1. NICOBAR ISLANDS AT A GLANCE

The beautiful tropical island arc of Nicobar is part of the union territory of Andaman and Nicobar Islands, India. These islands are situated in the south-east of the Bay of Bengal, around1200 km east of main land India between 6° - 10° N latitude and 92° - 94° E longitude, and separated from the Andaman group by 10° channel. A variety of landforms can be seen along the coast and isolated islands laden with lush green tropical vegetation and beaches dotted with coconut trees. The islands of Nicobar are inhabited by two aboriginal tribes of Indo-Mongoloid origin. One of them is Nicobarese who live in twelve inhabited islands with a major concentration in Car Nicobar. The other tribe is Shompen, whose members live in the interior areas of Great Nicobar. The lush evergreen forest, undulating terrain, tall coconut trees behind the scintillating sandy beaches, and coral belt surrounding the island with green water gradually merging with deep blue water characterize these islands from distance.

The Nicobar archipelago was not discovered all of sudden rather it was also known to the ancient mariners sailing to Southeast Asia from India, Middle East and Europe. A careful insight into the maritime history of the Indian Ocean would reveal several references to these islands by different mariners in different names. It may be a passerby citation or sometimes detailed description of its location and resources as could be seen from the Chola dynasty inscriptions of South India and Chinese travelers' remarks. Between the 11th and 12th centuries A.D. some of these islands came under the dominating influence of maritime power of Southern India and as history would repeat itself it again became a part of the mainland India about nine hundred years later (Syamchaudhuri, 1977).

Geologically the Nicobar Islands are part of a great island arc created by the collision of the Indo-Australian Plate with Eurasia. The collision lifted the Himalayas and most of the Indonesian islands, and created a long arc of highlands and islands, which includes the Arakan Yoma range of Burma, the Andaman and Nicobar Islands, and the islands off the west coast of Sumatra, including the Banyak Islands and Mentawai Islands. Nicobar Islands are formed on a coralline base with marine sediments. Except for Great Nicobar Island, all other islands in the Nicobar group are relatively smaller in size surrounded by reef.

The Islands

The Nicobar group is having 22 islands of which 12 are inhabited and are divided into three distinct groups (Fig.1.1) based on its geographical location.They are Northern, Central and Southern group of Islands.

i. Northern Group

This consists of oval shaped Car Nicobar (126.9 km²) Island located just below the 10° channel with the largest Nicobari population.

ii. Central Group

This consists of lot of small and medium sized islands lie scattered in the Bay of Bengal. It exhibit diversity in terms of nature, resources and culture. These islands suffered extensive damage during the December 2004 tsunami. This includes Chowra or Sanenyo (8.2 km²), Teressa or Luroo (101.4 km²), Bompuka or Poahat (13.3 km²), Katchal (174.4 km²), Camorta (188.2 km²), Nancowry or Nancowrie (66.9 km²) and Trinket (until 2004, 86.3 km², surface greatly reduced after the Tsunami) islands.

iii. Southern Group

. This is called the Sambelong and consists of Great Nicobar (1045.1 km², the largest island in the Nicobar group), Little Nicobar (159.1 km²), Kondul (4.6 km²) and Pulo Milo or Pillomilo (Milo Island; 1.3 km²) islands

Among the inhabited islands Great Nicobar is the largest island and the southernmost location of India, **Indira point** (earlier referred as Pygmalion point) is located here. During the devastating tsunami of December 2004, the light house located here was submerged. The Nicobar Islands cover a land area of 1,840 km^2 with the population of 36,842 (Census of India, 2011).

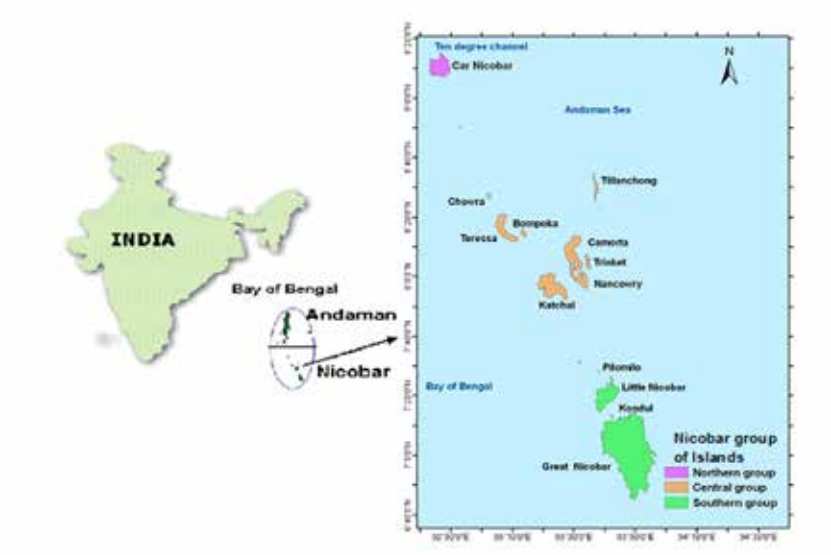


Fig. 1.1 Location of Nicobar Islands

Climate

These islands experience hot and humid climate because of their location in the equatorial zone surrounded by Andaman Sea in the east and Bay of Bengal to its west. The Nicobar Islands receive copious amount of rainfall from both the south-west and north-east monsoon and measures 2900 mm average annual rainfall with values ranging from 2750 to 3100 mm (Fig.1.2). The historical climatic data shows that the mean relative humidity is 79%, maximum temperature is 30.2° C, and minimum temperature is 23.0° C. Maximum rainfall is received during May to December and dry period extends for 3 to 4 months from January to April. These islands are having more than 130 average numbers of rainy days however during the month of February lowest amount of rainfall is received with an average of only 3.2 rainy days. In general, the rainfall decreases with latitude in post-monsoon season and during monsoon period rainfall increases with latitude. In contrast, there has been no uniform trend in case of pre-monsoon rainfall. The rainfall pattern largely decides the water availability and crop distribution in these islands.

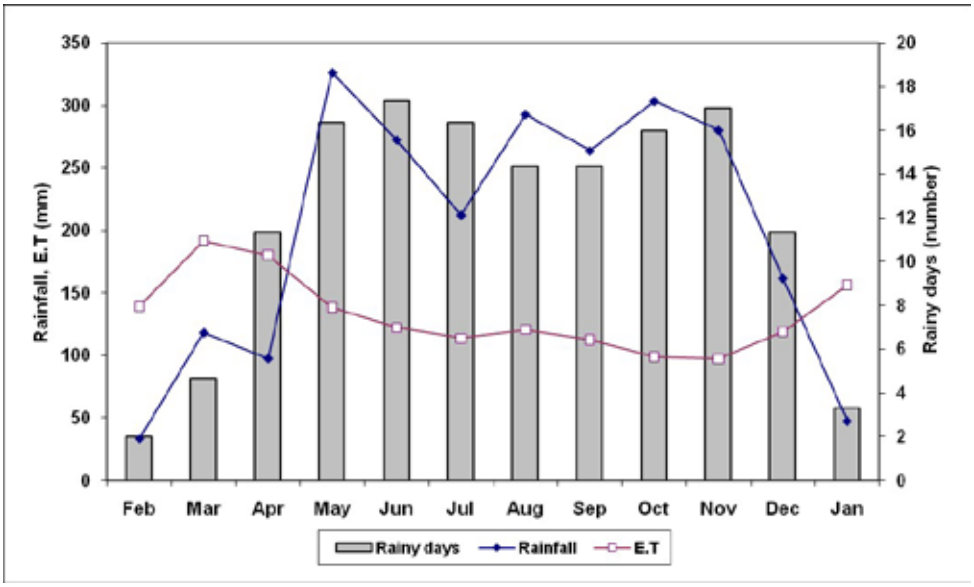


Fig. 1.2 Climate of Nicobar Islands

Population

The Nicobar group of Islands is home to two aborigines of Indo-Mongoloid origins *viz*., Nicobarese and Shompens. The latter is mainly a hunter-gatherer tribe with gardening and herding as subsidiary livelihood. They are confined to Great Nicobar Island ever since their first settlement and there is no credible evidence of any kind to suggest that

they have also gone to other islands during their settlement history. The Nicobarese are horticulturists and herders and mainly distributed in Car Nicobar, Katchal, Camorta and Chowra. In spite of a wind of change in recent times, a vast majority of the Nicobarese still pursue their traditional occupation of coconut and arecanut plantation and rearing of pigs. Some of them have also taken up rearing of livestock and poultry which marked a shift from free ranching to commercial production.

Out of these two, the Nicobarese are the largest tribal group inhabiting 12 Islands with major concentration in Car Nicobar. They were the last indigenous people to arrive on these Islands and have racial mixture with the natives of South East Asia (Das 1982). Out of the 22 islands in the Nicobar group only 12 Islands are inhabited and the Island wise population distribution is given in table 1.1. As per the census of India (2011) the tribal population accounted for 63.1% of the total population. Except Great Nicobar, tribal population is predominant in all other Islands but the alarming issue and set back to tribal policy is decrease in the decadal (2001-2011) population growth rate (-12.4%). The decadal growth rate of female population (-17%) is much worse than male population (-8.6%).

Table1.1 Tehsil wise population distribution

S. No	Tehsil	Islands	Total population	Tribal Population	Percentage
1.	Car Nicobar	Car Nicobar	20292	15899	78.4
2.	Nancowry	Chowra	1385	1376	99.4
		Tillang Chong	13	4	30.8
		Teresa	2026	1826	90.1
		Bampooka	55	55	100.0
		Katchal	5312	2662	50.1
		Camorta	3412	1854	54.3
		Nancowry	927	881	95.0
		Trinket	432	429	99.3
3.	Great Nicobar	Little Nicobar	353	345	97.7
		Kondal	150	141	94.0
		Pilmillow	145	138	95.2
		Great Nicobar	7566	955	12.6

(DES, 2015)

Physiographic description of different Islands

The Nicobar Islands are surrounded by shallow seas and coral reefs. From the elevation map (Fig. 1.3 A) of the Nicobar Islands (indicated in meters above mean sea level) it is seen that baring a few islands the terrain is mostly undulating with the main ridges running North-South. In between the main ridges deep inlets and creeks are formed by submerged valleys. In most of the Islands perennial streams are non – existent except in Great Nicobar where there are 5 perennial rivers flows out from the North-Eastern part of the island in the downstream region of Mt. Thulliar.

Car Nicobar is flat except a small cliff in the north and small hill in the centre. It is bordered by a flat ground consisting of coralline diluvium. In the Central group, Nancowry and Kamorta, have a hilly terrain covered with grass, forming undulating meadows (Fig. 1.3 B). Katchal is slightly hilly in the centre but has a remarkable flat area, like Car Nicobar. Trinket is a flat Island, while Chowra is almost flat except for a small hill located at its southern tip. Teresa, Tillangchong and Bompoka have hilly terrain. Great Nicobar is the southernmost land mass, it is hilly and undulating. Galatea, Alexandra and Dagmar are the perennial rivers. Kondul and Little Nicobar are also hilly and undulating. The physiography of each island has profound influence on the distribution of crops and type of farming. Often the picturesque beauty of these islands is difficult to describe in words.

