VI. SUMMARY

1. The studies showed that leaf yield in mulberry intercropped with “dhaincha” was 8146.05 kg/ha/crop compared to 7313.71 kg/ha/crop in control. The infestation of tukra and leafwebber was found less in “dhaincha” intercropped cropping system due to crop diversity than sole crop. Among the two cropping systems, the succeeding crop system ($S_2$) was significantly performed over intercropped system ($S_1$). Among the treatments, full dose of ammonium sulphate in single split + “dhaincha” + neem oil cake (NOC) + Azospirillum ($T_1$); full dose of ammonium sulphate in two splits + “dhaincha” + NOC + Azospirillum ($T_2$); 75% of ammonium sulphate in single split + “dhaincha” + NOC + Azospirillum ($T_3$) performed better than all the treatments followed by 75% of ammonium sulphate in two splits + “dhaincha” + NOC + Azospirillum ($T_4$) in both the systems ($S_1$ and $S_2$).

2. Among the eco feast crops studied, the cowpea was preferred by coccinellids; spiders and marigold by spiders; parasitoids. The population of Maconellicoccus hirsutus was found more on mulberry than kenaf and not found on any other eco feast crops. The population of other insect pests like Diaphania pulverulentalis, Aleurodicus dispersus and Pseudodendrothrips mori were found only on mulberry. Similarly, Helicoverpa armigera and Aphis craccivora were found on marigold and pulses (green gram, black gram and cowpea) respectively.

3. The IPM module was developed by including several components viz., pruning and removal of pest infested mulberry stalks from the garden; ploughing to turn the soil and also to expose pupae in the soil to sunlight; the full dose of soil test based recommendation of FYM on 3rd day after pruning was applied (10 MT/ac/annum in 2 splits); sowing of “dhaincha” @ 10 kg/ac/crop on 7th day after pruning after seed treatment with Rhizobium and incorporation of the same in situ at pre flowering stage. Sowing of Hibiscus cannabinus and marigold Tagetes sp. in every sixth row and 10th row respectively besides cowpea along the bunds as trap/eco feast crop; monitoring for insect pests by observing the movement of ants, malformation of tender leaves, flattening of stem, faecal matter on leaves and defoliation; Application of 75% of soil test based recommendation of ammonium sulphate and
full dose of single superphosphate and muriate of potash on 15\textsuperscript{th} day after pruning; erection of bird perches @ 20 numbers/ ac to attract birds; spraying of neem oil at 2\% and 3\% concentration on 10\textsuperscript{th} and 20\textsuperscript{th} day after pruning respectively with 0.5 \% wetting agent was sprayed by using high volume sprayer on both the surfaces of leaf; releasing of the egg parasitoid, \textit{Trochogramma chilonis} @ 3 cc as 96 bits/ac on 15\textsuperscript{th} day after spraying; releasing of the Australian lady bird beetle, \textit{Cryptolaemus montrouzieri} @250 beetles/ac on 15\textsuperscript{th} day after pruning; application of the biofertilizers, \textit{Azospirillum} and Phosphobacteria (\textit{Bacillus megaterium}) @ 1.6 and 2 kg/ac/crop along with100 kg well powdered and decomposed FYM followed by copious irrigation on 30\textsuperscript{th} day after pruning and conservation of the natural enemies like parasitoids and predators in the ecosystem.

4. The studies on validation trials in the study villages showed that in Avathanapatti village, the reduction (\%) of infestation of \textit{M. hirsutus} was 78.24 and 16.48 in M\textsubscript{1} and M\textsubscript{2} adopted gardens respectively. In Kokkanur, the reduction (\%) of tukra was 77.23 in M\textsubscript{1} and 21.29 in M\textsubscript{2} adopted gardens. In Kollapalli, incidence reduction was 74.66\% in M\textsubscript{1} adopted gardens and 9.70\% in M\textsubscript{2} adopted gardens. The infestation of leafwebber reduction was found as 82.93\% and 31.15\% in M\textsubscript{1} and M\textsubscript{2} adopted gardens respectively at Avathanapatti. In Kokkanur, the reduction (\%) of leafwebber infestation 84.26\% in M\textsubscript{1} and 5.39\% in M\textsubscript{2} adopted gardens. The reduction in leafwebber infestation 87.12\% in M\textsubscript{1} adopted gardens and 12.94\% in M\textsubscript{2} adopted gardens at Kollapalli. The study revealed that in Avathanapatti village, the population of coccinellids and spiders was found more in M\textsubscript{1} as compared to M\textsubscript{2}.

