
<td>3.2</td>
<td>Methods</td>
<td>34 - 34</td>
</tr>
<tr>
<td>3.2.1</td>
<td>Studies on rainfall during drought - Dharmapuri dist. Vs. state level</td>
<td>34</td>
</tr>
<tr>
<td>3.2.2</td>
<td>Case study in Palacode sericulture cluster in Dharmapuri district</td>
<td>34</td>
</tr>
<tr>
<td>3.2.3</td>
<td>Impact of drought on sericulture - Tamil Nadu Vs. National level</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>Classification of land &amp; seasonwise normal rainfall in TN (Fig. 3.1)</td>
<td>35</td>
</tr>
<tr>
<td>Part-II</td>
<td>Studies on water stress management in mulberry</td>
<td>36 - 66</td>
</tr>
<tr>
<td></td>
<td>(Experiments)</td>
<td>36 - 43</td>
</tr>
<tr>
<td>3.3</td>
<td>Materials</td>
<td>36 - 43</td>
</tr>
<tr>
<td>3.3.1</td>
<td>Experiment field location</td>
<td>36</td>
</tr>
<tr>
<td>3.3.2</td>
<td>Weather and climate</td>
<td>36</td>
</tr>
<tr>
<td>3.3.3</td>
<td>Soil</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>Weather data - First experimental year (Tab. 3.1)</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>Weather data - Second experimental year (Tab. 3.2)</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>Weather data - First experimental year (Fig. 3.2)</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>Weather data - Second experimental year (Fig. 3.3)</td>
<td>40</td>
</tr>
<tr>
<td>3.3.4</td>
<td>Crop and variety</td>
<td>41</td>
</tr>
<tr>
<td>3.3.5</td>
<td>Irrigation water</td>
<td>42</td>
</tr>
<tr>
<td>3.3.6</td>
<td>Silkworm breed</td>
<td>42</td>
</tr>
<tr>
<td>3.3.7</td>
<td>Silkworm rearing house</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Soil characteristics of the experimental field (Tab. 3.3)</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>Quality of irrigation water (Tab. 3.4)</td>
<td>43</td>
</tr>
<tr>
<td>3.4</td>
<td>Methods</td>
<td>44 - 66</td>
</tr>
<tr>
<td>3.4.1</td>
<td>Experiment plan layout</td>
<td>44</td>
</tr>
</tbody>
</table>
3.4.2 Treatments 44 - 45
3.4.3 Preparation for furrow irrigation 45
3.4.4 Installation of sprinkler irrigation system 45, 49
   Experiment layout *(Fig. 3.4)* 46
   Treatments’ combinations & distribution in plots *(Tab. 3.5)* 47
   Photograph - mulberry plot - furrow irrigation *(Plates 1 & 2)* 48
3.4.5 Installation of drip irrigation system 49
   Photograph - mulberry plot - drip irrigation *(Plates 5 & 6)* 50
   Irrigation pipeline & experiment plot distribution *(Fig. 3.5)* 51
3.4.6 Irrigation schedule 52
3.4.6.1 Surface irrigation 52
3.4.6.1 Microirrigation (sprinkler & drip) 52
   Photograph - mulberry plot - sprinkler irrigation *(Plates 3 & 4)* 53
3.4.7 Maintenance of mulberry garden - conduct of experiments 54
3.4.8 Silkworm rearing 54 - 55
3.4.9 Mulberry growth observation 55 - 60
   Branch height 55
   Plant height 55
   Number of branches per plant 55
   Total shoot length per plant 55
   Photograph - outer & inner view of rearing house *(Plates 7 & 8)* 56
   Photographs - experimental rearing *(Plates 9)* 57
   Photographs - spinning worms, cocoons, reeling etc., *(Pls. 10 - 12)* 58
   Number of leaves per branch 59
   Leaf area 59
   Leaf area index *(LAI)* 59
   Leaf yield per plant 59
   Leaf yield per ha. 59, 61
   Photographs - showing height of mulberry *(Pls. 13 - 14)* 60
   Water use efficiency 61
   Mulberry leaf quality 61 - 62
   Leaf moisture content *(LMC)* 61
   Moisture retention capacity *(MRC)* 61
   Mulberry leaf quality analysis 61 - 62
   Protein content of leaf 62
   Total sugar content of leaf 62
   Silkworm growth observation 62
   Silkworm crop schedule - feeding & moulting duration 62
   Larval weight 62 - 63
   Silkworm rearing crop performance 63
   Cocoon yield by number / 10000 larvae reared 63
   Cocoon yield by weight / 10000 larvae reared 63
   Cocoon analysis 63
   Single cocoon weight 63
   Single cocoon shell weight 63
   Cocoon reeling parameters 64 - 65
   Single cocoon filament length 64
   Single cocoon reeling break 64
   Raw silk recovery 64
   Single cocoon denier 65
   Renditta 65
3.4.16 Water stress management & irrigation water savings 65 - 66
3.4.17 Cost benefit ratio 66
3.4.18 Irrigation calendar 66
3.4.19 Statistical analysis 66