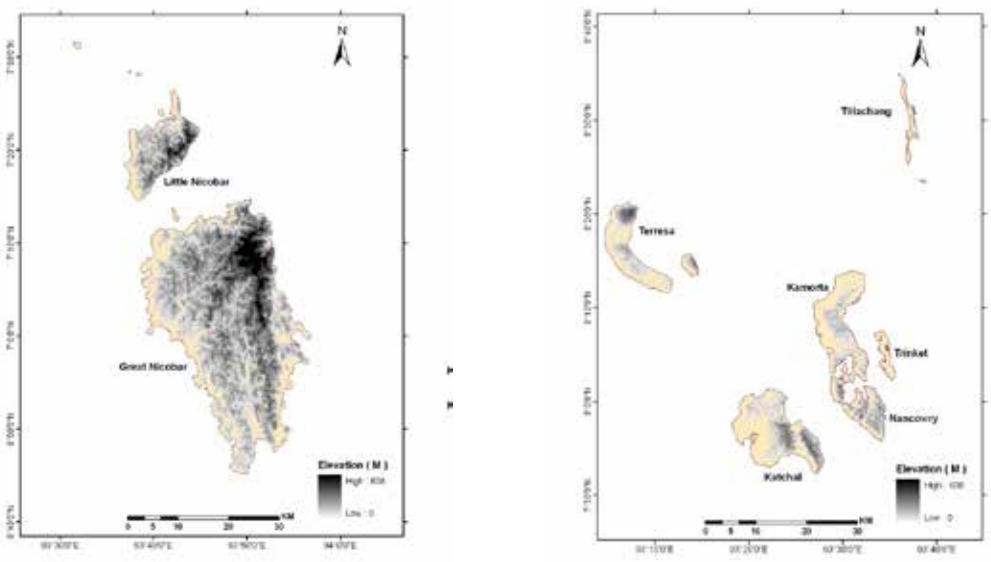


Fig. 1.3 A. Elevation map of Nicobar Islands

Undulating meadows of central group of islands

A cliff surrounded by flat land in Chowra

Flat topography of Nancowry

Fig. 1.3.B Different terrain features of Nicobar Islands

Land resources

Favoured by hot and humid condition with copious amount of rainfall spread over almost eight months in a year, these islands have lush green tropical vegetation. Particularly, these vegetation in Great Nicobar Island have not been much disturbed for centuries and maintains its natural state. For this reason several plant species have evolved and the region harbours wide variety of plant diversity. About 97% of reported area of these islands is under forest cover and the remaining only 3% is available for other land uses including agriculture (Table 1.2). However, the proportion of agricultural land to total area varies from island to island. In Car Nicobar and Katchal over 40% area is under plantation crops and rest of the islands have cultivable area between 0-19%. Out of the total geographical area of 1841 km^2, an area of 1547 km^2 is covered under forests. The central group of islands show signs of human influence in the form of extensive grassland introduced by the European colonisers. Similarly rubber plantation was introduced into Katchal islands after independence. In spite of all these influences coconut plantation is still maintained as a dense stand (Fig. 1.4).

Table1.2 Land utilization pattern in Nicobar Islands

Sl.No	Land use category	Area (km^2)
1	Total Geographical area	1841
2	Reporting area for land utilization	1577
3	Forest area	1542
4	Current fallow	472
5	Fallow land other than current fallow	731
6	Net area sown	267
7	Area sown more than once	110
8	Total cropped area	377

(Hand Book of Statistics, 2011)

Dense coconut plantation in Car Nicobar

Rubber plantation in Katchal

Fig. 1.4 Land use in Nicobar islands

The Soils of the Nicobar Islands were classified into 3 orders *Entisols*, *Inceptisols* and *Alfisols*. The main agricultural soils are found in the valleys and are of alluvial and colluvial origin. The soils of the islands vary in depth, texture and chemical composition and are acidic in nature except Car Nicobar and Katchal. Humus is generally lacking in the forest soils as it is generally washed away due to copious rainfall and steep slopes. The soils are sandy to clay loam, partially drained and have poor water retention capacity. The depth of the soils is very shallow in the hill slopes to more than 1.5 m in the valleys. The soils are low to moderate in nitrogen and phosphorus content.

Water is one of the most critical resources essential for sustaining human life in Island ecosystem and the only source is rainfall. Rainfed agriculture is practised in the entire Nicobar Islands. The region is in the active tectonic belt experiencing subsidence and

uplift. Besides this, the topographical features such as central high land surrounded with coastal plain, smaller size of the islands, undulating terrain and faster infiltration in the downstream doesn't favour the concentrated flow of run-off. Consequently there is no well developed drainage system and there is very limited scope for the development of large scale reservoir, drainage system or canals. The surface water sources include only ponds and small streams. The major ground water sources are the porous formation consisting of beach sand with coral rags and shells, the thin cover of alluvial or colluvial deposits in the coastal or intermountain valleys and adjoining foot hills besides fractured volcanic and igneous rocks. There is a growing demand for fresh water however in these islands the ground water resources are not well developed due to several reasons (Central Ground Water Board 2010).

Farming practices

i. Crop production

There is no irrigation facility anywhere in Nicobar Islands due to the reasons discussed earlier therefore, only rainfed agriculture is practiced. As the climate is very congenial for the growth of plantation crops, coconut occupies the major area under agriculture. Except in few locations, it is mostly grown as self-propagating crop. On an average the productivity of coconut is only 3500 nuts ha^{-1} which is much below the national average of 7821 nuts ha^{-1}. The low productivity is due to unproductive and senile palms, inferior genetic base, poor soil conditions, rainfed nature of crops, high palm density, poor management and inadequate plant protection measures (Fig. 1.5 A). The local cultivars like Andaman Tall and Katchal Tall are poor yielder of only 30 to 35 nuts per palm per year. The other major crops grown are banana, papaya, tapioca, sweet potato, pine apple etc. The cereals and other food crops like rice, wheat, pulses are imported from outside as the climatic conditions do not favour their cultivation. The farmers are practicing subsistence farming or natural farming and most of the cultivable areas are organic by default. They do practise shifting cultivation to a limited extent in the form of community garden to meet their demand for fruits and vegetables.

ii. Livestock production

Livestock rearing is an integral part of the farming systems of South Asia more so in Nicobar Islands (Fig. 1.5 B). The Nicobari tribes during migration brought livestock such as pig and poultry with them and thrived, but depended on the natural ecosystem for feed and fodder. In Car Nicobar the major livestock comprised of pig (76%), goat (18.2%) and poultry which are reared in extensive open semi-feral system with no intension of

business. The pig plays a very important role in Nicobari society and culture. In contrast, the cattle population was higher in Great Nicobar mainly because of the dominance of settlers rather than tribal population. The indigenous birds (Nicobari poultry) are reared which resembles other birds except for its shorter legs. There are many scientific reports of its resistance to most local diseases and it is the best egg layer in India with a laying capacity of 160 eggs per year.

Fig. 1.5 A. Dense unmanaged coconut garden

B. An adult Nicobari pig

iii. Fisheries production

The Andaman and Nicobar Islands have a coastal length of 1,912 km and the continental shelf area of about 35,000 km^2. The Exclusive Economic Zone (EEZ) around these islands is about 600000 km^2 comprising 28% of the total EEZ area of the country. The fishing as profession is lacking among the Nicobari tribes. In Nicobar Islands, fishing is carried out by the tribes with spears. The crafts and gears used by the fishermen are of the traditional type and of limited capacity. The fishery is thus mostly confined to backwater creeks, estuaries and coastal areas. Endurance for high sea fishing, exploratory and multi-day fishing, fishing for coastal tunas, oceanic tunas and other straddling stocks are not possible with the limited capacity of the craft and gear in addition to lack of deep sea fishing skills. As a result out of the total fishery potential of 1.48 lakh tonnes, only around 35000 tonnes was exploited annually as per 2011-12 data. This clearly indicates a vast scope for the development, exploitation and utilization of the fish resources of these islands.

Socio-economic status of tribal population

The Nicobari tribe spread across all the islands is living in a social system called *tuhet*, an extreme kind of joint family group where head of the *tuhet* owns the land and forest and only usufructuary rights are with the individuals for agriculture and other purposes (Mann 2005). Coconut is the major agricultural produce providing income,

whereas other food items are mostly shared among themselves or exchanged by barter system. Another ethnic tribe who are still at primitive stage of civilization lives only in Great Nicobar Islands.

Conclusions

Looking back into its past history it can be seen that Nicobar group of Islands has never remained completely isolated. With limited resources, these islands could not support the development of large civilization nor did it attract the settlement of any major maritime power. Except for Great Nicobar islands, other islands mainly comprise central high land surrounded by coastal plain. Till the establishment of Indian administration primarily aimed at tribal welfare, the tribal economy has been largely subsistence in nature, copra is the only surplus item available for trade and these tribes depend on land and seashore for their food requirement. Car Nicobar has progressed well with time, the central group is struggling but slowly catching up with the introduction of organized external trade, but the tribes of Great Nicobar Island has fallen back in the developmental process. Implementation of tribal centric long-term developmental strategies supported by administrative and judicial system of the country is essential to slowly bring them into mainstream social life while allowing them to progressively evolve and retain their ethnic and cultural identity.

THE EARLY HISTORY AND FARMING

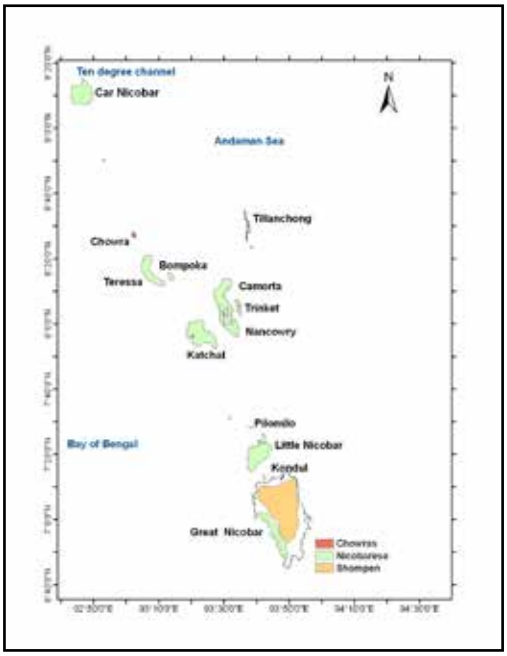
The Nicobar archipelago was not unknown to the ancient mariners sailing to Southeast Asia from India, Middle East and Europe. The Greek geographer Ptolemy places certain islands in the sea where the Andaman and Nicobar Islands stand and Car Nicobar was called probably as '*Maniola'*. Fa Hien, a Chinese traveller, sailed in a merchant vessel from India to China in the 6th century A.D. probably passed through the Nicobar water collecting foods and drinking water. An Arab merchant who visited southern China in 851 A.D. described the Nicobarese as Nagabalus, inhabited by people who went almost naked.

In those days, when the art of navigation entirely depended on the freak of nature, long and distant voyages could not have been performed by trading vessels without intermediate halts for food and water. The Nicobar Islands were, no doubt, used as a halting station by the ancient mariners voyaging from different Indian ports. Before, the spread of the Muslim influence, the Nicobar Islands were used by a powerful king of south India called Rajendra Chola I, the son of popular Chola king, Rajaraja I. King Ranjedra Chola of Tanjore, sent an expeditionary force across Bay of Bengal about 1125 A.D to Malay, then a kingdom of the Sailendras. From the historical account of the Cholas, it is ascertained that for about fifty years from 1017 A.D the Nicobars were used by them as a base station for waging war and keeping control over the territories in Malay. In the annals of Rajendra Chola II, Car Nicobar was identified as *Kar Dwipa,* the Great Nicobar as *Naga Dwipa* and the entire Nicobar group was known as *Neccavaram*. But they were not interfered with the collection and hunting nature of the Nicobarese and there was no account of organized farming in these islands. Towards the beginning of the 12th Century A.D. the Arabs gained dominance over the sea routes between India and Southeast Asia. In the book of Sir Marco Polo, Nicobar was described as '*Necuveram*' located 150 miles north of islands of Java. These evidences suggested that the ancient voyagers from India used to replenish stock of firewood, drinking water, coconut and food from Car Nicobar and Nancowry group of islands.

During the European expedition and trade sailing, Captain John Devis, piloting a Dutch ship arrived in the Nicobar in 1599 which is enshrined in the Nicobarese folk. He described the islands as pleasant and rich in coconut, fruits including oranges, lemons, and ambergris for bartering. Danish and British ships also landed in these islands before the establishment of British authority over these islands in 1869. The historical evidence suggests that there were no trace of use of cereals, the inhabitants promoted coconut and other food crops in the natural habitats but not cultivated.

2. TRIBES OF NICOBAR ISLANDS

The Nicobar group of Islands is home to two important tribal groups of Andaman and Nicobar Islands *viz.,* Shompens and Nicobarese. Both of them are Indo-Mongoloid origin but settled in these islands at different period of time. The knowledge, skill, courage and seamanship of these tribes could be seen from their spatial distribution in different islands (Fig. 2.1).The Shompens were the first to arrive on the Great Nicobar islands and settled there as forest dwellers. They did not move to other islands of Nicobar group. They are food gatherers, hunters and practice primordial stage of economy. They depend on forests and marine resources for their livelihood and sustenance. In contrast, the Nicobarese arrived from the Burmese coast in batches and spread to other Nicobar Islands. Evidences suggest that some of them might have come to these islands at different point of time and settled in Nicobar Islands (Das 1982). As of now, they are well developed among all the tribes inhabiting Andaman and Nicobar islands. They are agriculturists practicing natural farming and live in higher state of economy. The socio-cultural aspects of these two important tribes decide the state of farming system and resource use apart from the enterprising settlers of mainland India.