5. The impact of IPM module on the soil physical parameters such as bulk density; total porosity (\%); water holding capacity and volume expansion showed non-significant difference between M\textsubscript{1} and M\textsubscript{2}. Further, certain soil chemical properties like soil pH and electrical conductivity (m.mhos/cm) had not shown any improvement significantly before and after adoption of M\textsubscript{1} and M\textsubscript{2}. However, there was an improvement in the contents of organic carbon (\%), available phosphorus (kg/ ha) and available potassium (kg/ ha) before and after imposing treatment of M\textsubscript{1}.
and M₂. The population of earthworms, centipedes, millipedes, ants, field cockroach, ground beetles and dung rollers in a cu. ft. in M₁ and M₂ were found significant. The pooled value of collembolans population was found as 9.33 and 1.89 /250 g. of soil in M₁ and M₂ adopted garden with significant difference. The number of oribatids / 250 g of soil were ranged from 4.33 to 6.67 and 0.00 to 0.67 in M₁ and M₂ adopted gardens respectively. The study also revealed that the overall mean value of bacterial, fungal and actinomycetes population was found non-significant between M₁ and M₂. The presence of Azotobacter and PSB was found non-significant. It was observed that there was significant improvement in microbial population before and after imposing module. The overall mean values of Azospirillum population at M₁ (0.029 x 10⁴ CFUs/g of soil) and M₂ (0.012 x 10⁴ CFUs/g of soil) were found significant.

6. The study showed that the IPM module (M₁) had enhanced the mulberry growth parameters such as plant height, number of leaves / plant, biomass, leaf yield and leaf shoot ratio by reducing the weed population and accumulating biological nitrogen in the soil.

7. The results indicated that the tender leaves of M₁ had total chlorophyll of 3.11, 2.87 and 2.75 mg/g in Avathanapatti, Kokkanur, Kollapalli respectively. The total chlorophyll in medium leaves of M₁ was ranging from 2.97 to 3.5 mg/g and 2.35 to 2.74 mg/g in M₂. The coarse leaves in the M₁ had total chlorophyll between 2.66 and 2.82 mg/g and 2.16 and 2.45 mg/g in M₂. The total sugar content in tender leaves of M₁ adopted gardens was 14.17% and M₂ adopted gardens 12.62%. The medium leaves of M₁ adopted gardens in the study villages had total sugar content of 10.03% and M₂ of 9.53%. The total sugar content in the coarse leaves was ranging from 8.53 to 8.90% and 8.05 to 8.61% in the M₁ and M₂ adopted gardens of the study villages. The mean value of starch content in each module (M₁ and M₂) within a village was found non-significant. However, the overall mean value of M₁ (10.42%) and M₂ (9.68%) was found significant. The mean value of carbohydrates in M₁ (21.63) and M₂ (19.50%) in Avathanapatti village was found significant and non-significant in other villages. The mean values of total phenols content M₁
(7.14, 7.00 and 6.89%) and M2 (6.11, 5.89 and 5.57%) in Avathanapatti, Kokkanur and Kollapalli were found significant. The study revealed that the overall mean value of leaf nitrogen in M1 (3.22%) and M2 (2.94%) was found highly significant. The difference between overall mean of leaf phosphorus content in M1 (0.31%) and M2 (0.22%) was found highly significant. The mean values of leaf potassium content at M1 (2.41, 2.39 and 2.38%) and M2 (2.02, 1.91 and 1.96%) in Avathanapatti, Kokkanur and Kollapalli was found significant. The mean values of crude protein content at M1 (22.71, 22.94 and 23.77%) and M2 (18.60, 17.81 and 18.73%) was found significant.

