

CHAPTER – 7

SUMMARY AND CONCLUSIONS

Non-timber forest products (hereafter, NTFPs) were previously assumed to be minor in deriving the economic benefits in comparison with timber and fuel wood. Recent studies have however shown that NTFP play an important role in local economies. Millions of people around the world rely on NTFPs to meet their subsistence and cash needs.

In order to ensure sustained NTFPs and economic flows, it is important to use forests in sustainable ways, which in turn requires information on levels of production, extraction and regeneration. While several studies have documented the social and economic benefits of NTFPs, little is known about the biological consequences of harvesting these products.

Therefore keeping in view the economic importance of NTFPs, the ecology and fruit productivity of four important species, Nelli (Gooseberry: *Phyllanthus emblica* and *P. indofischeri*), Antuwala (Soapberry: *Sapindus laurifolia*) and Sige (Soapnut: *Acacia sinuata*) were studied.

Nelli (*Phyllanthus emblica* and *P. indofischeri*):

Nelli flowers in the month of February and March, and fruiting is seen from April to February. Percentage of fruiting ranged from 61% to 88 % in *P. emblica* and 36.6% to 92% in *P. indofischeri*. This long fruiting period indicates that the trees are experiencing moisture stress and therefore does not result in the early

maturing of fruits. Population density was 13.5 trees per hectare in *P. emblica* and 137.75 trees per hectare in *P. indofischeri*. There was no significant difference in mortality among the size classes in both species. The proportion of individuals in 1-10 cm DBH was 56.8% indicating that regeneration was adequate.

Across the years there was an increase in the proportion of fruiting individuals from 51% to 92 in *P. emblica*. Number of fruiting trees and average fruit production per tree showed biannual increase across five years and also bears an evidence that the fruits of *P. emblica* are being sustainably harvested by the Soligas.

Across the years there was an increase in proportion of fruiting individuals from 27% to 42% in *P. indofischeri*. Over all fruit production per tree in the population showed an alternative trend for first three years and declined in last two years, which may be due to low rainfall.

In *P. emblica*, overall harvest intensity was relatively low (29%) across all years and sites. There seems to be a threshold limit for the collectors to harvest fruits from a given tree. In case of *P. indofischeri*, overall harvest intensity was relatively high (60%) across all years and sites. This could be because the trees are shorter, and fruits are larger than that of *P. emblica*.

The Soligas harvest an average of 88% of the fruit yield on a per tree basis. Percentage of such tree harvest was 4.5 in *P. emblica* population. It was 92 % in the case of *P. indofischeri* but the percentage of such tree harvest was 9.9. Current harvesting levels of fruits seem to have less impact on population growth rates.

Cutting primary branches to harvest fruits has a deleterious effect on fruit productivity in subsequent years in both *P. emblica* and *P. indofischeri*. After 4 years, the primary branches recovered to produce fruits in *P. emblica*. Fire is another parameter that can influence the yield of *P. emblica* and *P. indofischeri*. Average fruits per tree in burnt plots were significantly lower than in unburnt plots implying that fire has a negative role in determining fruit productivity in deciduous forest.

Infestation of mistletoes seems to affect tree survival apart from reducing the fruit productivity. Nearly 54 % of the trees infected with mistletoes experienced mortality, while fruit production in trees with the mistletoes removed and unparasitized trees was higher than trees with mistletoes. This is a serious threat for populations of *P. emblica*. Removing mistletoes can save the trees from high mortality rates. Mistletoes were shown to have a negative impact on fruit productivity, growth, fruit and seed size.

The population growth rates suggest that, the densities of seedlings and of adult trees of both species were similar, but the density of saplings of *P. emblica* was lower than that of *P. indofischeri*. The size class distribution of *P. indofischeri*, as against that of *P. emblica*, followed the inverse-J-shaped curve typically associated with regenerating populations, suggesting a higher mortality of seedlings and saplings of *P. emblica* than that of *P. indofischeri*.

Overall fruit productivity and number of fruiting individuals of *Phyllanthus emblica* showed biannual peaks and overall harvest intensity was relatively low across all years and sites. However, *P. emblica* did not show typical inverse 'J' shaped population structure due to high mortality that indicates biotic and abiotic factors like, weeds, mistletoes and fire etc are affecting the population.

P. indofischeri showed an alternative fruit productivity for first three years and in last two years fruit production declined perhaps may due to drought and harvest. Harvesting levels are high at individual tree level and considerably low at population level. Regenerating population followed the inverse-J-shaped curve due to low level of mortality indicating sustainable harvest.

Experiments show that cutting of branches has deleterious effect on fruit productivity. The results indicate that the process was not significant though time was saved in cutting primary branches. Thus branch cutting is not a prudent way of harvesting fruits.