A Nicobari family

A Shompen family

Fig. 2.1 Distribution of tribes in Nicobar Islands

2.1 The Shompens

Origin in the Island

As discussed earlier, both Shompens and Nicobarese belong to mongoloid ancestry but have different settlement history / origin in this Island. The Shompens arrived on Great Nicobar from Sumatra more than 10,000 years ago, while Nicobarese came from mainland Southeast Asia much later (Arora 2010). Unlike the Nicobarese the former have not ventured into other islands. Shompens live a semi-nomadic life and have not been colonised at one place in a defined reserve forest as could be reported for Onge and the Great Andamanese. The Shompens have two divisions *viz*. Mawa Shompens (kalay) a smaller group and hostile Shompens (keyet) a major group. The Mawa Shompens inhabit areas very close to the west coastal region along the river valleys of Great Nicobar and have contact with the Nicobarese. The major group of Shompens are the hostile Shompens living in Alexandra and Galatia river areas and also on the east coast of the area in the interior of the Great Nicobar Island.

> The Shompen, one of the most isolated and poorly understood contemporary hunter–gatherer populations, inhabit Great Nicobar Island, the southernmost island of the Nicobar archipelago. Morphological imprints in the Shompen were interpreted to favour a mixed Indo-Chinese, Malay, Negrito and Dravidian origin. Analyses of the mitochondrial, Y-chromosomal and autosomal gene pool of contemporary Shompen have revealed low diversity, illustrating a founder effect in the island population. With the different types of genetic markers analysed, the Shompen exhibit varying levels of genetic relatedness with the Nicobarese, and Austro-Asiatic speakers of mainland India and Southeast Asia. These genetic analyses provide evidence that the Shompen, an offshoot of the Nicobarese, are descendants of Mesolithic hunter–gatherers of Southeast Asian origin, deriving from at least two source populations.
>
> (Trivedi *et al*., 2006), Journal of Human Genetics, 51(3): 217-226

Social setup

The Shompens are basically hunters and gatherers, their life is inextricably linked with forest and maintains a balance between the resource availability and use. They are semi-nomadic and live in scattered habitats located inside the forest of Great Nicobar. The Shompen tribe is organized into different bands, the biggest social group. In general, a band consists of 25-30 persons representing 8-10 families. There is no division based on birth and the elder man leads the groups in many activities. The pattern of family

reported in the contacted bands of Shompens is largely of nuclear type. The average family size is 3.1 to 4.0 and the division of labour within the family is well demarcated. However, the full strength of the band may not be available at one place as they move on to different locations as per their food requirement and its availability. But, their identity with a specific band is always recognized and a band as for as possible is endogamous.

Fig. 2.2 A. A Shompen group in their temporary hut

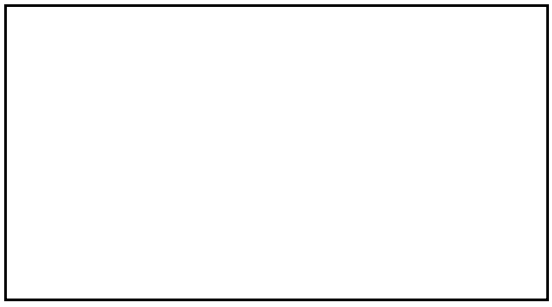
B. A Shompen hut with walls on all sides

The Shompen's territory is divided into four distinct regions based on the movement of different groups. After clearing the forests of 100 -250 m^2, pile of huts are raised as a temporary shelter. The individual huts were raised on posts or tree trunks of height 1.8 to 2.4 m. A well-built Shompen settlement as seen in Fig. 2.2 is located in a secured place from where they can easily reach out to all basic resources. They are known to grow tobacco, chili, lemon and colocasia near to huts. The Shompen men wear loin cloth while women use scanties made of barks of *Ficus brovicuppis* or *Stercules macrophylla*. The men collect the bark and brought to the hut while women do fermenting, separation of baste from cortex, shredding and making of cloth. When contacted the Shompens tried to keep their women and children away from the sight of an outsiders due to social reason and probably fear of diseases as well. At present they are not totally hostile to outsiders however, they maintain traditional relation with the coastal Nicobarese settled in the Great Nicobar Island.

Economic activities of Shompens

The economic state of the Shompens is still primitive, they don't do organized economic activity, rather their activities are mostly restricted to satisfy their food and other basic requirements. They are known to use both plants and animals available in the island as the source of food but never exploit to the level of extinction. They are hunting-fishing arboriculturists having apiculture as well. Arboriculture is the major occupation of Shompens. They grow pandanus as a major plantation crop followed by colocasia,

which is another important source of plant food, grown on the hill slopes after clearing forests and making zigzag fence to prevent destruction by wild pigs. Lemon, betel nut, chili, tapioca and tobacco are also grown by them in a small area. The plantations are grown on community basis that is for a band in their camps. But sometimes individual claims of trees were also accepted. Those who have interaction with coastal Nicobarese raised few coconut trees in their camps.



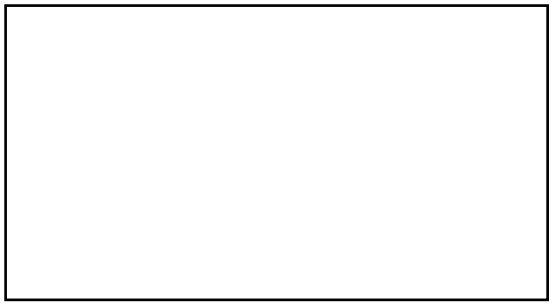


Fig. 2.3. A. Collection of *Pandanus* B. Hunting with spear

Hunting is another important activity of Shompens (Fig. 2.3). They hunt wild pigs, monitor lizard and megapod birds and their eggs which forms indispensable part of their diet. Besides hunting, they also go for fishing in the stream creeks or in coastal waters using mainly spears. They also practice simple and natural apiculture. The Shompen have barter exchange with Nicobarese since beginning. They used to exchange honey, lemon and resin for tobacco, cloth and iron with coastal Nicobarese. Later, they started working in Nicobarese villages as labourers probably after they developed strong interest for drinking toddy which was introduced to them by the coastal Nicobarese.

While dealing with the barter trade of the Shompens with the Nicobarese, Sarkar (1989) observes, “The Shompens living near Trinket channel had traditional barter relation with the Nicobarese of Kondul Island. They used to get clothes, iron implements, tobacco leaves etc. from them. Similarly, the Shompens living in the west coast near the Nicobari village of Pulo Bhabi have close economic relations with them and exchange honey, arecanut etc. with iron implements and tobacco. Sometimes, the trade is not in favour of Shompens when they exchange canoes with loin cloth and cooking utensils.

2.2 The Nicobarese

Origin in the Islands

The Nicobarese were the last indigenous communities to arrive on these islands and is the largest tribal group inhabiting the inhabited Islands (see the distribution in Fig. 2.1) with major concentration in Car Nicobar followed by Chowra and Nancowry. In due

course Nicobarese settled in different islands have developed distinct socio-economy and dialect (Fig. 2.4). Similar to Shompens they are also Mongoloid origin and have racial mixture with the natives of South East Asia (Das 1982). Invariably, they have yellow brown skin, medium stature and domesticated animals and cultivate crops. As the population grew in size, to overcome the problem of over population in Car Nicobar, 165 tribal families were shifted to Harminder Bay in Little Andaman in 1973.

Fig. 2.4 Hinonga village, Nancowry Arong Village, Car Nicobar Chowra Islands (with pottery)

Social setup

The Nicobari tribal is living in a social system called *tuhet*, an extreme kind of joint family group where head of the *tuhet* owns the land and forest and only usufructuary rights are given to the individuals for agriculture and other purposes (Mann 2005). Among the tribes there are no division based on birth and all are treated equally in the society. In a village there are number of *tuhets* and each village is headed by a village headman called "captains" (Fig. 2.5). There are up to five headmen or captains in a village elected by the villagers. They are instrumental in motivating the people to progress in all walks of life. Besides, there is a tribal council in each island, which has the powers of managing all the affairs of their people. In recent time there are changes in the tribal administrative system with the spread of modern education and democratic values. Further the outside influence on Nicobarese society led to the adoption of Christianity and Islam though they retained larger part of their ethnic and cultural identity.

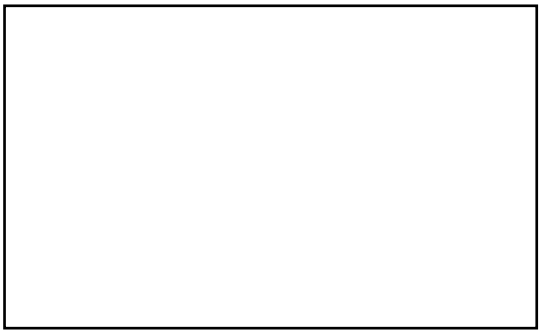


Fig. 2.5 A tribal captain with his village people The hierarchy in the tribal society

Economic activity

The economic activities of Nicobarese invariably in all the islands depend on coconut palm. They produce copra by traditional methods and sell through tribal cooperatives for cash with which they meet their other requirements. Some of them have mastered in extraction of coconut oil and some other in virgin coconut oil too. Among the other plantations raised are the large sized pandanus, papaya, yam, banana and some local vegetables. Citrus fruits are grown in Teressa Island. Among the livestock, pigs form the wealth of Nicobarese and it occupies the centre stage in most of their social gatherings. After 2004 tsunami, permanent dwellings with community center (*El-panam*), schools,

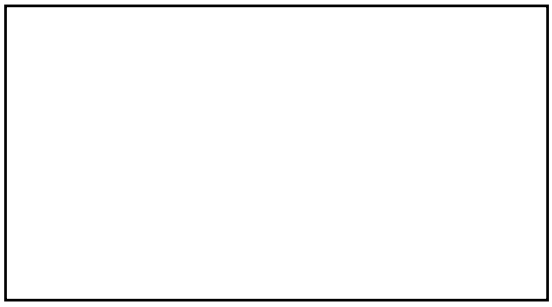
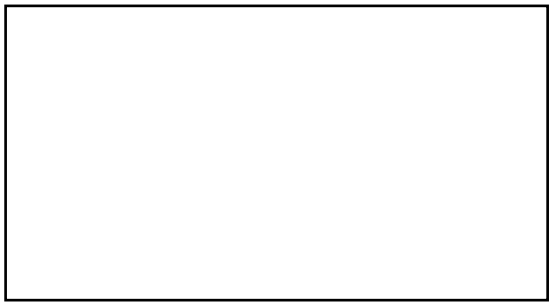


Fig. 2.6 Pig fighting - a social gathering



Very eager to learn and adopt technology

play grounds and other common facilities were constructed by the government as a part of rehabilitation program. At present they are well educated and most advanced among all the tribes of Andaman and Nicobar islands (Fig. 2.6). This is largely due to the eagerness of the tribe to adapt to the changes and the impact of various change agents. The typical Nicobari huts can be seen only in few places and the old landscape has greatly changed.

The Nicobarese are busy with different type of their routine activities which include,

- Household work: Nurturing homestead garden, feeding livestock and making craft items for use and sale
- Agriculture and Trade (external as well as internal): Sale of agricultural produces particularly copra
- Religious ceremonies and feasts: Very important part of their social life and involve people from different villages as well

In addition, the Nicobarese are engaged in some special occupations such as pottery in Chowra, basket work in Car Nicobar, making of canoes and iron spears in the Central group, and of baskets, matting, wooden spears, and the collection of jungle produce in

the Southern group of islands. After the introduction of money economy, establishment of tribal cooperative and trading company, the barter system got reduced, and these institutions take care of trading of copra produced by the Nicobarese. As a result, some of the savings are done through compulsory deduction of thrift deposit while purchasing coconut and betel nut from them at cooperative societies.

Apart from this, the Nicobarese have been trading among them and in many occasions it is not beyond barter. The canoes and earthen pots, prepared by the Chowrities, as also the canoes prepared by the Nicobarese of Kondul and Great Nicobar, are in the internal trade, bartered for pigs, tobacco, cloth and other implements. Owing to the spread of modern education, many Nicobarese have found employment in the Government service mostly as teachers, medical attendant and ministerial staff. This greatly enhanced the purchasing power of the Nicobarese and they go for cash purchase as well.

