Chapter — VI

Agriculture and Agroforestry

6.0 Introduction

The present population growth rate, which compels to grow more food, leads to the technological advancement to fulfill the needs of an expanding population. For the last two decades, the national and international level research has contributed substantially for sustainable development of agriculture. Attention has been given to the services like the production, as well as distribution of good seeds, fertilizers and pesticides, flow of credit to resource poor farmers and above all transfer of technology through effective communication network by the extension personnel for the service of the farmer.

6.1. Evolution of Agricultural Landscape

During 1822 to 1823 Mr. Princep surveyed the land of Sundarban and divided the reclaimed lands into 'lots'. Division of the land into 12 plots from A to L was followed by further subdivision into 167 lots. Presently however, the number of lots has increased drastically. With the reclamation, gradual recession of the northern limit occurred followed by bifurcation of land use pattern into forest based and agro-based economy. Most of the agricultural land is not suitable for second crop. Only at Mathurapur and Haroa the land is suitable for a second crop.

The process of distribution of land started way back in 1787. Each lot constituted of 66 acres of land. Since Sundarban was not included into the permanent settlement the exact boundary or demarcation of the land was not made accurately. Thus continued a prolonged period of rivalry between the Zamindars. In the end, Dampier and Hodges Line were drawn and Third Regulation Act was made (1828). Thus, the foreign settlers could easily purchase lands.
Gradually, after 1819 mangrove coverage started to decline giving way to agriculture primarily. Hundred years after 1773, the scenario of land coverage presented a figure given below in the table number 6.1.

**Table No. 6.1. Categories of Land Use (1883)**

<table>
<thead>
<tr>
<th>Serial</th>
<th>Categories</th>
<th>Area in Square Kilometers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Arable Land</td>
<td>1,087</td>
</tr>
<tr>
<td>2</td>
<td>Forest</td>
<td>3,967</td>
</tr>
<tr>
<td>3</td>
<td>Rivers and Canals</td>
<td>1,884</td>
</tr>
<tr>
<td>4</td>
<td>Others</td>
<td>603</td>
</tr>
<tr>
<td>5</td>
<td>Total Area</td>
<td>7,541</td>
</tr>
</tbody>
</table>


Presently, in several places chilly cultivation has fetched huge returns, mainly in the different parts of Ganga Sagar.

The land utilization pattern of reclaimed Sundarban (1941), shows that the percentage of cultivated area, acreage per holding, percentage of unculturable area, percentage of twice cropped area etc. It was found that the percentage of area under cultivation was highest in Kakdwip, 73, and ranges between 53 and 69 in other parts. The percentage of culturable but not cultivated area was highest in Mathurapur, 24, and little over 10 in the remaining plains. About one third of the area was unculturable in the eastern part. In the remaining portion it comes to about one fifth of the total area. Nothing but Aman (monsoon variety) was cultivated in this region and exportable surplus was found. Since the agricultural workers bring their own plows from their home district the number of plows per one thousand acre is below one hundred in all but one police station.

The density of livestock is pretty low, considering the abundance of pastures. The density of carts is pretty low throughout the region, being the lowest in the western part. A greater part of the Sundarban Abads (agricultural farms), is cultivated by seasonal workers, who come
mainly from the Midnapore district of Bengal and return home, after sowing and transplanting rice. Thus during the growing season, large areas of rice fields were left, without a trace of human habitation. In south-western parts however, the cultivators had settled near their farmland. They built hamlets, utilizing dried mud bricks, thatching grasses etc. The thorny leaves of the date palms served as the fence.

**Land Utilization in the Reclaimed Sundarban**

Agriculture, being the main occupation of the local people, poverty was found to be a common phenomenon amongst most of the villagers. Deposition was further aggravated due to the physical and climatic hazards of the area such as occasional flood and intrusion of saline water into the agricultural field. The single crop system was practiced while double cropping system was the requirement, with more stable embankment and proper maintenance, throughout the year.

The Sundarban Development Board was formed in 1973, and entrusted with the responsibilities of development and planning for this region. The board gave special emphasis to the land and stated that it should be utilized for higher production, keeping in view the benefit of the small and marginal farmers also. Horticulture, animal husbandry, poultry and dairy farming etc. were all in the list of the programmes, of the Sundarban Development Board.