IV Results and discussion 67 - 189

4.1 Part-I Studies on the impact of droughts on sericulture in Tamil Nadu (2001-02 to 2003-04) (Survey) 68 - 78
4.1.1 Rainfall during drought - Dharmapuri dist. Vs. state level 68
4.1.2 Case study in Palacode sericulture cluster in Dharmapuri district 68,72
Rainfall data - (Fig. 4.1, a,b) 69
Case study (Tabs. 4.1, 4.2) 70 - 71
4.1.3 Impact of drought on sericulture - Tamil Nadu Vs. National level 72 - 73
SWOT analysis in a nutshell on sericulture activities in TN state 73
Impact of drought on sericulture in Tamil Nadu (Tabs. 4.3,4.4) 74 - 75
Impact of drought on sericulture in Tamil Nadu (Figs. 4.2,4.3) 76 - 77
Status of sericulture in Tamil Nadu (1975-2010) (Fig. 4.4) 78

4.2 Part-II Studies on water stress management in mulberry (Experiments) 79 - 189
4.2.1 Irrigation water and schedule 79
4.2.2 Mulberry growth analysis 80 - 125
4.2.2.1 Branch height 80,84
Cropwise branch height (Tabs. 4.5 & 4.6) 81 - 82
Average branch height (Tabs. 4.7) 83
4.2.2.2 Plant height 84,85
4.2.2.3 Number of branches per plant 85
Cropwise plant height (Tabs. 4.8 & 4.9) 86 - 87
Average branch height (Tabs. 4.10) 88
Cropwise number of branches (Tabs. 4.11 & 4.12) 89 - 90
Average branch height (Tabs. 4.13) 91
4.2.2.4 Total shoot length per plant 92
4.2.2.5 Number of leaves per branch 92
Cropwise total shoot length (Tabs. 4.14 & 4.15) 93 - 94
Average total shoot length (Tabs. 4.16) 95
Average total shoot length (Fig. 4.5) 96
Cropwise number of leaves / branch (Tabs. 4.17 & 4.18) 97 - 98
Average number of leaves / branch (Tabs. 4.19) 99
Average number of leaves / branch (Fig. 4.6) 100
4.2.2.6 Leaf area 101
4.2.2.7 Leaf area index (LAI) 101
Cropwise leaf area (Tabs. 4.20 & 4.21) 102 - 103
Average leaf area (Tabs. 4.22) 104
Average leaf area (Fig. 4.7) 105
Cropwise leaf area index (Tabs. 4.23 & 4.24) 106 - 107
Average leaf area index (Tabs. 4.25) 108
4.2.2.8 Leaf yield per plant 109
Cropwise leaf yield per plant (Tabs. 4.26 & 4.27) 110 - 111
Average leaf yield per plant (Tabs. 4.28) 112
4.2.2.9 Leaf yield per ha. 113 - 116
4.2.2.10 Water use efficiency 116 - 117
Cropwise leaf yield per ha. (Tabs. 4.29 & 4.30) 118 - 119
Average yield per ha. (Tabs. 4.31) 120
Average leaf yield per ha. (Fig. 4.8) 121
Cropwise water use efficiency (Tabs. 4.32 & 4.33) 122 - 123
Average water use efficiency (Tabs. 4.34) 124
Average water use efficiency (Fig. 4.9) 125
4.2.3 Mulberry leaf quality analysis 126 - 135
4.2.3.1 Leaf moisture content (LMC) 126
4.2.3.2 Moisture retention capacity (MRC)
Cropwise Leaf moisture content (Tabs. 4.35 & 4.36) 127 - 128
Average Leaf moisture content (Tabs. 4.37) 129
Cropwise Leaf moisture retention capacity (Tabs. 4.38 & 4.39) 130 - 131
Average Leaf moisture retention capacity (Tabs. 4.40) 132
Average Leaf moisture & Moisture retention capacity (Fig. 4.10) 133
4.2.3.3 Protein content of leaf 134 - 135
4.2.3.4 Total sugar content of leaf 135
4.2.4 Silkworm growth analysis 135
4.2.4.1 Silkworm crop rearing
Cropwise leaf protein content (Tabs. 4.41 & 4.42) 136 - 137