Conclusions

Shompens are the first settler on Nicobar Island but still live in scattered habitats in the forest and practice primitive state of economy. Creation of Shompen cooperative similar to Onge is urgently needed to regularize the barter trade in favour of Shompens. It is essential to redesign the Shompens welfare policy keeping in mind the requirement of coastal and forest Shompens in their respective context. Whereas, the Nicobari tribes are well settled in all the islands of the Nicobar group, but they should be given access to new technologies to enhance their farm production and equal economic gain for individual families. Economic stratification is also noticed in the Nicobarese society particularly in Car Nicobar from the material possession and way of living of some land owners and tribal chiefs. Government policies should encourage positive socio-economic transformation of tribes but evolved within the tribal society for the benefit of every individual.

Looking at the impressive progress of the Nicobari society, one should encourage the change agents to bring the Shompens also on board to development. The collection of primary products should pave way for producer economy. The policy of leaving them to their destiny doesn't look logical in the long-term well being of the Shompens and regional development.

3. SOIL RESOURCES OF NICOBAR ISLANDS

Crop production to a great extent is based on the inherent nature and management of land resources particularly soils. For large-scale and low-cost crop production, there is no viable substitute for natural soils as a substrate for crops in the foreseeable future. Soils are the precious natural gift for small islands on which the vegetations flourish and the natives derive their livelihood. Soils are the uppermost part of the earth's crust, formed mainly by the weathering of rocks, formation of humus and by material transfer. They differ greatly in their morphological, physical, chemical, mineralogical and biological characteristics from place to place. Since these characters control the response of soil to management practices, the knowledge on the potential of soil resource and its limitations, present use and the methods of management is vital for its sustainable use for production purposes. Unlike farming in mainland India, the tribes of Nicobar Islands have not meddled with the soil by unsustainable agricultural practices but learned to live in harmony with the nature. The crops and cultivation practices followed by them are striking example of utilization within its capabilities and limitations. This attitude or social customs helped them to conserve this precious resource. In this chapter we present some of the important features of the nature and properties of soils of Nicobar Islands.

3.1 Parent materials

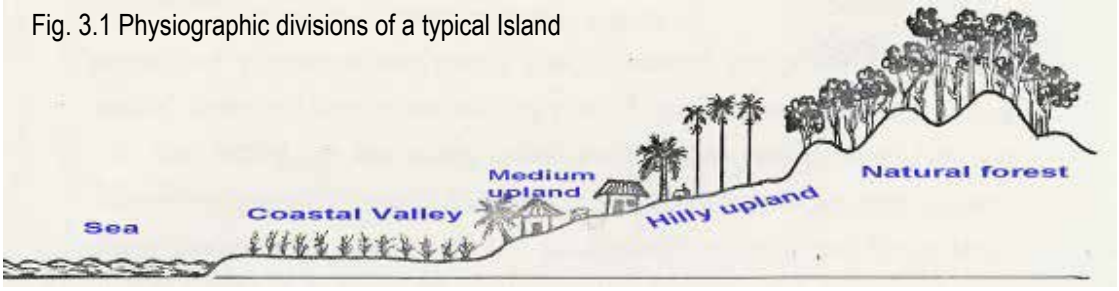
The soils of Nicobar Islands are mainly derived from sedimentary rocks like mud stone, lime stone, clay stone and associated conglomerate besides sandstone. In certain places soils are formed from plastic and magnesian clay, marls and partially serpentine rocks. According to the soil, the major land use in Car Nicobar and Nancowry group of Islands are plantations (coconut and arecanut) and homestead gardens where tuber crops, fruits and vegetables are grown. In Great Nicobar rice, pulses are grown in coastal plains and plantations in upper slopes. In the acid soils of Katchal rubber is grown and in rest of the area natural forest dominates with wide varieties of tree species influenced by slope, depth of soil and its nature. However, in the tropical islands of Nicobar the soils differ from their parent materials and so many variations in the nature of soils are observed due to the dominant influence of climate, vegetation and topography or relief.

3.2 Physiography

Knowledge on the kind of soils and their extent is very essential for sound land use planning. Soil resource inventory provides the vital information achieved through systematic soil survey. The islands are divided into flat lands, hills and hill slopes based

on its physiographic positions (Fig.3.1). Flat lands are subdivided into valley flats and coastal plains which is the depositional landform near the coast in which coastal marshes and marine sand are also found. The hill slope is subdivided into gentle slope and upland. These are further subdivided based on the drainage conditions and nature of materials deposited. The uplands under plantations and forest cover are intensely leached due to the prevailing climatic conditions favoured by topography. Such soils are severely eroded and less fertile. The valley floors comprise of depositional land forms and have been termed lowlands and have developed from the out wash of parent material from the surrounding hills. These soils are medium to heavy textured and moderately well drained and subjected to seasonal fluctuations of ground water.

Fig. 3.1 Physiographic divisions of a typical Island



3.3 Soil classification

After physiographic analysis of Nicobar Islands using satellite imageries and aerial photographs extensive survey was conducted during the soil survey programme (Singh and Mongia, 1985). Recently the information was updated by systematic survey of the islands, creation of GIS based digital data base led to the mapping of rocks and geomorphology of these islands (Fig. 3.2). Most of the rocks found in these islands are sedimentary origin and the soils of Nicobar Islands are formed under the dominant influence of climate, parent materials and topography.

Table 3.1 Taxonomic position and limitations of soils found in Nicobar Islands

S. No	Order	Suborder	Great group	Limitations
1	Entisol	Fluventts Orthents Psamments	Tropofluvents Troporthents Fluventic	Moderate erosion and O.C; low base status Moderate erosion, loss of top soil, low nutrients Coarse texture, low water holding and nutrient retention capacity

2	Inceptisol	Ochrepts	Typic dystrochrepts	Sloppy land, moderate erosion, shallow depth of soil
3	Alfisol	Ustalfs	Haplustalfs	Moderate erosion, low water holding and nutrient retention capacity

The soils are classified into three orders (*Entisol, Inceptisol and Alfisol*) and five suborders and so far eight soil series have been established (Table 3.1). In certain valley marshes, high organic matter content was observed, but certain elements limited it being qualified for *Mollisol*. Further, the organic carbon distribution in various physiographic locations in different islands needs to be studied in detail. Nevertheless, the soil series occur either as a single entity or as an association of two to three series in a mapping unit. The major limitations are erosion, soil acidity, low base saturation and nutrient status.

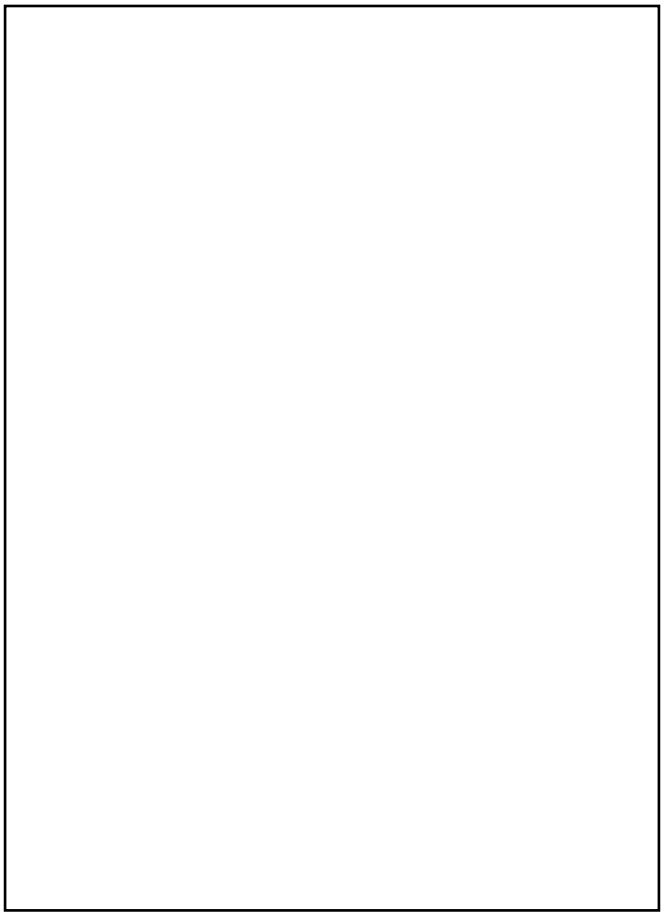


Fig. 3.2 Rock type and Geomorphology map of Nicobar Islands

3.4 Soil properties

The soils of the islands vary in depth, texture and chemical composition. In general the soils are acidic in nature except in Car Nicobar and Katchall. The soil properties in natural condition influence the crop distribution and yield which in turn get influenced by the types of vegetation.

Physical properties

The major soil physical properties relevant for agricultural activities are soil texture, compaction, bulk density, soil depth, water holding and infiltration capacity. Soil texture is an expression used to describe the physical composition of the soil more technically which is the relative proportions of the various size groups of soil such as sand, silt and clay in a mass of soil. Sandy loam to clay loam mixed with coarse materials of coralline origin dominates the soil texture of these islands. Loam is the ideal soil texture for crop cultivation and the clay loam or silty clay loam provides the ideal soil-air-water relationship for plant growth. The coastal plains and beaches have sandy soil in most of the islands (Fig. 3.3). In Car Nicobar, only the top 30 cm layer is having root activity particularly in sandy soils which is black in colour due to accumulation of organic materials. The subsurface layers are sandy, white in colour with poor water and nutrient retention capacity. The mountain soils of Great Nicobar are fine textured, having medium to high organic matter content.

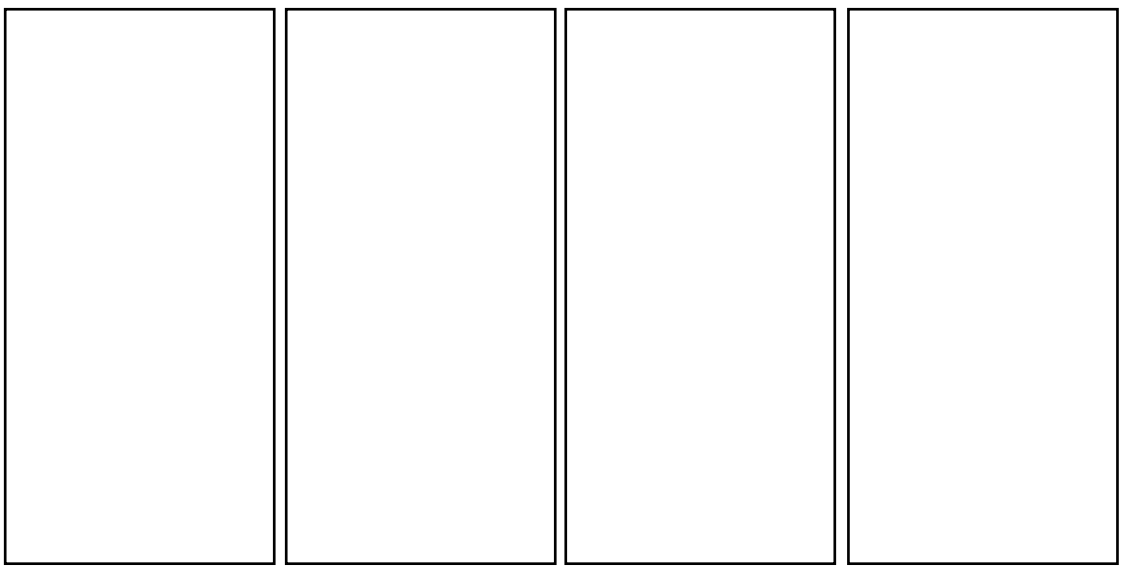


Fig. 3.3 The nature of soils in Nicobar Islands

In the central group of Islands except Katchal, the coastal plains are mostly sandy in which the top layer is thin, dark in colour having fresh and decomposed organic matter derived from plantation crops. The understanding of these properties are very important as soil texture has a significant relationship with the available water and infiltration rate, along with soil organic matter content helps in making effective interpretation of crop growth.

The soil depth is of vital importance for plant growth as it provides foothold for roots to draw the required water and nutrients. As such greater soil depth normally results in better plant growth due to proliferation of roots. The roots have adequate space to grow well if there is adequate soil depth without any barrier underneath. In contrast, the roots respond by getting thicker, stubby and contorted, adversely affecting the physiological functions in shallow soils. During the summer months the crop stand and the yield levels are better in deep soils as they do posses adequate moisture with depth which can provide water and nutrients for plant growth. In view of its importance for plant growth soil depth is considered at various levels in soil classification. The depth of soil depends largely on the terrain, stage and conditions responsible for soil formation and erosion. Therefore, in *jhum* cultivated areas of Car Nicobar Island more soil loss occurs during heavy rainfall incidences than under plantations leading to shallow depth *viz.* very shallow (< 25 cm) to shallow (25-50 cm). The depth of the soil is very shallow in the hill slopes, moderately deep in table land (50-100 cm) and rarely exceeding 2 m in the valleys.