Though main crop was *Aman* (monsoon variety) paddy, *Aus* (early summer variety) and *Boro* (winter variety) paddy were also cultivated sporadically. The erection and round the year protection of the embankments was found to be the prime necessity for stable agricultural production and for undertaking other developmental works. (De, 1994)
The entire cultivation was dependent upon rain water. The ground water, suitable for agriculture was available below 244 to 305 meters. Embankments and consequent riverbeds restricted the carrying capacity of the drainage basin where flooding had been a recurrent phenomenon. With the help of the Sundarban Development Board, the agriculture experienced certain transformations. The traditional agricultural method was initially supplemented with modern agricultural techniques for higher production. Stress was given to supply of better seeds, fertilizers, insecticides etc. During this time it was realized that the economy of the region was solely dependent upon agriculture. Several centers were chosen to supply the materials given by Sundarban Development Board. The growth centers formed in 1979 included those at Ganeshpur, Bamankhali, Purushottampur, Namkhana, Mahadebnagar, Kuemuri, Raidighi, Mathurapur, Jadavpur, Dakshin Barasat, Canning, Ghutiari Sarif, Basanti, Chottomokhali, Dayapur, Kalinagar, Bhangar, Haroa, Minakhan etc. Cultivation of *Boro* (winter variety) paddy, chilly, watermelon, mustard, groundnut and other vegetables were also introduced in the dry season. (Murherjee, 1996)

Great quantity of sugarcane was also grown along with tobacco. The sunflower and cotton cultivation was introduced at an experimental stage. For the improvement of agriculture, International Fund (IFAD) had come along with the other associated groups and banks encouraged loans for irrigation and double cropping systems.

Sugar beat cultivation was introduced because it reduced the soil salinity. Cultivation of *Aman* (monsoon variety) paddy is mainly dependent on rainfall. However, without proper drainage of water, production of *Aman* (monsoon variety) received a setback.

**Present Scenario of Land Utilization**

According to the latest published data of land utilization, it is found that 3,04,834 hectares of land were occupied by net area under cultivation. The cultivable wasteland, however.
CATEGORIES OF LAND UTILIZATION IN SUNDARBAN [1997-1998]

INDEX
Area in Hectares
- Net area under cultivation
- Area under pasture and orchard etc
- Cultivable wasteland
- Homestead land
- Forest

Fig. 22
- - - - 100,000 hectares
occupies 6,828 hectares, forest land 86,442.74 hectares, area under pasture and orchard is 3,527 hectares out of the total of 4,05,569.44 hectares. It was found that the area under cultivation was greatest at Alipur Sadar sub-division and least at Basirhat sub-division. Another interesting feature observed was that the cultivable waste land is maximum at Sandeshkhali-2 block. The gradual forest cover depletion in the Basirhat sub-division is the result of early reclamation followed by expansion of cultivation and settlement. The forest cover is greatest at the Diamond Harbour sub-division which totals to about 58,444.04 hectares. (Fig. 22 & 23)

Table 6.2. Land Utilization (1997-98)