Average leaf protein content (Tabs. 4.43) 138
Cropwise total sugar content of leaf (Tabs. 4.44 & 4.45) 139 - 140
Average total sugar content of leaf (Tabs. 4.46) 141
Cropwise rearing - feeding, moulting duration (Tabs. 4.47) 142
4.2.4.2 Larval weight
Cropwise larvae weight (Tabs. 4.48 & 4.49) 144 - 145
Average larvae weight (Tabs. 4.50) 146
4.2.5 Silkworm rearing crop performance analysis 147 - 153
4.2.5.1 Cocoon yield by number / 10000 larvae reared 147
4.2.5.2 Cocoon yield by weight / 10000 larvae reared 147
Cropwise yield by No. / 10000 larvae reared (Tabs. 4.51 & 4.52) 148 - 149
Average cocoon yield by No. / 10000 larvae reared (Tabs. 4.53) 150
Cropwise yield by wt. / 10000 larvae reared (Tabs. 4.54 & 4.55) 151 - 152
Average cocoon yield by wt / 10000 larvae reared (Tabs. 4.56) 153
4.2.6 Cocoon assessment 154 - 164
4.2.6.1 Single cocoon weight 154
4.2.6.2 Single cocoon shell weight 154 - 155
4.2.6.3 Shell ratio 155
4.2.7 Cocoon reeling parameters 155
4.2.7.1 Single cocoon filament length 155,165
Cropwise single cocoon weight (Tabs. 4.57 & 4.58) 156 - 157
Average single cocoon weight (Tabs. 4.59) 158
Cropwise single shell weight (Tabs. 4.60 & 4.61) 159 - 160
Average single shell weight (Tabs. 4.62) 161
Cropwise single shell ratio (Tabs. 4.63 & 4.64) 162 - 163
Average single shell ratio (Tabs. 4.65) 164
4.2.7.2 Single cocoon reeling filament break 165
4.2.7.3 Single cocoon denier 165
4.2.7.4 Raw silk recovery 166
4.2.7.5 Renditta 166
Cropwise single cocoon filament length (Tabs. 4.66 & 4.67) 167 - 168
Average single cocoon filament length (Tabs. 4.68) 169
Cropwise single cocoon reeling break (Tabs. 4.69 & 4.70) 170 - 171
Average single cocoon reeling break (Tabs. 4.71) 172
Cropwise single cocoon denier (Tabs. 4.72 & 4.73) 173 - 174
Average single cocoon denier (Tabs. 4.74) 175
Cropwise raw silk recovery (Tabs. 4.75 & 4.76) 176 - 177
Average raw silk recovery (Tabs. 4.77) 178
Cropwise renditta (Tabs. 4.78 & 4.79) 179 - 180
Average renditta (Tabs. 4.80) 181
Average renditta (Fig. 4.11) 182
4.2.8 Water stress management & irrigation water savings 183 - 184
Irrigation water savings under different practices (Tab. 4.81) 183
4.2.9 Cost benefit ratio 184
Cost benefit ratio (Tab. 4.82) 184
Average water use efficiency (Fig. 4.12) 185
4.2.10 Average cost benefit ratio (Fig. 4.13) 186
Irrigation calendar 187
Model Irrigation calendar for mulberry crop (Tab. 4.83 & 4.84) 188 - 189
V Summary 190 - 201
VI Conclusion and recommendations 202 - 204
Publications and Seminars attended 205
References 206 - 228
Annexures & Appendices
Annexure - 1 Areas under micro irrigation in some ICID member countries 229
Annexure - 2 Proforma for survey of sericulture farmers 230
Annexure - 3 Crop irrigation schedule, climate/ETo/rain hart, irrigation scheduling & crop water requirement graph as per modified Penman & Monteith formula for 8 crops during experimental period 231 - 270
Appendices - 1 - 8 Details of irrigation water applied under different crops during experimental period 271 - 286
Preface