Soil nutrient status

For several reasons the detailed fertility status of the tribal areas was not available which impeded proper planning and developmental efforts. Therefore, a systematic study of these islands with the view to prepare detailed fertility map was initiated by Central Island Agricultural Research Institute, Port Blair. Before going into the detailed discussion on the topic let us define the concept of soil fertility so as to properly understand where these island stands.

Soil fertility refers to the status of the soil with reference to supply of essential plant nutrients in a form that can be readily absorbed by plant roots. The preliminary study on soil physico-chemical and nutrient status indicated wide variations in soil fertility across the Islands. The soil samples collected from 4 major land uses viz., plantations, homestead gardens, natural forests and waste land were analyzed in laboratory for pH, electrical conductivity (EC), organic carbon (OC), available nitrogen (N), available phosphorus (P), available potassium (K), and DTPA extractable zinc (Zn), iron (Fe),

manganese (Mn) and copper (Cu) besides hot water extractable boron (B). The summary of the study is given in table 3.2.

Soil reaction suggests acidity or alkalinity in a given soil and is determined in terms of their hydrogen ion activity and expressed as soil pH. The average pH values varied from 5.08 to 8.10 in surface soils across the Islands. In Car Nicobar, soils are slightly acidic to neutral with mean pH value of around 7.2. In some places lime concretions are found indicating the presence of calcareous soils. In central or Nancowry group of Islands, except Katchal others are acidic with pH values less than 6.0. The soils of Great Nicobar also showed acidic reaction with pH values ranging from 4.5 to 5.6. The difference in pH among the islands is mainly because of differences in parent material from which the soils are derived and leaching of basic cations. Apart from this at few locations the coastal marshy soils in Katchal and Great Nicobar are potential acid sulphate soils which on drying become extremely acidic during summer months.

Table 3.2 Mean of surface soil (0-20cm) properties of Nicobar Islands

Island	Stat. parameters	pH (1:2)	EC (dS m^{-1})	O.C. (%)	Available macronutrients (kg ha^{-1})		
					N	P	K
Car Nicobar	Mean	7.07	0.06	2.03	261	22	230
	SD (±)	0.67	0.05	0.39	66	7.32	82
Nancowry	Mean	5.78	0.10	1.59	250	9.1	309
	SD (±)	0.80	0.03	0.68	91	5.44	74
G. Nicobar	Mean	5.08	0.05	2.65	346	9.1	228
	SD (±)	0.35	0.04	0.83	61	1.99	36
Critical limit (Medium fertility)		6.5-8.5	< 0.8	0.5-0.75	280- 560	11-22	110-280

The mean EC value of the three Island groups varied from 0.05 to 0.10 dS m^{-1} which is mainly due to leaching of soluble salts caused by intensive weathering caused by existing hot and humid climate where mean annual precipitation exceeds 300cm.The soils are non-saline and not much variation was found across the Island group irrespective of their pH or land use. In certain locations close to the coastal region acidity and salinity coexists resulting in acid- saline soils.

The status of soil organic carbon is one of the most important soil fertility indicator which serves as a reservoir of chemical elements which are essential for plant growth. It is

well known that intensive agricultural system with less organic input / recycling results in depletion of soil organic carbon. The amount of organic matter present in a soil depends on the yearly addition, temperature and the rate of its decomposition. In the hot humid climate of Nicobar Islands organic matter accumulates in the soil due to thick vegetative growth. This is more significant for crop production and maintaining soil quality at a given point of time. Most of the nitrogen occurs in organic form and only a small fraction (1-3%) usually occurs in inorganic forms. A considerable quantity of phosphorus and sulphur also exist in organic forms. The environmental conditions, which are favorable for rapid plant growth also favours rapid release of nutrients from the organic matter. In addition, many microorganisms capable of breaking down organic matter become less active as acidity increases resulting in accumulation of higher amount of organic matter in the soils. Acid sulphate soils of Andaman and Nicobar Islands are a typical example of this kind. Also the clay soil protects the organic matter from fast decomposition as in the case of some parts of the Nicobar Islands where fine textured soil is found. The surface soils are high in organic carbon with mean values ranging from 1.00 to 2.65% except in the coastal sandy soils. By virtue of its profuse thick vegetation and acidic condition, Great Nicobar soils are rich in organic carbon. In a marshy condition with dense swampy vegetations in the intermontane valley organic matter content exceeds even more than 4%.

A complete evaluation of soil fertility requires estimation of all macro and micronutrients in the soil. The soils of tribal areas have never been applied with any kind of inorganic fertilizers. The soils are medium in available N (250 – 346 kg ha^{-1}), low to medium in P_2O_5 (9.1 – 22 kg ha^{-1}) and medium to high in K_2O (250 – 346 kg ha^{-1}) content. N is available mostly in organic form as most of the organic residues are recycled in Nicobar Islands except in the coastal sandy areas. The P availability is significantly higher in Car Nicobar compared to central and southern group of Islands mainly because of slightly acidic to neutral soils resulting in maximum P availability. But in other group of Islands, because of highly acidic reaction, the available P is limited due to conversion of soluble P into insoluble forms by various soil components. This limits the crop production and without external P addition or correction of acidity, it is difficult to enhance the crop productivity particularly of tubers and vegetables which are important component of tribal diet.

Micronutrient deficiency in Indian soils has emerged as one of the major constraints to crop productivity, where zinc, iron, boron and manganese deficient areas are vast, copper and molybdenum deficiency has also been observed in many districts of the

country. The soil test values of micronutrients showed that the soils of Nicobar Islands are high in DTPA Fe^{2+} (14.2 to 21.4 mg kg^{-1}), Mn^{2+} (4.8 to 10.7 mg kg^{-1}), Zn^{2+} (1.2 -1.8 mg kg^{-1}) and Cu^{2+} (0.6 -1.3 mg kg^{-1}) indicating that they are available at required level and not limiting crop production in these Islands (Fig. 3.4). However, at many locations Fe and Mn contents are more than the upper critical level which are toxic to crop plants.

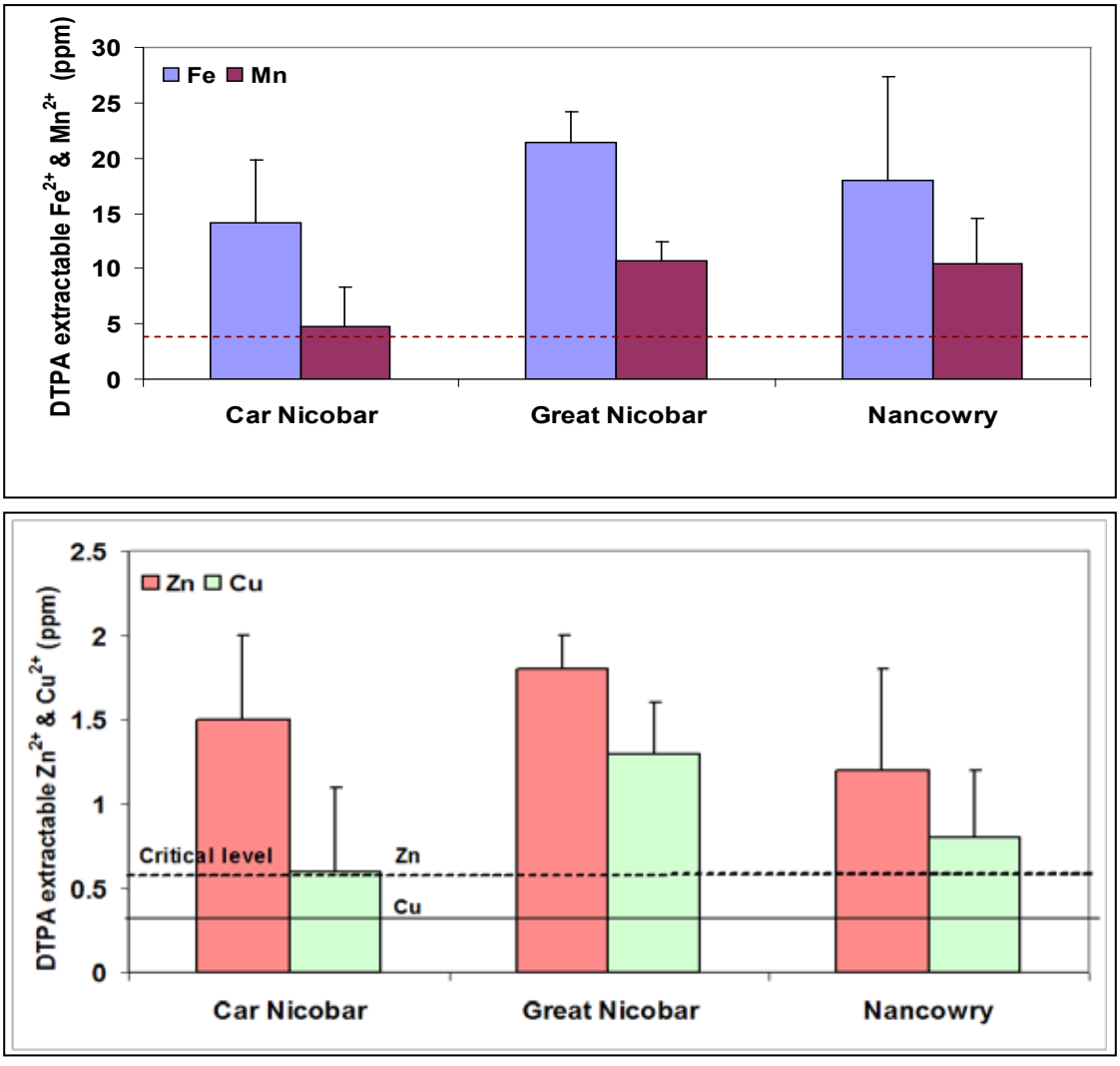


Fig. 3.4 DTPA extractable micronutrient status of Nicobar Islands

However, the water soluble boron (0.21 to 0.29 mg kg^{-1}) content in Nicobar Islands is less than the optimum level of 0.58 mg kg^{-1} mainly due to acidic reaction where boron is in soluble form and leached by intensive rainfall received in these areas (Fig. 3.5). Thus,

phosphorus and boron nutrition is important for improving crop production in these Islands. There is no major soil degradation concern in these islands as the tribes never resorted to intensive or unsustainable agricultural practices. The inherent nature of the soil is the only constraint for enhancing crop production.

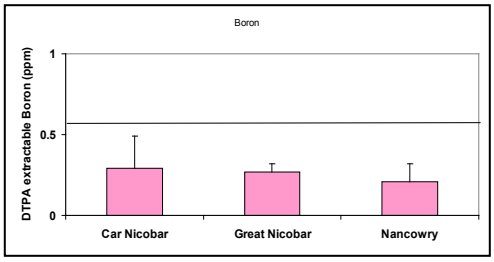


Fig. 3.5 DTPA extractable boron status

3.5 Nutrient management for sustaining agricultural production

Any intensification of agricultural activities in Nicobar Islands should ensure the sustainability of soil fertility. As the production system is organic by default in Car Nicobar and Nancowry group of Islands, adequate care should be taken to ensure organic production by recycling locally available resources within the small holder farms. Another important factor influencing the land use pattern in Nicobar group of islands is by its social control as seen in Car Nicobar Island.

Organic waste recycling

The best option to meet the nutrient requirement and manage the soils is to go for composting of crop residues and animal wastes by earthworms as in these Islands, plenty of plantation wastes like coconut, arecanut leaves and their husk are available. It was estimated that 14 t $ha^{-1}year^{-1}$ of biomass in the form of leaves, spathe, bunch waste and husk from a well managed coconut garden with 175 palms ha^{-1} (Coconut Mission, 2009). Besides, the animal wastes like pig, goat and poultry can be collected by providing night shelters and used for composting. For instance, pigs of average size of 60-70 kg can excrete around 2500 to 3000 kg in a year. As the pigs are the major farm animal found in Nicobar district, a small step to collect its waste can make significant quantum of manure which can be used for coconut and other crops. Similarly goat can also contribute significant amount of manure (350kg yr^{-1}). Another good source of manure is poultry litter. Though the animals are grown under free ranching system but providing night shelters and collection of wastes therein would play a significant role in improving crop production as well as maintaining soil fertility in these Islands. In the Shompen areas of Great Nicobar some form of domestication or semi-feral system of pigs and birds will go a long way in improving the farm production. The vermicomposting of these wastes would generate a substantial amount of organic manure which can be used for growing crops like vegetables under semi intensive production system.