<table>
<thead>
<tr>
<th>C.D. Blocks</th>
<th>Net Area Under Cultivation</th>
<th>Area Under Pasture and Orchard etc.</th>
<th>Cultivable Waste Land</th>
<th>Homestead Land</th>
<th>Forest Land</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dist. North 24 Parganas</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basirhat S.D.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Minakhan</td>
<td>11400</td>
<td>11</td>
<td>--</td>
<td>663</td>
<td>--</td>
<td>12074.00</td>
</tr>
<tr>
<td>2. Haroa</td>
<td>9100</td>
<td>200</td>
<td>--</td>
<td>368</td>
<td>--</td>
<td>9668.00</td>
</tr>
<tr>
<td>3. Sandeshkhali-1</td>
<td>8064</td>
<td>116</td>
<td>--</td>
<td>281</td>
<td>50.70</td>
<td>8511.70</td>
</tr>
<tr>
<td>4. Sandeshkhali-2</td>
<td>7730</td>
<td>76</td>
<td>4000</td>
<td>36</td>
<td>3832.00</td>
<td>15674.00</td>
</tr>
<tr>
<td>5. Hasnabad</td>
<td>11020</td>
<td>1030</td>
<td>--</td>
<td>940</td>
<td>20.00</td>
<td>13010.00</td>
</tr>
<tr>
<td>6. Hingalganj</td>
<td>14200</td>
<td>125</td>
<td>154</td>
<td>1315</td>
<td>240.00</td>
<td>16034.00</td>
</tr>
<tr>
<td>Total</td>
<td>61514</td>
<td>1558</td>
<td>4154</td>
<td>3603</td>
<td>4142.7</td>
<td>74971.7</td>
</tr>
<tr>
<td>Dist. South 24 Parganas</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alipore Sadar S. D.</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Canning-1</td>
<td>13985</td>
<td>120</td>
<td>--</td>
<td>11.55</td>
<td>5950.00</td>
<td>20066.55</td>
</tr>
<tr>
<td>8. Canning-2</td>
<td>16900</td>
<td>225</td>
<td>120</td>
<td>5.90</td>
<td>4949.10</td>
<td>22200.00</td>
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<tr>
<td>9. Basanti</td>
<td>24359</td>
<td>41</td>
<td>95</td>
<td>32.24</td>
<td>4075.76</td>
<td>28603.00</td>
</tr>
<tr>
<td>10. Jaynagar-1</td>
<td>9462</td>
<td>350</td>
<td>--</td>
<td>24.47</td>
<td>--</td>
<td>9836.47</td>
</tr>
<tr>
<td>11. Jaynagar-2</td>
<td>14068</td>
<td>260</td>
<td>--</td>
<td>1.52</td>
<td>2413.00</td>
<td>16742.52</td>
</tr>
<tr>
<td>12. Kultali</td>
<td>19826</td>
<td>66</td>
<td>--</td>
<td>26.28</td>
<td>4029.72</td>
<td>23948.00</td>
</tr>
<tr>
<td>13. Gosaba</td>
<td>25790</td>
<td>302</td>
<td>--</td>
<td>54.58</td>
<td>2438.42</td>
<td>28585.00</td>
</tr>
<tr>
<td>C.D. Blocks</td>
<td>Net Area Under Cultivation</td>
<td>Area Under Pasture and Orchard etc.</td>
<td>Cultivable Waste Land</td>
<td>Homestead Land</td>
<td>Forest Land</td>
<td>Total</td>
</tr>
<tr>
<td>-------------------</td>
<td>----------------------------</td>
<td>------------------------------------</td>
<td>-----------------------</td>
<td>----------------</td>
<td>-------------</td>
<td>----------------</td>
</tr>
<tr>
<td>Total</td>
<td>124390</td>
<td>1364</td>
<td>215</td>
<td>156.54</td>
<td>23856.00</td>
<td>149981.54</td>
</tr>
<tr>
<td>Diamond Harbour S.D.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Kakdwip</td>
<td>21100</td>
<td>45</td>
<td>500</td>
<td>35.33</td>
<td>3174.00</td>
<td>20576.87</td>
</tr>
<tr>
<td>15. Namkhana</td>
<td>15544</td>
<td>24</td>
<td>170</td>
<td>31.87</td>
<td>4807.00</td>
<td>24854.33</td>
</tr>
<tr>
<td>16. Sagar</td>
<td>19880</td>
<td>145</td>
<td>778</td>
<td>39.47</td>
<td>29557.53</td>
<td>50400.00</td>
</tr>
<tr>
<td>17. Mathurapur-1</td>
<td>12120</td>
<td>86</td>
<td>--</td>
<td>15.36</td>
<td>2607.64</td>
<td>14829.00</td>
</tr>
<tr>
<td>18. Mathurapur-2</td>
<td>19780</td>
<td>81</td>
<td>50</td>
<td>16.17</td>
<td>3123.83</td>
<td>23051.00</td>
</tr>
<tr>
<td>19. Patharprotima</td>
<td>30506</td>
<td>224</td>
<td>961</td>
<td>39.96</td>
<td>15174.04</td>
<td>46905.00</td>
</tr>
<tr>
<td>Total</td>
<td>118930</td>
<td>605</td>
<td>2459</td>
<td>178.16</td>
<td>58444.04</td>
<td>180616.20</td>
</tr>
<tr>
<td>Grand Total</td>
<td>304834</td>
<td>3527</td>
<td>6828</td>
<td>3937.70</td>
<td>86442.74</td>
<td>405569.44</td>
</tr>
</tbody>
</table>

**SOURCE:** Government of West Bengal (Statistical Abstract)

### 6.2. Land Reforms

During the colonial period, the big landlords were getting patronage of the Government. The farm size was very big which was rather justified considering high salinity and low yield of the crops. Gradually, the region experienced the influx of migrant people, from the neighbouring districts. The labourers were getting paltry wage and share croppers were getting one third share of the product, while the rest was taken away by the land owner. Immediately after independence, a peasant movement was organized demanding two third share of the harvest for the share croppers providing agricultural equipments. However, the landlords ultimately compromised with them by conceding either two third of the product or one third product and the rest paid in money. The holding size remained unchanged. In the late sixties of the last century Land Ceiling Act was implemented in proper sense of term and anybody owning more than 75 bighas (about 25 acres) of land lost the excess land. Government of West Bengal confiscated such land and distributed the small slices among the
marginal farmers and landless labourers. Obviously, holding size was reduced. These small farms are not profitable. In many cases it has been observed that the indebted labour had mortgaged the small plot of land to the original landlord thus belying the purpose of land reform. Another system of recording permanent right to plough the land at the disposal of the landlord was introduced during this period. This system is well known in West Bengal as ‘Operation Barga’.

6.3. Agricultural Ecosystem

When man started to settle in the mangrove forest, replacement occurred by introduction of cropland. Thus the agricultural ecosystem took its path. Dependency is mainly upon a single crop. Saline alkaline soil with dominance of heavy texture is the type of soil observed here. Embankments constructed to protect the land from saline water caused negative effect. The saline water entry by breach of embankment is responsible for transforming agricultural lands into waste lands. These are later converted into ‘bheris’ (fishing pond) for prawn culture. Conversion of paddy field into ‘bheris’ has caused serious environmental imbalance.

6.4. Crop Combination

Study of crops on regional scale must take into consideration the combinational analysis and relative position of the crops. This proves to be helpful in interpreting some aspects of social and economic geography of the region and this will also reflect variable position of individual crops.

