CHAPTER VI

SUMMARY
AND
CONCLUSION
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6.1 In jute, manual weeding operation is generally required to be done twice or sometimes thrice, involving 120 to 150 mandays per hectare which accounts around 35 per cent of total cost of cultivation. Availability of such a large number of labourers is often difficult during the peak period of crop growth. Inadequate or incomplete weeding results in poor crop growth despite the best use of other agronomic practices. There is, therefore, a great need to find out an optimal weed management system in jute cultivation.

In the present thesis an effort has been made to evaluate optimum weed management system for jute based crop rotation through combination of crop rotation and herbicide application.

A field experiment was conducted at the Central Research Institute for Jute and Allied Fibres, Barrackpore, West Bengal for seven successive years from 1975-1981 in fixed plots, in a split plot design with three crop rotations as *main plot* treatment and five weed management systems as *sub-plot* treatment with three replications.

The schematic diagram of the treatment is shown below:

![Schematic diagram of treatment](image-url)
Three crop rotations were $R_I$ (jute-rice-wheat), $R_{II}$ (jute-rice-potato), $R_{III}$ (jute-rice-maize). The five weed management systems were: $S_1$ (C-C-C), repeated application of herbicides to all crops in rotation, $S_2$ (C-H-H), seasonal application of herbicide to the first crop, $S_3$ (H-C-H); seasonal application of herbicide to the second crop, $S_4$ (H-H-C); application of herbicide to the third crop of rotation, $S_5$ (H-H-H); no application of herbicide to crops, but hand weeded.

The crop that did not receive any herbicide was hand weeded (H). The weed management systems were compared with hand weeded check, $S_5$ (H-H-H); Assessment of the direct effect of the herbicide and residual effect of herbicides on the succeeding crops were made from the second year after the completion of one cycle of rotation.

The following herbicides were applied to the crop fields; in jute; tetrapion, in rice; butachlor, in wheat; nitrofen, in potato; alachlor and in maize; atrazine. The present work gives the details of the investigation aimed at substitution of manual weeding in jute, partially or wholly by intensive cropping of three crops per year and using herbicides at recommended levels.

The work embodied in the present thesis also deals with the effect of crop rotation and weed management systems on changes in the composition of weed flora of jute and rice fields, on plant height, basal diameter and yield of jute, on dry weight of weeds. Correlation studies of weed population with the yield of jute fibre has been worked out. Side effects of the herbicides on rhizosphere soil microorganisms have also been studied. An economic analysis on net return and cost-benefit ratio of individual
crops under different weed management systems has been worked out.

The salient findings of the experiment and conclusions drawn are summarised under following headings.

**Change in weed flora in jute**: Continuous cropping of jute on the same plot for seven years brought out a change in the composition of weed flora. Initially, *Echinochloa colona* (grass), *Cyperus rotundus* (nutsedge) and *Fimbristylis dichotoma* (sedge), dominated the jute field at the early stage of crop growth (5 weeks after emergence of jute seedlings - 5 WAE), during the first three years. Broadleaf dicot weeds were absent during the first three years at the early stage of crop growth. Broadleaf dicot weeds gradually showed their appearance in the early stage of crop growth from the fourth year and in the 7th year *Portulaca oleracea*, *Euphorbia hirta*, *Alternanthera philoxeroides* were established in the jute field.

**Shift in weed density**: Among the three crop rotations the greatest total weed density was observed in the jute field where maize or wheat was rotated. The picture was different with jute-rice-potato rotation. Continuous cultivation of potato pulverized the soil and reduced the perennial nutsedge (*Cyperus rotundus*) population.

**C₃ Crop and C₄ Weed Competition**: Jute is a C₃ plant but most of the grassy weeds and sedges that infest the jute crop are C₄ plants. C₄ plants are found to grow faster up to 5 weeks after emergence (5 WAE) of jute seedlings, and become more competitive than C₃ jute plant, especially under high light intensities. After the 7th
week, the picture was dramatically opposite. Once the canopy was formed by the C_3 crop, the C_4 weeds were found to recede gradually owing to decline of light intensity under the crop canopy.

**Impact of rotation on crop**: Among the three crop rotations, 'Jute-rice-potato' enhanced the plant height of jute significantly at 60, 75, 90 and 105 days of crop age, than that of 'Jute-rice-wheat' or 'Jute-rice-maize'. The inclusion of potato significantly increased the yield of jute fibre.

**Impact of Weed management systems**: Five different weed management systems were chosen to find out their long-term effect of herbicides on the performance of jute and succeeding rice crop as well as on the weed spectrum of crop fields.

In system - 1 (C - C - C), herbicides were applied repeatedly to three respective crops of rotation. The population of grassy weed like *Echinochloa colona* was reduced significantly in this treatment and with the control of *E. colona*, the population of nutsedge *C. rotundus* increased in the plot, especially at the later years of the experiment. Among the broadleaf weeds *Portulaca oleracea*, *Euphorbia hirta* started to appear from the fourth year. Application of three herbicides maintained the pooled crop yield of jute (24.46 q/ha) at per with the yield of hand weeded check plots (25.98 q/ha) under system - 5. The interaction of cumulative effect of herbicide and 'Jute-rice-potato' rotation produced fibre which was 10% more than that of 'Jute-rice-maize'. The results indicate that continuous application of three herbicides in crop rotation did not manifest any harmful effect on the yield of jute.
In system - 2 (C - H - H), tetrapion at 4 Kg. a.i./ha was applied only once in a year in the jute and was referred to as direct effect. Tetrapion significantly reduced the grassy weed (*Echinochloa colona*). The sedges remained in soil in moribund condition. Their shoot growth was arrested and gradually withered. The dry weight of weeds were significantly reduced at 5 WAE stage. The pooled level of jute yield was at par with that of hand-weeded check plots. The interaction of direct effect of herbicide and 'jute-rice-potato' produced 13% higher fibre yield than that of 'jute-rice-maize' rotation.