Other organic manures

- Green manure crops like *Gliricidia sepium* and *Sesbania sp*. can be grown in the farm boundaries or as a biofence in the home gardens. The leaves can be incorporated into the soil before taking up crop cultivation as a green manure. They can also be used in vermicomposting of plantation wastes as the leaves contain higher amount of nitrogen and very succulent as well.
- The green leaf manures like cow pea, *sesbania, crotalaria* can also be grown in basins formed around the coconut trees which can be directly incorporated into the soil as green manure.
- The concentrated organic manures like neem cake and bone meal can be a good source of N and P. In acid soils with perennial crops rock phosphate can also be used which releases P slowly in plant available form.
- As for as Nicobarese are concerned, capacity building on organic manure preparation and use is expected to impart skills and provide them some knowledge. On the other hand, in the Shompen areas concerted effort by change agents are required to introduce any changes but not before they start a settled life.

3.6 Conclusions

The soils of Nicobar Islands are slightly acidic to slightly alkaline in reaction with calcareous soils occurring at some locations in Car Nicobar. The salinity is not a major concern as the EC values are well within the acceptable limits. The organic carbon is high with mean values more than 1.2% except in coastal sandy soils. The determination of available macro nutrients indicated that the N and K content are medium to high. In contrast the phosphorus availability is very much limiting in central group (except Katchal) and Great Nicobar Islands. Whereas in Car Nicobar the P content varied from medium to high with mean of 22 kg ha^{-1}. Considering the micronutrients, the level of DTPA extractable Fe^{2+} and Mn^{2+} is not deficient but found in excess level. While DTPA Zn^{2+} and Cu^{2+} were found to be sufficient for crop production. Among the micronutrients the major concern is the availability of boron (Bo) which is found to be deficient with values less than the lower limit of 0.5ppm across the Islands.

As agriculture in these Islands especially in Car Nicobar and Nancowry group are organic by default, any attempt to intensify agricultural activity should sustain the soil fertility by application of organic manures or recycling the available residues efficiently

within the small holder farms. The tribal farmers are known to leave the coconut husk on the surface after removing the nuts. This can be recycled through vermicomposting or any suitable method and can be used for vegetable and fruit crops. In situ organic residue composting, growing of green manure crops and incorporation of green leaf manure crops like sesbania, cowpea, crotalaria etc. can meet the nutrient requirement of coconut plantations to a reasonable extent. In vegetable gardens, use of enriched compost with effective microbes and rock phosphate will supply the required nutrients. Focus should be to transfer the technology through demonstration by involving the tribes in the process.

LAND USE PATTERN IN THE TRIBAL AREAS

The general land use of the Islands inhabited by the Nicobari tribes has some special feature i.e within the specific limits, all the villages have shares of some patches of jungle, land for gardening, coconut plantation and dwelling area opening upon the sea beach. For producing food crops and drawing produces such as cane, wood, bamboo, thatches and firewood the householder has to go to the interior of the island away from the coast. On the either side of the dwelling area, the limits of village lands converge towards the centre of the island. Land is used for agricultural purpose in the interior of the island whereas, coco palm doesn't not thrive as good as on the coastal side. The expansion of economic activities in the dwelling areas situated near the sea beach is not allowed by either individual family or tuhet. This ensured the perfect balance between the economic activities and ecological protection in an island ecosystem.

Though pigs are raised in the interior areas of the island, some are kept in the *tu-het*, looked after carefully, fed and fattened, to be slaughtered on the occasion of special feasts. It is interesting to observe that the land use pattern in every village has a common feature that can be graphically represented by a triangle with broad base in the sea coast and narrow end towards the centre of the island. But there are no physical demarcation lines dividing the villages. Yet all have definite knowledge of their areas primarily determined by the limits of their homestead areas, plantations and wood lands. Thus, the villages either big or small are divided in such a way that each of them has almost all kinds of land uses for socio-economic use within its boundaries.

4. WATER RESOURCES AND ITS MANAGEMENT

Water is one of the most important natural resource plenty in supply but limited in availability which needs to be developed and utilized properly. Though water moves from one natural reservoir to another but it takes different resident time (Fig. 4.1). Due to human interference the quality of water gets affected at many a times resulting in scarcity of good quality water. Unlike a country with large geographical extent, as in mainland India, transport of water from available to scarce area is extremely difficult in these islands as they are located wide apart from each other and separated by the sea. Though the Islands receive more than 2900 mm of annual rainfall, development of large scale reservoir is not possible due to flat topography and smaller size of several Islands. In case of failure of monsoon or climatic variation resulting in shortage of fresh water availability will seriously affect the subsistence farming practised by the tribes in these islands. Sometimes Nicobari tribes inhabiting Chowra Island bring drinking water from nearby islands using their country boats. Under such situation the plight of livestock and plantations are unimaginable. Thus proper understanding of rainfall pattern, subsurface storage capacity as ground water, surface storage by small check dams and rain water harvesting for multiple use must be the core of the water resource management strategy for these Islands.

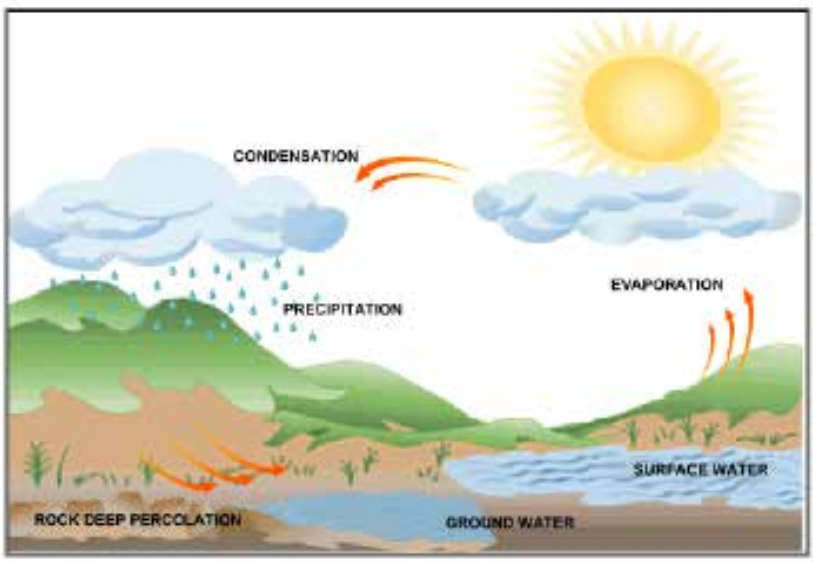


Fig. 4.1 Water cycle through various reservoirs

4.1 Surface Water Bodies

As the region is in the active orogenic belt involving subsidence and uplifts, there is no well-developed surface water system. Moreover the topography is dominated by central high land surrounded by coastal plain, and in some cases undulating terrain with the mountain chain parallel to the length of the islands which limits the proper development of drainage system or canal network. The catchment area is only a few km^2 which is not sufficient to make the river perennial. Further, the soil beneath the river bed is sandy with coralline base, as a result, runoff water quickly percolates downward. For these reasons there is no large or perennial river system in these islands. Only small streams of seasonal nature flow to sea with very short length and depth (Fig. 4.2). The present status of fresh water resources is discussed below.

Fig. 4.2. Fresh water stream used by tribes of Great Nicobar and Car Nicobar

Rivers/ Streams

These Islands are devoid of any big river system and obviously without vast catchments. However, a few streams such as Mithakari, Protheropore Nala, Burma Nala, Pema Nala, Karmatang, Betapur, Korang, Rangat, Dhanikari etc. drain the Andaman Islands. The Great Nicobar is the only Island with five perennial rivers viz., Alexandria, Amrit Kaur, Dagmar, Galatea and Danes, each of them has its origin in the Mt Thullier.

Some of the major rivers making an important part of the topography of Great Nicobar (Fig 4.3)

Fig. 4.3 Drainage map of Great Nicobar

and also contributing to the daily trade of people in the region are,

- The Alexandria river makes a major part of perennial rivers of the Great Nicobar and situated just at the mouth of Alexandria. It is known for its leatherback nesting beaches scenically located on the Great Nicobar Island.
- Another perennial river of the great Nicobar is the Galatea which flows over faulted anticline. It is basically the presence of a block faulting just at the downstream side of Galatea river. This river is mostly used by Shompen tribes for various purposes, including drinking, fishing and transportation.
- The Dagmar is also counted as the major perennial river of the Great Nicobar which is also a clear ground for nesting of Leather Black Turtles.
- In Car Nicobar, there is no large stream / river system. The existing streams are small and seasonal in nature. It is not properly developed to utilize the flow by storing the water.

Lakes/ponds

There are no natural lakes worth mentioning, however, at places some small water tanks and fresh water gets collected in depressions (Fig. 4.4.A). It is possible to develop surface storage structures like ponds to harvest and store rainwater. During crisis time, this will augment the freshwater supply for various purposes.

Canals

There are no major irrigation projects tapping surface water resources and canals are not feasible in these Islands. In some cases the stream is diverted into the cultivated land using gravity flow for irrigation. But, largely the canal system either large or small is non-existent in these islands.

4.2 Ground water

There are two major formations of ground water as indicated by Central Ground Water Board (CGWB, 2009). They are coralline limestone in majority of the areas and fractured volcanic and igneous rock formations in other areas. The coralline is porous formation consist of beach sand with coral rags and shells, the thin cover of alluvium in the valleys and foot hills adjacent to valleys and the moderately thick pebbly valley fill deposits (colluvium) in the narrow intermontane valleys constitute the water table aquifer. These formations form potential aquifer in shallow horizon and can be developed by

dug wells in Car Nicobar, Katchal etc. A 4 - 5 m diameter dug well to a depth of 6m may yield around 15000 to 90000 litres of water per day (Fig. 4.4.B).

The fractured volcanic and igneous rocks otherwise known as the fissured formation consists of the upper cretaceous ophiolite suite of rocks including the basic volcanic, ultra basic and intermediate to acid plutonic rocks. The weathered sandstone is poor aquifer whereas the weathered volcanic rocks act as moderate to good aquifer at suitable locations. The area covered with semi consolidated lower tertiary sedimentary rocks in the Great Nicobar Island is thin bedded fine grained sand stone – clay stone alternation cannot be properly termed as aquifers. In general the ground water occur in shallow aquifers though the rainfall is not limiting in terms of water input but the capacity of good water lens is limited by its size.

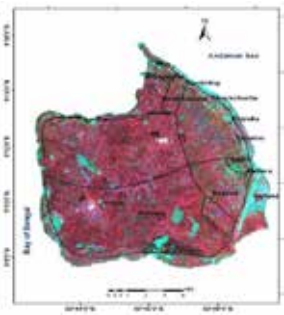


Fig. 4.4 A Fresh water collected in the natural depressions

Fig. 4.4 B. Shallow rings wells tap the subsurface flow

4.3 Rainfall

The rainfall is the only source of surface and recharge of subsurface water. These Islands receive an average annual rainfall of about 2900 mm in which about 95 percent of annual rainfall is received during May-December (May to September is south-west monsoon and October-December is north-east monsoon) but due to the erratic nature of rainfall during the monsoon, moisture stress is common affecting the yield of coconut and other crops grown in dry season. Analysis of historical data revealed an average surplus of about 1530 mm rainwater from mid-May to mid-December and a deficit of about 610 mm during January-April (Fig. 4.4). These kinds of rainfall pattern and other climatic parameters mostly favours the plantations and perennial crops. This is a major reason for the tribes to depend chiefly on coconut and tuber crops.