The method of assessing the relative strength of individual crops is to rank them according to their importance; the crops occupying highest acreage being dominant crop followed by grouping of other crops ranking first, second and third respectively.
For this sort of assessment relevant formulae enunciated by J. C. Weaver (1954) and K. Doi (1959), is usually followed. Practically the whole area depends on a single crop, the monsoon paddy. In recent years Governmental and Non Governmental organizations have made possible the cultivation of a second crop. This has brought 10 to 15 percent of the land under cultivation.

6.5. Cropping Pattern

The total land under agriculture in Sundarban is about 4,00,000 hectares. With the rapid development of science and technology, agricultural scenario experienced a massive change. Practically, the whole area of Sundarban depends on the single crop — the rain-fed paddy. Recently, however, the second crop has also been possible during the same season. Due to the tidal influx, most of the land is saline. This saline soil was suitable for cultivation of different varieties of paddy as Rupsal, Patnai, Benisal, Kumargora, Kartiksal, Matla, Dudhersar, Hamilton etc. The yield was much less. The ravi (winter crop) crops include varieties of pulses as, Khesari, Kalai etc. It also includes cultivation of vegetables and til (oil seed). These would grow in an isolated manner at subsistent level.

Table No. 6.3. Cropping Pattern of Sundarban.

<table>
<thead>
<tr>
<th>Cropping Pattern</th>
<th>Production Kg./Hectare</th>
<th>Gross Income Rs./Hectare</th>
<th>Net Profit Rs./Hectare</th>
<th>Expenditure: Profit Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paddy (123) — Moong (78)</td>
<td>4225 954</td>
<td>83,945</td>
<td>23,020</td>
<td>2.10</td>
</tr>
<tr>
<td>Paddy — Khesari (72)</td>
<td>4117 816</td>
<td>36,163</td>
<td>18,213</td>
<td>2.05</td>
</tr>
<tr>
<td>Paddy — Groundnut (129)</td>
<td>4178 1463</td>
<td>51,191</td>
<td>20,441</td>
<td>1.66</td>
</tr>
<tr>
<td>Paddy — Mustard (120)</td>
<td>3936 1134</td>
<td>43,428</td>
<td>15,978</td>
<td>1.58</td>
</tr>
<tr>
<td>Paddy — Cotton (176)</td>
<td>4086 1586</td>
<td>57,261</td>
<td>29,536</td>
<td>2.06</td>
</tr>
</tbody>
</table>

Note: Figures in parentheses indicate the life span of the crops in number of days.

SOURCE: Maitra et al, 2000
The second crop which is possible during ravi (winter crop) is, however, susceptible to insects and pests and sharp fluctuations in prices, causing heavy loss to the farmers. As a result, the second crop is never reliable or significant source of additional income.

6.6. Crop Calendar

Owing to the location at the head of the Bay of Bengal, the district of South 24 Parganas receives the full force of the south-west monsoon. Variation of rainfall within the district exerts profound influence on the distribution of crops.

The year in the Sundarban is divided into four seasons based on temperature, rainfall and atmospheric disturbances. a very mild dry winter, which hardly lasts for three months — December, January and February; an early summer with moderate rainfall and high temperature, lasting from March to May; a late summer with heavy rainfall and high temperature, known as the rainy season, lasts from June to September; and a fine autumn with some rainfall prevailing in the two months — October and November. (Mandal and Ghosh, 1989)

6.6.1. Activity of the Farmers

The activity of the farmers follows the cyclic order of the seasons. During the month of July-August, greater amount of rainfall helps in the sowing of Aman (monsoon variety of paddy). However, often due to improper drainage the farmers rely on the primitive method of farming for indigenous Aman (monsoon variety) as well as for high yielding variety of seeds. (Khosla, 1993)

During the last two decades rapid reclamation and distribution of the land to the marginal farmers has paved the way for development of agriculture and even raised the economic condition of the farmers. Several types of pulses grow which can even flourish in less irrigated soil. The farmers have tried cultivation of oil seeds (sunflower, mustard, til, groundnut etc.) but they remained at the experimental level bringing in lower margin of
profit. The farmers presently do not take risk in introducing third crop in the field. The seasonal activity of the farmers is reflected more in the cultivation of different types of vegetables. These brought profit to certain extent.

6.7. Irrigation

In view of brackish character of the water, options for various methods of irrigation are limited. Sweet water raised with the help of deep tube well is normally used as potable water and not available for irrigation. Any such attempt may lead to acute scarcity of potable water due to exhaustion of fresh water reserve. Under the circumstances, storing the rain water in the ponds and using it for irrigation is the best suitable provision, in conformity with the ideal agricultural ecosystem of Sundarban. Water may be pumped out from the pond and may be spread by drip irrigation method through narrow pipelines aligned according to the rows of the standing crops. The pipelines are perforated at regular intervals through which the water releases in drops. Wherever, in Sundarban, the stock of fresh water is limited, such a process of irrigation is highly relevant.

Most of the land of the Sundarban where cultivation is practiced on low lands, continuous layering of clay has led to the increase in the slope of the land. Preserving rain water and using it for agriculture is not possible.