In system - 3 (H - C - H), herbicide butachlor was applied to the rice crop. Application of butachlor manifested no beneficial effect on the increment of yield of jute or on the reduction of weed population in succeeding seasons.

In system - 4 (H - H - C), herbicide nitrofen was applied to wheat; alachlor to potato and atrazine to maize. In the following jute cropping season, the carryover effect of the herbicides initially checked the germination of grassy weeds. The yield levels of jute in system - 4, were higher in most of the years than that of hand weeded check plots under system - 5.

In system - 5 (H - H - H), all the crops of rotation were hand weeded every year. It was observed that the population of grassy weed like *E. colona* in jute field gradually increased. The interaction of crop rotation and hand weeded treatment neither reduced the weed density nor the number of weed species.

Studies on the correlation of weed parameters with the yield and its components of jute revealed that plant
height, basal diameter and yield of jute had significant negative correlation with weed population that remained in the jute field at 7 WAE stage.

Considering the critical role of weeds at 7 WAE stage simple regression analysis between fibre yield (Kg./ha) and weed population (No./m²) was done. It reveals that in system - 2 (C - H - H), jute crop suffered minimum loss of fibre yield \( Y = 321.6 - 11.1714 \times \), whereas in handweeded check plots in system-5 (H-H-H), the loss of fibre was maximum \( Y=341.733-24.2571 \times \) with the increase in number of weed population per square metre.

**Effect of crop rotation and weed management systems on the weeds of rice field and yield of rice**:

**Change in composition of weed flora in rice**:
Initially four predominant species of weeds viz-Echinochloa colona, Cyperus rotundus, Fimbrystylis miliacea and Commelina benghalensis were found in rice field. After seven years of continuous rice cropping, three new species were established in rice field, such as Ludwigia perennis, Alternanthera philoxeroides and Ammania baccifera.

**Impact of Crop rotation**:
It was observed that the situation obtained through jute-rice-potato rotation was in favour of rice as this rotation reduced sedges in rice, though there was a slight increase of broadleaf weeds at the later stage of crop growth. The grain production of rice was increased in jute-rice-potato rotation.

**Impact of weed management**:
In continuous application of chemical herbicides in system - 1, the percentage of grassy weed population tended to remain at 8% while the percentage of sedges increased to 44% and
broadleaf dicot weeds were 27%. On the other hand in hand weeded check plots sedges were low (29%) but broadleaf weeds increased (40%). The cumulative effect of herbicide resulted in pooled yield of 34.21 q/ha of rice grain.

In system – 2 (C – H – H), where herbicide was applied to the jute crop, the first residual effect of herbicide did not show any phytotoxic effect on the succeeding rice crop. The pooled yield of rice was at par with hand weeded check plots.

Side effects of rotation and weed management system on rhizosphere soil micro-organisms.

The bacterial and fungal population was comparatively higher in soil after jute cultivation where jute-rice-maize was rotated.

The herbicides had no overall adverse effect on the microbial population of rice field. The herbicides imparted a general stimulatory effect on the fungi and actinomycetes flora of rabi crops (wheat, potato or maize) indicating that the herbicides left no deleterious effect on the soil micro-organisms at the doses used.

Economic Analysis: The cost and return analysis for all the five weed management systems and three crop rotations were worked out.

Impact of Rotation: The highest net return of Rs 3058/ha was obtained in jute from jute-rice-potato rotation and the lowest of Rs 2277/ha was from jute-rice-maize. Jute-rice-potato also resulted in highest net return (total of 3 crops, Rs 16129/ha/year) followed by jute-rice-maize, (total of 3 crops, Rs 14709/ha/year) and
lowest in jute-rice-wheat, (total of 3 crops), Rs. 7522/ha/year). Jute-rice-potato rotation also showed the higher cost - benefit ratio (0.84) of jute, as compared to other two rotations.

**Impact of weed management systems**: The highest net return was obtained in jute (Rs 3330/ha) from system - 2 (C - H - H). The lowest net return in jute (Rs 2626/ha) was obtained from system - 5 (H - H - H) with hand weeded plots, obviously due to the high cost of labour. As regards the cost - benefit ratio, the highest value was obtained in jute (1.04) from system - 2 (C - H - H) with jute-rice-potato rotation. On the other hand the lowest value was obtained in jute (0.65) from system - 5 (H-H-H) of the identical rotation.

The system - 2, also enhanced the cost - benefit ratio of rice in jute-rice-wheat (1.11) and in jute-rice-potato (1.21). The continuous use of herbicides for all the crops in system - 1 also showed higher cost - benefit ratio of rice.

Considering the economics and effectiveness it can thus be concluded that system - 2, would be best and system - 1 may be second best from economic point of view.

From the above results it is also evident that jute-rice-potato is an ideal rotation under the agro-climatic condition of 24-Parganas, West Bengal.