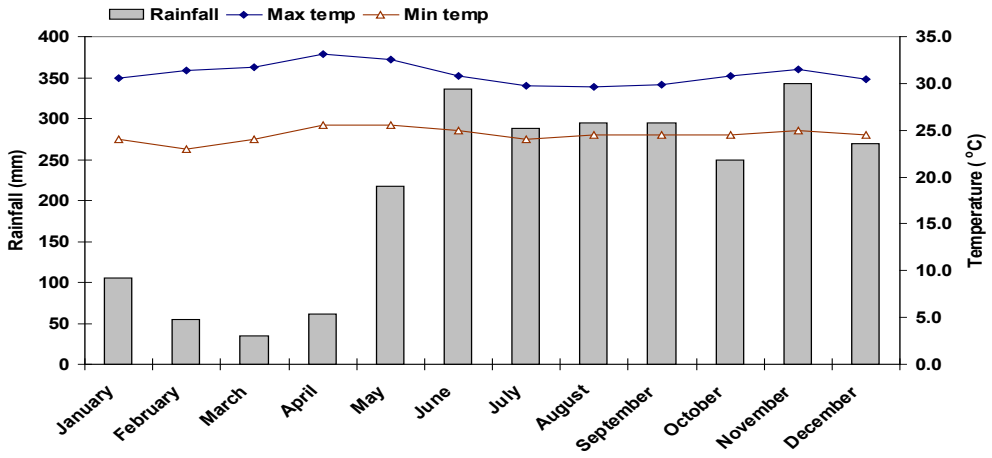


Fig.4.4 Annual rainfall pattern of Nicobar Islands

4.4 Water resource assessment

Fig. 4.5 Galatea river in Great Nicobar

The water resource of the selected Islands where population is more than 1000 has been estimated and given in table 4.1. It is observed that the per capita water availability in these Islands is quite high in comparison to national per capita water availability of 1700 m^3. Great Nicobar has greater potential (Fig. 4.5). Among the individual Islands, per capita water resource potential in Car Nicobar and Chowra Islands are far below and the projected water availability will decrease mainly due to population growth in Car Nicobar and limited geographical extend in Chowra. Besides, limitations of topography, subsurface structures, and geomorphologic features resulted in lesser amount of water available for harvesting and storage than the estimated potential of 5.9 BCM (Srivastava and Ambast, 2009).

Table 4.1. Projected population and water availability in selected Islands (population >1000)

Name of the Island	Area (km^2)	Projected population		Projected water availability (m^3/capita)	
		2021	2051	2021	2051
Nicobar district	1841	67745	138450	86420	42285
Car Nicobar	126.9	32677	66777	12349	6043
Chowra	8.2	2230	4557	11691	5722
Teressa	101.4	3263	6668	98833	48357
Katchal	174.4	8554	17481	64832	31726
Kamorta	188.2	5495	11229	108922	53296
Great Nicobar	1045.1	12184	24899	272769	133478

The estimated ground water resources of Andaman and Nicobar Islands are as follows:

- Gross Ground water Recharge : 326.273 MCM
- Tentative Base Flow : 5.475 MCM
- Net Ground water Recharge : 320.798 MCM
- Available ground water in A&N Islands for future use : 302.772 MCM
- Stage of Ground water development : 3.73 %

The maximum discharge obtained from ground water source was 187 l hr^{-1} and quality of water was normal to brackish. In sedimentary rocks in valleys and adjacent to Bays, depth of dug wells are restricted to 3.5 to 4 m below ground level (bgl), depth to water level in the dug wells in valleys range from 2.5 to 2.75 m, while in the igneous rocks in same physiographic unit it is generally less than 3 m bgl, with a seasonal fluctuation of 1.5 to 2.5 m. As it is the major source of fresh water in these islands, it merits for most judicious use. Though large scale industrialization will not occur in near future, but household and agricultural requirement may increase. In addition, the ground water lens is seen as a natural protection against the intrusion of saline sea water into these islands.

4.5 Rainwater harvesting and its efficient utilization

The water resource development and its use for various purposes in Nicobar Islands should be based on utilization of rainwater either through surface storage or enhanced

ground water recharges. Considering the topographical constraints, surface storages at different habitation area/cultivated land instead of centralized location should be preferred. The natural drainage network of the Islands should be used for developing the water resource plan. Rainwater harvesting and storage in surface and sub subsurface structures is one of the viable option to meet the demand of freshwater requirement in every island. The following methods are suitable for in situ rainwater harvesting in these islands.

Lined tanks

A part of runoff or rainfall, which goes waste, could be stored for giving irrigation during dry season. However, high percolation **rate** of light textured soils especially in hilly terrain decreases the storage level in unlined tanks/ponds at a faster rate. The seepage losses are also quite high due to coarse soil texture and porous coral base at lower stratum. A tank of 10-15 x 7 x 2.5 m size can be constructed with silpaulin lining for effective storage of water (Fig. 4.6) can be used as a source to provide supplemental irrigation to crops during dry season (Nanda *et al*. 2011).

(a) Dug out tank

(b) Laying of Silpaulin

(c) Finished lined tank

d) Rainwater harvesting in lined tank (Champin Is.)

Fig. 4.6 Process of lining of tank and use

In small and isolated places like Chowra and Champin Islands, rainwater harvesting in lined tank is the pragmatic solution to drinking water problem. In Lakshadweep Island, under similar situation, desalinization plants are largely used to get fresh water for drinking from saline sea water.

Roof top rainwater harvesting

Rainwater harvesting is the process of collecting and storing rainfall water for future productive use. Rainwater falling on roofs is collected in a tank or sent through collection and filtering system for future productive use (Fig. 4.7). This is especially important in areas where the presence of fluoride, nitrate, iron or salt in the groundwater renders it unfit for consumption or agriculture. In Nicobar group of Islands water is scare during dry season and ground water is saline. In such places rainwater harvested in a suitable tank can provide mineral free water even for domestic consumption and agricultural use as life saving irrigation.

Fig. 4.7 Rainwater harvesting and its use in the back yard cultivation

The amount of rainwater that can be collected by this method depends on the rooftop area, the size of the tank and the rainfall of a place. For example, as provided in table 4.2, in Car Nicobar with average annual rainfall of 2900, rainwater falling on the roof area of a group house with 300 m^2 is 9 lakh liters and with collection efficiency of 70%, 6.30 liters of rainwater can be harvested.

Table 4.2 Annual potential for water harvesting in Nicobar district

Sl. No	Parameters	Amount
1	Total annual rainfall (mm)	2,900
2	Area of rooftop per group house (approximate) m^2	300
3	Total amount of water falling on rooftop (liters)	9,00,000
4	Collection efficiency (%)	70
5	Amount of water harvestable (liters)	6,30,000
6	Total rooftop area of household in Nicobar district (m^2)	8,07,500
7	Potentially harvestable water (million liters)	508725

Utilization of harvested water

During rainy season beginning from June to November storage is not required as the soil is mostly saturated. In addition, summer rain and early monsoon showers are received during May which can be stored. Only during February and March the amount of harvestable water is very low. But, during December to April at least two rainy days are available in every month which is very critical for collection of rain water. Thus depending on the size of the rainwater tank and the distribution of rainfall, even a 1000 liter tank per household may be sufficient to collect the water for its use during dry season. This water can be effectively used to provide irrigation to vegetable, tuber and fruit crops grown during dry season besides for livestock and domestic consumption (Fig. 4.8).

Fig. 4.8 Rainwater harvesting and use in homestead cultivation

4.6 Water quality

Water quality refers to the chemical, physical and biological characteristics of water. It is a measure of the condition of water relative to the requirements. Water quality assessment is very important because of risk to human being and ecosystem associated with poor quality water. Long term use of poor quality water for irrigation will lead to land degradation and negatively reflect in crop production. Further, it also affects the health as in the case of drinking water with high calcium carbonate content. The prevalence of kidney stone among the Nicobari tribes has become a common feature due to poor quality drinking water. During the time of water scarcity, the tribes try to use every drop of available water on the island. They normally collect and store water for drinking, afterwards, they provide it for livestock. It is very difficult to bring water from other larger islands until it is unavoidable. Therefore, it is utmost important to understand the water availability and its quality in these islands. The water quality parameters for different Islands were presented in table 4.3. The EC values of the region varied from 250 to 860 µS cm^{-1} with mean value of 497 µS cm^{-1}. As per TDS classification, water resources in these Islands are fresh water type with values ranging from 160 to 476 ppm (Freeze and Cherry 1979).

Among the dissolved ions, Ca^{2+} and Mg^{2+} predominates the cation, while HCO_3^- and Cl^- dominates the anion concentration. The pH of the water samples varied from 7.3 to 7.9 with mean value of 7.6 indicating that the dissolved carbonates are mainly in the form of HCO_3^- (Adams et al. 2000) which was also evidenced from individual ionic composition of water samples. The nitrate concentration was very low (1.5 $\pm$ 1.2 ppm) as there is no scope for contamination from agricultural sources where only natural farming is practiced without any chemical inputs.

Table 4.3 Status of water quality in different Nicobar Islands

Name	pH	EC^x	TDS*	Ion concentration (ppm)									TH ppm
				Ca^{2+}	Mg^{2+}	Na^+	K^+	CO_3^{2-}	HCO_3^-	SO_4^{2-}	Cl^-	NO_3^{2-}	
C Nicobar	7.9	0.64	409	37.0	18.2	14.2	7.1	0.4	85.8	2.1	74.2	1.8	165
Katchal	7.9	0.43	256	53.0	30.3	10.0	15.3	1.4	84.6	2.6	166.8	0.6	253
Kamorta	7.4	0.40	256	51.3	13.2	7.5	6.9	0.0	104.5	1.5	32.8	2.2	181
Nancowry	7.9	0.50	320	39.4	18.7	16.8	7.4	2.4	133.2	1.2	137.8	2.2	173
Hut Bay	7.5	1.628	1041	28.0	16.8	18.2	2.1	1.2	100.0	1.6	213.0	3.1	

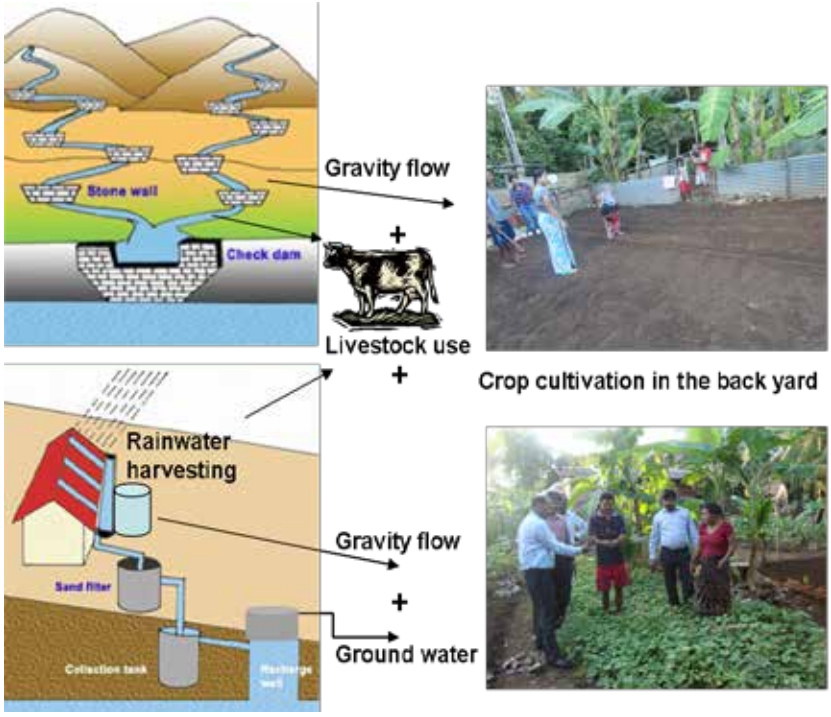
Note: ^{x}EC in dS m^{-1}, * - Total Dissolved salts, **-Total Hardness as $CaCO_3$

Based on the analytical results, the suitability of the water samples for domestic and agricultural usage was evaluated as per the World Health Organization (WHO 1993) and Indian Standards (ISI 1991). The water samples are within the permissible limit as prescribed by both WHO and ISI. Similarly, according to Freeze and Cherry (1979) the water in these Islands are classified as freshwater type and are desirable for drinking. Hardness is an important criterion for determining the suitability of water for various purposes. In the study region total hardness ranged from 54.4 to 349.4 ppm and classified as moderately hard and are suitable for domestic use as per WHO and also ISI standards. They are mainly of carbonate and bicarbonate type constituting only temporary hardness which may affect the taste and cause scale formation in pipes.

The tribal practices, climatic parameters and water resource data suggested that water availability is a major concern than water quality. The ground water of these islands is not contaminated as indicated by the water quality parameters. However, saline water intrusion is observed in some coastal areas as indicated by the ionic ratio. Therefore, over exploitation of ground water during dry season in such areas may result in salinization of ground water.