6.8. Polymulching

The process of covering the land surface in the root zone of the trees is known as mulching. Normally, the local people use hay, dry leaves, dry water hyacinth and even grass as cover with a view to conserving soil moisture. It has been observed that use of polythene sheet is more effective than those materials. The process of covering the land surrounding the trunk of the trees is known as polymulching.
Table 6.4. The Benefits of Polymulching

<table>
<thead>
<tr>
<th>Crops</th>
<th>Growth of the Crops in Percent</th>
<th>Moisture Retention in Percent</th>
<th>Weed Control in Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moong</td>
<td>70</td>
<td>40</td>
<td>--</td>
</tr>
<tr>
<td>Groundnut</td>
<td>46</td>
<td>26</td>
<td>30</td>
</tr>
<tr>
<td>Mustard</td>
<td>10</td>
<td>28</td>
<td>74</td>
</tr>
<tr>
<td>Til (oil seed)</td>
<td>135</td>
<td>--</td>
<td>62</td>
</tr>
<tr>
<td>Cotton</td>
<td>22</td>
<td>40</td>
<td>--</td>
</tr>
<tr>
<td>Tomato</td>
<td>56</td>
<td>29</td>
<td>91</td>
</tr>
<tr>
<td>Banana</td>
<td>10</td>
<td>53</td>
<td>90</td>
</tr>
<tr>
<td>Chilly</td>
<td>49</td>
<td>37</td>
<td>85</td>
</tr>
</tbody>
</table>

SOURCE: Maitra et al, 2000

In Sundarban region, low density, fifty micron thick, black polythene sheet is used for growing the vegetables. This process is conducive for reducing evaporation and maintaining soil moisture. It does not require frequent irrigation and thereby save water, time and expenditure due to reduction in evaporation; capillary action is restricted and possibility of ascending movement of sodium is reduced. It controls diurnal range of soil temperature by maintaining warmth during the night and controlling the soil temperature during the day, which ultimately helps the growth of nursery roots. In fact coverage of the land by polythene sheet differs from one vegetable to another as evident from the table below:

Table No. 6.5. Required Amount of Polythene Sheet and Mulching

<table>
<thead>
<tr>
<th>Serial</th>
<th>Name of the Crop</th>
<th>The Polythene Sheet Covered Area in %</th>
<th>Area of Polythene Sheet Coverage Bigha/Kg.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The cultivation of climbers as Gourd</td>
<td>20</td>
<td>13</td>
</tr>
<tr>
<td>2</td>
<td>Brinjal, Tomato, Chilly, Ladies Finger, Capsicum, Beat etc.</td>
<td>40-60</td>
<td>25-38</td>
</tr>
<tr>
<td>3</td>
<td>The creepers include water melon, Cucumber, Gourd etc.</td>
<td>80</td>
<td>50</td>
</tr>
</tbody>
</table>

SOURCE: Maitra et al, 2000
6.9. Special Protection for Vegetable Culture

Vegetables in Sundarban are often affected by excessive rainfall and cyclonic storm. In some pockets of the region an experiment for special protection for the vegetables have become successful. A platform is constructed with the help of bamboo and wooden logs. Often these are bended in the form of a bow. This structure is covered by transparent polythene wheat and well fitted with a special type of net for protecting the vegetables from high velocity winds. The farmers intending to grow the winter vegetables during the summer have used 50% opaque polythene in the lieu of transparent one. The polythene sheets with 100 micron thickness with a capacity to protect the vegetables from ultra violet ray make the structure durable for couple of years. Provision for aeration within the polythene cover structure is necessary because the inner temperature is normally 4° centigrade higher in relation to the uncovered area. The initial cost is of course high, but ultimately it becomes profitable.

6.10. Economic Condition of the Farmers

Most of the farmers of the Sundarban are poor, illiterate and suffer from poor health conditions. This is mainly due to very low per capita income. The classification of different types of farmers is given below where the economic status, monthly income of a family and monthly expenditure of the family is stated.

<table>
<thead>
<tr>
<th>Serial</th>
<th>Categories of Farmers</th>
<th>Monthly Income of the Family in Rs.</th>
<th>Monthly Expenditure of the Family in Rs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Big Farmers</td>
<td>925.79</td>
<td>577.16</td>
</tr>
<tr>
<td>2</td>
<td>Middleclass Farmers</td>
<td>333.64</td>
<td>249.19</td>
</tr>
<tr>
<td>3</td>
<td>Marginal and Small Farmers</td>
<td>220.54</td>
<td>229.89</td>
</tr>
<tr>
<td>4</td>
<td>Landless Labourers</td>
<td>127.29</td>
<td>146.86</td>
</tr>
<tr>
<td>5</td>
<td>Other Farmers</td>
<td>351.86</td>
<td>248.83</td>
</tr>
</tbody>
</table>

SOURCE: Mistry, 2000
It is evident from the table that big farmers can save a large part of their income which often allows them to form capital for investment in the next season. Middleclass and other farmers are capable of small savings. But the marginal farmers and landless labourers are running with deficit budget and they become easy prey of the local money lenders. In extreme cases some of them are converted into bonded labours.