In continuation of my M.Phil., degree (Batch Top) at Bharathidasan University, Tiruchirapalli, Tamil Nadu in the year 1986, while working for Ph.D., with JRF., UGC., under the guidance of Prof.K.V.Krishnamurthy (Prof.B.G.L.Swamy’s the best student) my “guru”, as my family situation did not permitted me to continue my research studies, I was forced to opt for a job and I have been selected as Senior Research Assistant in Central Silk Board (CSB.,) in 1987, I was posted at REC., Bangiriposi in Orissa under the control of CTR&TI., Ranchi. Later in the year 1989, I was transferred to Kerala state and entrusted by the organization to discharge my duties in the field of sericulture extension for implementation of the World Bank & Swiss Democratic Corporation (SDC.,), aided National Sericulture Project (NSP.,) through establishing a Technical Service Centre (TSC.,) at Marayoor in Idukki district. The TSC., Marayoor has “bagged three awards” out of total nine awards declared for the Pilot Sericulture States for the successful implementation of the NSP., by the CSB., at the end of the project in the year 1996, I also organized “two workshops” during 1995-'96 & 1996-'97 under Bivoltine Sericulture Technology Development (BSTD) of JICA. Based on the request made by Kerala State Govt., to the CSB., I have extended my service to the Kerala State Govt. on deputation [Idukki (initial 3 years) as District Sericulture Officer & in Thiruvananthapuram as Assistant Director (Technical) (later 2 years)] for 5 years upto 2001 for successful transition of the sericulture developments made by the CSB., under the NSP., to the Kerala State Sericulture Cooperative Federation Ltd., (SERIFED). I have functioned as member in different committees & Chairman of the SCA/SCP/TSP committees etc., constituted by the “SERIFED” for the development of sericulture in the Kerala state. On successful completion of the assignment, I was posted at Silkworm Seed Production Centre (SSPC.,), under the erstwhile National Silkworm Seed Project (NSSP.,) [now National Silkworm Seed Organization (NSSO.,)] of the CSB., Dharmapuri at the end of 2001 in Tamil Nadu and entrusted me to strengthen the activities for the quality seed production and extension of service to sericulture farmers’. Moreover I was fully utilized by the NSSP., in different activities of silkworm seed production including the studies on seed production in West Bengal, as a member in the committee for Accreditation System for Quality Seed Production and formation of the “National Silkworm Seed Committee” at the national level, coordination in “KIOSK” on sericulture industry in Tamil language etc.,. While I was undertaking the task assigned by the NSSP., to assess the impact of droughts on sericulture prevailed during 2001-2004 in Tamil Nadu, I was wounded by various incidences like vacating farmers with their family members including children discontinuing their studies in schools in mass from their villages to urban
areas and near by state in search of employment after disposing their cattles at a very nominal cost due to poor buyers for want of feed etc., I pained much from the wound created by the incidences, I have decided to do some thing to the farmers’ beyond what I was doing for them in the past more than two decades and immediately expressed my desire of undertaking research work related to irrigation water management in mulberry cultivation to the organization and considering the importance of the work I was sanctioned 2 years study leave by the organization to carryout this study.

I took lot of efforts and pain with full personal involvements on each and every aspect of the study to find out an appropriate solution for the management of limited irrigation water availability in mulberry cultivation to achieve the combined effects of quality linked sustainable productivity for increased income at farmers’ level in Tamil Nadu state. I hope that the results of the detailed studies conducted presented in this thesis in the form of a book will be much useful for the researchers, irrigation planners, and the Government as a document and reference volume for making the sericulture industry a sustainable one in the state of Tamil Nadu and others, the model irrigation calendar for mulberry crop prepared and presented in this thesis will be much useful for the sericulture farmers’, extension workers and stakeholders in the field of sericulture in addition to the simple book already available under the title “Advanced Technologies for Modern Sericulture” in Tamil regional language.

Based on the difficulties faced by farmers in undertaking various works, requirement of huge man power and drudgery in carrying out certain work etc., in sericulture, to make relief from the above I have already involved in an other assignment on innovation of different types of simple efficient machines with its uniqueness in operation to undertake various agronomical and other works in the field of mulberry cultivation and silkworm rearing for effective utilization of human resources, to reduce man power requirement in the field of agriculture in general and sericulture in particular, to reduce the cost of cocoon production and to increase quality linked sustainable unit productivity and income at farmers’ level are in pipeline.

Salem, 

S.RAJARAM