8. The study revealed that the effect of Shannon-wiener Index (ln) and Shannon-wiener Index (log) at M1 and M2 was found significant. The effect of richness between M1 and M2 was found significant (r = 0.825). The dominance index (D) was found as 0.192, 0.238, 0.324 and 0.198, 0.284, 0.310 in the M1 and M2 adopted gardens of the study villages. The effect of diversity was found significant between M1 and M2 adopted gardens (r = 0.888). At Avathanapatti, Coccinella septumpunctata was found maximum (26.57 and 26.90%) in M1 and M2 of Avathanapatti and minimum (9.33 and 5.86%) of Micraspis discolor. At Kokkanur, M. discolor was found 0.00 at M1 and in M2 found as 7.29% which resulted in less diversity and more dominance among the coccinellids population in the ecosystem. At Kollapalli, coccinellids species were found less and the total percentage of population was shared by only four species.

9. The study revealed that the single larval weight (g) was found as 3.42 to 4.10 and 3.10 to 3.46 in the silkworm rearing of M1 and M2 adopted farmers in the study village with significant difference. The mean of M1 (1.74) and M2 (1.50) was found non-significant. The mean value of single shell weight (g) was recorded as 0.37 g and 0.28 g in the M1 and M2 respectively, which was found significant. The shell ratio of M1 (21.47%) and M2 (18.67%) was found significant. The difference between the mean value of cocoon yield / 100 Dfls at M1 (71.03 kg) and M2 (58.63 kg) adopted gardens was found significant. The defective cocoons % was ranging from 2.50 to 3.51% at M1 and 4.6 to 4.70% at M2 differed significantly.
10. The study indicated that the effect of azadirachtin in neem oil and dichlorvos assessed by EIQ was found as 6.00 and 41.40 on farm worker, 5.50 and 17.60 on consumer, 24.80 and 100.82 on ecology respectively. Thus, the total EIQ of azadirachtin and dichlorvos was found as 12.10 and 53.27 respectively. The impact of neem oil in total on farm worker, consumer and ecology was 0.59, 0.54 and 2.42 with the field use EIQ of 1.18. The effect of dichlorvos with 76% active ingredient @ 0.26 litre /ac in 5 applications for the control of *M. hirsutus* was calculated as 41.38 on farm worker, 17.59 on consumer and 100.76 on ecology with the field use EIQ of 53.24. The application of dichlorvos @ 0.1 litre/ac in 3 applications for the control of *D. pulverulentalis* was having effect on farm worker, consumer and ecology was as 9.61, 4.09 and 23.41 respectively with the field use EIQ of 12.37. In a year, its total effect was 50.99 on farm worker, 21.68 on consumer and 124.17 on ecology with the field use EIQ of 65.61.

11. The total expenditure was estimated as Rs.2,38,095.81/ha/year and Rs.1,84,266.26/ha/year towards IPM and farmers practice. The dfls reared per ha/annum was recorded as 3,884 and 2,731 in IPM and farmers practice adopted gardens with the margin of 1,153 dfls. The cost of cocoons/kg was Rs.201.50 and Rs.172/- with the margin of Rs.29.5 / kg. The income obtained/annum was Rs.5,62,668.25 and Rs.2,74,770.58 with the margin of Rs.2,87,897.67 from the IPM and farmers practiced gardens through silkworm rearing. The net profit was estimated as Rs. 3, 24,572.44/- and Rs. 90,504.32 in a year. The B: C ratio was found as 1: 2.36 and 1: 1.49 with the margin of 0.87.

The present study thus revealed the scope of developing an IPM module without any chemical insecticide and releasing of bio-control agents overcoming the unfavourable effects of chemical pesticides and disturbance to agro ecosystem and which paved the way for conservation and build-up of natural enemies in the ecosystem for the best biological pest suppression. Thus ultimately, by avoiding pesticides, an IPM module has been developed in this study and validated in different villages. It has been found to be highly effective against target pests and safer to non-target organisms. Further this module has also improved the qualitative and quantitative parameters of mulberry and silkworm crop. Therefore it will not only help the sericulturists to harvest better crops of mulberry as well as silk cocoons at a reduced cost but also protect the environment simultaneously.