6.11. Problems of Agriculture

Despite various efforts of agricultural development, neither the yield has been increased nor diversification of crops has been possible to the level of satisfaction. Various constraints may be held responsible for this.

- Though an enormous amount of water flows down the river everyday, it is unfit for use in agriculture because of its salinity. The farmers have tried with the salt resistant variety of crops, but they prove to be unprofitable. Thus this option had been negated in this saline marshy track.

- There is acute crisis of water for agricultural purposes. The saline water available does not encourage cultivation and the question of using underground water does not arise because even for drinking water, 800 to 1200 feet is to be dug. The problem of scarcity of drinking water from the surface sources coupled with limited scope of utilization of underground water discourages utilization of the underground water for the purpose of irrigation. Misutilization of this valuable resource is out of question. The water stored in the ponds, canals and other water bodies cannot be used for agriculture because this would cause scarcity of non saline water required for other purposes.
Plate 21: Fish cum paddy farmers ventilating their grievances.

Plate 22: Interaction with a fisherman cum farmer at Frazerganj.
The only practical way of increasing the supply of irrigation water for the ravi (winter variety) crop is to store as much rain water as possible. The problem, however, is that though the Sundarban gets about 1900 mm of rain every year, most of it falls within the short span of June to September. The seasonality of rainfall and lack of adequate storage facilities is another glaring problem in the agricultural scenario.

The production of the aman (monsoon variety) crops and expanding the area under ravi (winter variety) has thus been a difficult task. The primary problem is that the farmers do not let their cultivable land to be used for digging ponds or canals.

With a hope of increasing crop production easily, chemicals fertilizers, pesticides have been used indiscriminately. The local dealers of these products cause damage in two ways. a) The quality and productivity of the land diminishes. b) Pesticides contaminates the ponds, canals and food causing various types of diseases, which carried over to the future generation. Residues of toxic materials accumulated in soil from different pesticides of chlorinated hydrocarbon group (e.g. BHC etc.) and thiophosphate group (e.g. Phosphamidon, Parathion, Malathion etc.) ultimately contaminate the domesticated plants and even the nearest water bodies. Through the food chain these toxic materials are concentrated in the fat and milk of the herbivores. Obviously, human beings who are regarded as omnivores are also affected (Basu, 2002). Pesticides residues have a tendency to get adhered to the clayey soil of Sundarban, thus affecting the biotic life.

Cultivation of fodder crops have never been given due importance. Thus due to the lack of proper feed, the health of the cattle is extremely poor.

With the absence of proper soil testing and agricultural research at the block level the local problems remain unattended. Thus availability of good seeds, fertilizers and
non-persistent pesticides are transformed to an occasional affair, tackled by the Block Development offices and the Panchayats (local self government).

- Water logging is a major problem with the predominance of clayey soil. This does not encourage cultivation of any other crop than paddy.

- Water melon, sunflower, cultivation of mustard had been tried at an experimental level, but it failed to attract the farmers due to lack of profit. Moreover, there is the problem of carrying these to the local markets.

- The farmers do not get loan at a reasonable rate. The farmers get only one fifth of the loan sanctioned for different purposes in the Sundarban. In most of the cases they fail to show the security against the loan as demanded by the local banks.

- There are several landless agricultural labourers whose main problem is insecurity. They have no other alternatives other than extracting forest resources. Though at Kakdwip, Canning, Hasnabad and Jaynagar the land under second crop has been on the rise, lack of proper transport facilities allures the farmers for distress sell of their products.

- Areas where there is deficiency or scarcity of water, cotton cultivation was thought to be the most suitable solution. However, it has been found that cultivation of cotton prove to be a failure due to pest attack, untimely rainfall and improper agricultural management system. The farmers of Jaynagar, Mathurapur, Kakdwip, Basanti, Gosaba and Sagar had gone a long way in cotton cultivation, but were frustrated with the negative returns.

- It has been found that the various methods of treating salinity of the soil had failed. The alternative thought initially, was amelioration in the form of desalinization or
de-alkalization. It has been observed that during monsoon season the salinity decreases by flushing of sweet water. But during the pre monsoon and post monsoon period the salinity increases and artificial management for desalinization becomes impossible due to the paucity of the perennial supply of fresh water in required quantity. So, only one option is left that is introduction of salt resistant variety of paddy. In fact it was introduced much earlier, but unfortunately never gained popularity among the farmers because of lower yield in comparison to high yielding varieties (HYV).

6.12. Agroforestry

The possible solution of the unique mangrove ecosystem is thought to be that of agroforestry. It appears to be a major factor in determining how the new technologies affect the labour market, migration, market expansion, profit etc. at the boundary between cultivated land and forest.