Mistletoes have shown a negative impact on fruit production, fruit and seed weight. Mistletoes also have negative impact on mortality of trees. The removal of mistletoes can result in an increase in fruit production and tree survival, which in turn contributes to positive growth rate of the population.

Antwala (*Sapindus laurifolia*):

Flowers blossomed during the months of November and December. Fruits matured during the months of February and March. During five years of monitoring 94 % of trees produced flower buds and 89% trees produced fruits. Fruit productivity studies showed overall two consecutive low and high fruiting patterns. Overall an average of 1085 fruits were produced per tree. Overall harvest intensity was relatively low (32%) across all years, and sites. The intensity of harvest at harvested tree level was 86% and 95%. People harvested fruits from high yielding trees and sites, which are proximal to their settlements.

Effect of branch pruning on fruit productivity indicates that; primary branch cutting had not recovered for producing fruits even after 4 years and it will **have a negative impact on future fruiting potential.**

Regeneration studies indicate that, total number of individuals in 3.05 hectares were 3204 including seedlings, juveniles and trees. Out of them 2975 (92.8%) were seedlings, 118 (3.7%) were juveniles and 111 (3.46%) were trees. During the year 1999, the density of individuals was 1098 ha⁻¹ and it decreased to 854 during the year 2000 and increased to 1185 during the year 2002. The transition rate from seedlings to sapling was low probably due to density dependent factors such as grazing, animal trampling, insects and pests.

This study shows that though there may not be any significant impact of harvest on regeneration, the cutting of branches, particularly primary branches had a

negative impact on future fruiting potential. The community does not harvest fruits from trees that do not bear large fruits and overall harvest was only 38 percent. The number of seedlings found per hectare was high indicating that regeneration may not have hampered due to extraction.

Sige (*Acacia sinuata*):

In Sige, the phenological studies showed that, flowers blossom during the months of February and March. Fruits mature in the month of January and February (after ten to eleven months). This long fruiting period indicates that the lianas experience moisture stress. Number of flowering individuals ranged from 78 to 100 percent. All flowering lianas subsequently bore fruits. Fruiting behaviour across sites were almost same during the years 2001 and 2002 though there was variation among sites. Three out of the 5 sites showed similar levels of fruit production. Overall fruit productivity studies showed two consecutive low and high fruiting patterns. In all sites the fruit productivity was under 1000 fruits per liana. However, good fruiting was observed in Temple site during the year 2003 with over 5000 fruits. Fruit productivity was highly variable parameter indicating that such huge annual variations may be due to environmental attributes and therefore predicting yield of fruits is difficult.

In BRT, the fruit extraction ranges from 56% to 100% with an average of 90.8% of fruit harvest. Overall harvest across the year and across the site was 69.96%. Mortality of reproductive adults was very high in Sige with only 55% of the lianas alive at the end of 5 years. The cause for this high rate of mortality could be

due to debarking by elephants, death of host trees, and drying up of Shola forest. Regeneration was observed to be poor in Sige. Percentages of seedlings had reduced from 87% to 75% from the year 2001 to 2004.

The distribution of Sige is restricted to a few pockets of the sanctuary, mainly the transition zone of fragmented shola and parts of dry deciduous forests. It is a gigantic liana, and existing adults are sustaining in the forest by vegetative growth. Mortality rate of the reproductive adults was very high largely due to debarking by elephants, lack of host trees and drying of habitat. The percentage of harvest depends on the quantity of fruit production, proximity to the settlement and number of settlements involved in harvesting fruits from the site.

RECOMMENDATIONS

1. In the case of *Phyllanthus emblica* and *P. indofischeri*, presence of mistletoes increases mortality, reduce the fruit production, and fruit and seed weight. However, recovery is possible through manual removal of the mistletoes. In view of the fact that as mistletoes support bird life, then total eradication of mistletoes on the bird population should be assessed before resorting to the complete eradication of mistletoes.
2. The percentage of overall collection of Nelli and Antuwala fruits in BRT is low and does not seem to have a negative impact on regeneration. Government should therefore continue to permit the controlled harvest of fruits of these species by the tribal people. To enhance their income and

create conservation awareness, decentralized NTFP micro-enterprises should be encouraged.

3. In case of Sige, further research is required to understand whether seedling and adult mortality is due to a biologically mediated agent or other anthropogenic factors.
4. In order to conserve *Phyllanthus emblica*, *P. indofischeri*, *Sapindus laurifolia* and *Acacia sinuata* in the wild, it is essential to encourage domestication and also cultivation of these species under different agroforestry systems in nearby villages and towns. This is important in the context of both livelihoods and conservation.