Agroforestry in Deforested Areas of Sundarban

For more than two centuries the Sundarban region of West Bengal has suffered from deforestation. It would not be improper to discuss the environmental impact of deforestation first before dealing the issue of agroforestry itself. Deforestation and degradation of forest have many negative consequences. Loss of plant and animal species lead to the extinction of several species and to serious reduction in the genetic diversity of others. Loss of tropical forests have already affected millions of people in different continents through increased flooding, soil erosion, siltation of waterways, drought, shortages of fuel wood and timber and displacement of societies and cultures. The destruction of forests also produces adverse impact in the ecosystem and can cause irreversible changes. The most serious of which may be due to the large scale exposure of natural soil systems, leading to increased erosion and in
Impact of Deforestation on Natural Environmental Systems

Deforestation
- Decreased shade
- Increased convection
- Decreased evapotranspiration
- Decreased water retention

Litter and cover removal
- Intensified rainfall
- Increased insolation
- Induration
- Increased evaporation

Erosion
- Floodling
- Topsoil depletion → Retarded regeneration

Drought
- Less plant growth

Downstream damage
- Siltation of reservoirs and harbours
- Wash-out of roads and bridges
- Damage to coral reefs and coastlines
- Deltaic area becomes exposed to cyclonic storms

- Reduction in the capacity of reservoir
- Possibility of flood
- Reduction in carrying capacity of the river
- Problem of navigation and port oriented activities

Tidal waves over power fresh water flow
- Salinization of land and water

Switch over from fresh water to saline water ecosystem

Drastic fall in agricultural production

Fig. 24 Modified after Goudland, 1995
turn indirectly affecting water resource development. Growing population has stripped the forests from the habitable areas of Sundarban and so the chain effect is also applicable there. (Fig. 24)

Three interacting subsystems involved in the stewardship of the world’s forest are shown in figure 25. The growth of a forest has a long term stabilizing effect on region like Sundarban as it reproduces itself and grows. A constant intake of the necessary nutrients from atmosphere, soil and rainfall is balanced as leaves that fall off from the trees pile up on the soil surface and decompose and return some of the nutrients to the soil. Also the activities of microbes and soil fauna and the activities of roots make the soil soft and fluffy. With such soil, rich in nutrients and well suited for farming, forest land is an ideal target for farmland expansion. As a tract of land reclaimed from a forest is placed under cultivation for some duration, the nutrients are washed away and the soil hardens. After some time, the farmland must be left fallow until such time as a forest thrives there again and the soil fertility is recovered.

A secondary forest means forest successional vegetation which is anthropogenic in origin, has risen after complete (more than 90 percent) destruction of primary forest vegetation covering such a large area that it displays dynamics, structure and tree species composition differing from those of the original stand and has not yet reached the state of the original primary forest (Dotzauer, 1998). Figure 26 points to the fact that much of the secondary forest is in a closed cycle, in which its use alternates with regeneration. Species composition, structure and development of secondary forest depend on the ecological conditions and their alteration by human activities. The rotation time between land use changes and the intensity with which the land is being used are also being altered by humans.
Interactive Subsystems in Forests

Atmosphere
Physical
Chemical

Forest

Human Activities
Economic, Social

Biotic environment

Fig. 25
Secondary Forests as Part of Dynamic Land Use System

Fig. 26

After Dotzauer, 1998
**Tropical Agroforestry Systems**

Older forms of agroforestry involved modifying farming practices of shifting cultivators to include planting of trees, seedlings with food crops. As the tree canopy grew and started shading the annual crop, the farmer would move to another area for cropping. But the concept of modern agroforestry has changed.

There are three basic types of agroforestry systems (Nair, 1989):

a) Agrosilvicultural (crop — including tree and shrub crops — and trees).

b) Silvipastoral (pasture with animals and trees)

c) Agrosilvipastoral (crop + pasture with animals + trees)

The other specialized agroforestry systems include aquaculture in mangrove areas, apiculture with trees, and multipurpose tree lots. The component composition of the basic types of agroforestry systems is shown in the figure 27.

However, there are some environmental problems which agroforestry can potentially alleviate including soil erosion, soil fertility decline, forest resource loss, pasture degradation, river degradation, pest attack and drought (Kumar, 2001). While implementing agroforestry in the mangrove ecosystem much care must be taken to minimize the negative effects of agroforestry. In Sundarban the model of agroforestry could be the most important solution to the various problems (man made and natural). Combination of the interacting ecosystems — the forest, agriculture and aqua culture had been made possible utilizing the interactive parameters dynamically transforming to bring in the positive effect of agroforestry. Neither the forestry department nor the agricultural had tried to implement such an approach, which would be environment friendly and socio-economic escalator. Agroforestry is circumscribed
CATEGORIZATION OF AGROFORESTRY SYSTEMS
BASED ON NATURE OF COMPONENTS

After Nair, 1989.
by adding some positive interaction between trees and agricultural cultivation vividly depicted in figure 28 with forest ecosystem, agricultural ecosystem and the ultimate evolution of agroforestry ecosystem, which considered to be the ideal one.

Figure 29 illustrates the use of environmental information for the introduction and development of agroforestry. Using this system the large areas of teak plantations were established in Indonesia and Nigeria. There is scope for its application even in Sundarban.

6.13. Suggestions for Agricultural Development

- The field which is suitable for Aman (monsoon variety) cultivation should be preceded by Dhaincha (a leguminous plant capable of nitrogen fixation) and after harvesting, the field should be treated with two to three kilograms of nitrogen. If the field is impregnated with water, small balls of clay could provide a viable solution.
- In order to maintain the inherent nutrient status of the soil, utilization of chemical pesticides should be avoided. Other farm management practices like biological control should be adopted to avoid pest attack. Such a system would successfully utilize the service of the crop-friendly predators who would take care of the prey insects harmful for the crops.
- Cultivation of pulses encourages the organic fertilizer — Rhizobium, which adds to the nitrogen content of the soil.
- There is the need of applying Carbondazyme during chilly cultivation in order to protect the plant from the Enthraknose disease.
- During the cultivation of vegetables stress must be given to the utilization of organic pesticides instead of chemical pesticides.
NUTRIENT RELATIONS AND ADVANTAGES OF IDEAL AGROFORESTRY SYSTEMS IN COMPARISON TO CROPPING AND FORESTRY ECO SYSTEMS

[Common] Forest Ecosystem
- Addition through fall
- Large Canopy volume
- Favourable microclimate
- Little erosion, Run-off
- Soil Surface
- Release by root decay
- Uptake by deep roots
- Little loss [output] from the system

[Common] Agricultural Ecosystem
- Little or no plant cycling, low litter fall
- Nutrients unintercepted rainfall
- Large export of nutrients
- Heavy leaching, especially during no-crop seasons
- Surface accumulation of roots
- Release by weathering
- Heavy loss [output] from the system

[Ideal] Agroforestry Ecosystem
- Trees of desirable forms and root systems of appropriate management
- Large export compensated by turnover within the system and efficient use
- Litter fall pruning/lopping
- Complementary sharing of nutrients
- Uptake from deeper layers
- Release by weathering
- Light leaching
- Little loss [output] from the system

Fig.no.28

After Nair. 1989
• Before the rainy season or after it huge amount of organic and non-organic fertilizers should be added to the soil for the cultivation of coconut and areca nut.

• For cultivation of paddy such pesticides should be used which would cause less harm to the environment as Endosulfan, Monocrotophos, Malathion, Phosphamidon because these are less persistent in nature. Of course these can be used in case of non-availability of the provisions for biological control. Neem — an organic pesticide may be used as a viable alternative because of its biodegradable character.

6.14. Conclusion

Solution to the inherent problem of embankment breaching, salinization, occasional flooding, paucity of funds, lack of proper research and application is not, however, an easy task. The problems of the closed and open system both has to be dealt with in order to solve the problems of the farmers, keeping in mind the environmental factors also. Solution to such problems can be provided by agroforestry, which combines agriculture along with the forest negotiating the requirement of both the domesticated and wild plants.

The future planning of agriculture is made keeping in mind the demands of the ever growing migrant population and the fragile ecosystem of Sundarban. During the dry season lack of proper irrigation facility does not encourage second or third crop. Thus along with agriculture aquaculture, poultry and duckery, agroforestry, floriculture and orchard etc. should be carried out. At Gosaba, Sir Daniel Hamilton carried out an experimental development project on a cooperative basis long before. Extension of such cooperative movement could solve the problem of the farmers keeping in mind their economic backwardness.

Harvesting of fresh water through construction and digging of small water bodies could help in the process of cultivation of pulses and oil seeds. The banks of the water bodies could be
USING ENVIRONMENTAL INFORMATION ON AGROFORESTRY

WHAT CAN WE DO TO HELP THIS AREA?

Collect input data for environmental data base

Environmental descriptors of Library data base

What kind of ENVIRONMENT does it have?

What has been PUBLISHED on similar environments?

Multipurpose tree data base

What TREES grow well in these conditions?

Data on crop requirements (FAO, CSIRO)

What CROPS grow well in these conditions?

Agroforestry systems data base

What AGROFORESTRY SYSTEMS are found in similar environments?

Inventory of agroforestry experiments

What AGROFORESTRY RESEARCH is being done in similar environments?

Use SKILL, EXPERIENCE, and JUDGEMENT to analyze data

WE THINK WE CAN HELP YOU

Fig. 29

After Young, 1989
raised and high yielding varieties of paddy, cultivation of *ravi* (winter crop), certain fruits (salt resistant varieties) could be tried at an experimental level. There is a need of greater use of fertilizers mainly green manure, azola and rhizobium, which could enhance the yield of paddy and pulses. Local women may be encouraged in mushroom culture through formation of cooperatives. Culture of medicinal plants may be encouraged. Even the small farmers may grow these plants and take necessary care for their marketing. Many such plants are indigenous species.

**References**


Census of India (2001): Provisional Population Totals, West Bengal; Directorate of Census Operations, West Bengal, Kolkata.