MODEL FOR RAINWATER HARVESTING AND USE

Investment in small water harvesting structures, rain water harvesting, ground water recharge and selection of appropriate crop combination for Nicobar region will go a long way in improving the water availability and its productivity. The chief feature of the proposed model is based on rainwater harvesting from rooftop of group houses and utilization of run-off by constructing check dams across the streams. The quality of water is acceptable for livestock use, which encourages intensive livestock farming linked to crop production. A successful water resource development and use model is presented below for Nicobar Islands. Mixing of low quality ground water with harvested rain water will be a viable option to meet the urgent demand for irrigation and livestock during dry season.



The suggested model is expected to prevent water wastage by arresting run off, prevents soil erosion, sustains and safeguards existing water table through ground water recharge and increase water availability while improving water quality. The most important advantage is that it can arrests sea-water intrusion and prevents salinization of ground water.

Conclusions

As these islands are located in the active orogenic belt, well developed drainage system doesn't exist in the islands. The Great Nicobar Island is the only exception with five perennial rivers. The coralline formations form potential aquifer in shallow horizon and can be developed by dug wells in Car Nicobar and Katchal with a potential of yield 15000 to 90000 lpd. The water resource potential of Nicobar Islands is 5.9 BCM and per capita water availability is 110756 m^3 yr^{-1}, which is much higher than the national average of 1700 m^3 yr^{-1}. However, the seasonal availability during dry months is low due to lack of storage structures and geological limitations. Among the individual Islands, per capita water resource potential of Car Nicobar and Chowra Islands are far below than the district average and the projected water availability will decrease mainly due to population growth in Car Nicobar and limited geographical extend in Chowra. The actual exploitation of available resources is limited by restrictions imposed by topography, subsurface structures and geomorphologic features. The rain water harvesting at farm scale level such as lined ponds and roof top water harvesting will meet the water requirement during dry season mainly during March to May to a limited extent in these Islands. The water quality is pristine except for temporary hardness caused by bicarbonate ions and found suitable for domestic and agricultural purposes.

Crop water management is a key area to optimize crop production with limited and dwindling water supplies which is very much achievable with determined efforts. At the same time periodical reassessment of ground water resource, its recharge and quality is essential to judiciously plan for its multiple uses.

5. FISHERY RESOURCES AND ITS USE BY THE TRIBES

The Andaman and Nicobar islands has extensive coastal and marine resources which are significant in both ecological and livelihood perspectives. These islands are typically oceanic in nature and encompass an Exclusive Economic Zone (EEZ) of 0.6 million km^2 which is about 28% of the Indian EEZ. These islands have an aggregate coast line of 1,962 km which is nearly 25% of Indian coastline. The continental shelf around these islands is very narrow and on the western side relatively wider, extending up to 10 nautical miles in some places. All together the continental shelf is 35,000 km^2. These islands have diverse ecosystems like evergreen forests, mangroves, sandy beaches, tidal flats, coral reefs, etc. The mangroves occupy around 115 km^2, while the coral reefs are spread across an area of more than 2,000 km^2.

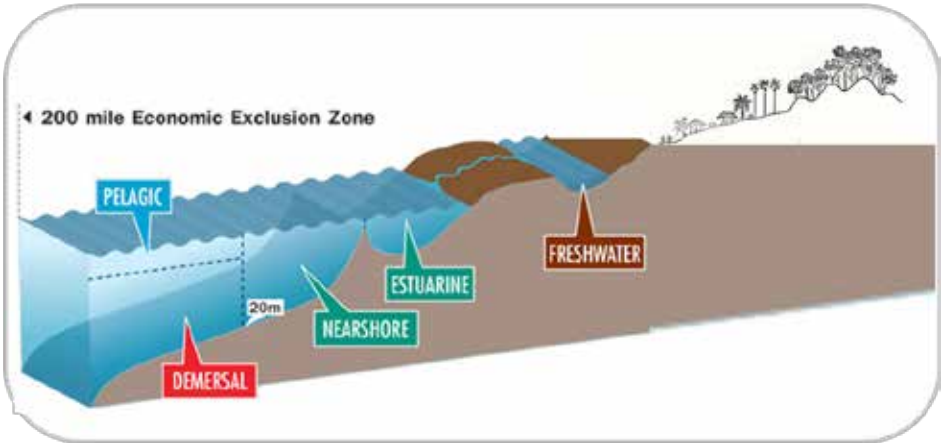


Fig. 5.1 A schematic diagram of biographical zones

Earlier studies have shown that the Andaman sea is oligotropic in nature with relatively low (273 mg C m^{-2} day^{-1}) primary and secondary productivity (288 mg C m^{-2} day^{-1}). However, primary production of Nicobar region is significantly higher than that of the rest of Andaman seas. The limitation in the extent of continental shelf is compensated by presence of numerous bays, creeks and inlets on the landward side and vast areas of productive oceanic waters of the Bay of Bengal and the Andaman sea on the east coasts (Fig. 5.1). Moreover the relatively unpolluted coastal water provide scope for developing coastal aquaculture and availability of high value marine seafood such as shrimps, lobsters, crabs and fishes like tuna, groupers and snappers having large export potential.

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The estimated fishery potential of the Exclusive Economic Zone (EEZ) of Andaman and Nicobar Islands is at 2.435 lakh tons as compared to 39.21 lakh tons for India forming only 6.21% of the fishery potential of our country (Dept. of Fisheries, 2013). In spite of having rich fisheries potential, at present (2010-11) only about 33,750 tons accounting 13.85% of the estimated potential was exploited which was mainly contributed by the traditional and artisanal sector (Handbook of Statistics 2011).The fish landing centers are scattered in various islands where some population centers exist. Considering the limited demand owing to low population of these islands, the fishermen restrict their catch to 50-100 kg per day and maintain a steady price for the fish landed earning the maximum possible revenue for their livelihood.

5.1 Marine fishery resources

The important marine fishery resources include coastal pelagic, demersal, offshore, and deep sea fishes. The bulk of the catch is from pelagic and demersal fishes like sardines, mackerel, anchovies, carangids, mullets, porches, silver bellies, barracuda and tunas (Roy and Grinson, 2010). The studies indicated that January to April is the peak fishing season while May- August is the lean season. Only 38% of demersal fishes are exploited because of non-availability of suitable craft and gear. Moreover, traditional boats operate in the in-shore and part of near shore waters only. Similarly the potential of harvestable oceanic tuna is estimated at 83000 Mt of which only 2.7% is exploited at present. The tunas are reported to occur in abundance especially around Great Nicobar, south of Car Nicobar and southern regions (Roy and Grinson, 2010). Besides, oceanic sharks, cephalopods (squids), deep sea lobsters, prawns also offer scope for exploitation. The sharks are mainly caught for their fins as exportable items which are now brought under regulations.

5.2 Reef fishes

Fig. 5.2 Vast expanse of reef areas available for fishing

The average potential of reef fishes is about 3000 to 6000 MT from existing coral reef areas (Dam Roy and George, 2010). Among the reef fishes, perches and perch like fishes represented by 7 major groups are important. The normal peak fishing season for these fishes is August to November. The groupers are specially targeted for export as live fish having annual potential of about 300-600 MT. As the actual fishing area is very much smaller compared to total exploitable area which may lead to over exploitation of these resources. The snappers and rabbit fish have high export value and the actual potential is not known but may be considered at the same level of groupers. There are only very few fishers from Nicobar Islands to utilize this vast resources due to lack of proper gear and craft.

5.3 Offshore Fisheries

There is no organized offshore fishing in Nicobar Islands. The major demersal fishes found in coastal waters are leiognathids (33%), upenids (19%), sciaenids (12%), skates (5%), rays (3.5%), shark (3%) (Sivaprakasam, 1979). Majority of local fishermen use *dinghies (country boat)* for fishing and go only up to 7 to 8 nautical miles from the coast (Fig. 5.3). Because of this the average catch is only 100-150 kg. The period between October and March is more productive than other period.

Fig. 5.3 Fishing boat in the off shore

5.4 Freshwater fishes

The sources of freshwater are rivers, nallahs and ponds. There are about 800 ponds having water spread area of 0.04 to 0.06 ha suitable for fresh water aquaculture. A composite fish culture with catla *(Catla catla*), rohu (*Labeo rohita*), mrigal (*Cirrhinus cirrhosus*), silver carp *(Hypophthalmichthys molitrix)*, grass carp(*Ctenopharyngodon idella*) and common carp *(Cyprinus carpio)* in suitable ratio depending on the available feeding niches can yield an annual production of 3 - 5 t ha^{-1} can be obtained. There are no major freshwater capture fisheries in the islands. The subsistence fishery is very marginal amounting to less than 50 t per year, mostly comprising air-breathing fishes like cat fishes (singhi-magur), anabas and tilapia. Many Indian carps have been introduced in the islands for culture in farm ponds.

5.5 Brackish water capture fisheries

Though the brackish water area in these islands is 33000 ha, majority of the area is under mangroves and reserve forests. The capture fishery is very limited to the catching of prawns, crabs and fishes like mullets from creeks and bays. Back waters and estuaries are regularly used by the tribes to catch fishes mainly for their home consumption and the excess catch is shared among the tuhet or village members (Fig. 5.4). Eco-friendly technologies have been developed by research institutes working in these islands for brackish water aquaculture of mullets, milk fish, sea bass, prawn as well as mud crab culture but the technology adoption and impact are limited by various factors.

Fig. 5.4 Estuary used for fishing in Car Nicobar

5.6 Fishery development in Nicobar Islands

In Nicobar Islands, fishing is carried out by the Nicobari tribes with spears and no mechanized fishing vessels are available. Most of the fisherman are farmer by default and venture into the sea as and when required. Only few of them undertake fishing as main profession. The crafts and gears used by the fishermen are of the traditional type and of limited capacity (Fig. 5.5). In general, the development of fisheries in these islands has been tardy. For instance they are using only gill nets (172 no's), cast net (181), hook and lines. Thus fisheries in these islands are mostly confined to limited areas with an estimated annual value of only Rs.350 lakhs which is mainly accounted by marine fisheries (Handbook of Statistics, 2011) and wide scope exist in the form of non-fish sea food, sea weeds and other fishes which can be even used as a feed for pig and poultry, thereby the food chain of tribes can be alternately linked to sea foods to provide nutritional security.

Scooping out a trunk of tree

Shaping of tree

A Constructed *Hodi*

Catch from handline

Artificial bait for handline

Hand Lines of varies sizes

indigenously made Hooks

FRP coated Hodi

Cast net with catch

Barb of Spears

Blankbuilt boat

Traditional craft with engine

Fig. 5.5 Glimpses of fishing gears and crafts used in Nicobar Islands

Conclusions

Fisheries sector has a huge potential to provide employment opportunities even in the far flung islands but at present it is largely a supplementary activity. Nevertheless, it can be practiced as a part time venture to ensure balanced nutritional diet. Besides, there is ample scope to supplement the livestock with sea products. At the same time it is clear that in the present situations endurance for high sea fishing, exploratory and multi-day fishing, fishing for coastal tunas, oceanic tunas and other straddling stocks are not possible with the limited capacity of the craft and gear. Lack of modern and adequate infrastructure for landing, storage, processing and transportation of fish and fishery products, remoteness of the islands from the main land, limitations in marketing and trade, both for local as well as consumption on the mainland, poor information and communication facilities, lack of adequate data on the stock size and accessibility coupled with improper development plan have contributed to the inadequate development of fisheries in these islands. Under such situations the off shore fishing can be promoted as the tribes do find leisure time in their farming calendar for harnessing fisheries potential of these islands.

6. FARMING SYSTEM CHARACTERISTICS OF NICOBARI TRIBE

Even before the introduction of modern agricultural inputs whatever in a limiter scale, the tribes are there in the islands for centuries surviving with limited natural resources. Coconut based farming, free ranching of pig and fishing in the off-shore areas have been the main agricultural activities though slight variation exists between different islands. Although modern agricultural inputs like chemical fertilizers, pesticides, high yielding varieties and practices have not encroached into the tribal way of farming in Nicobar Islands, they have been supplying few industrial raw materials since historical times. For this reason several mariners since ancient times have been trading with these islands. The historical evidences suggest that many times landing at these islands was mainly for getting supply of essential items. Political interest grew after the establishment of British authority in 1869 before that the farming was greatly influenced by the tribal culture. In general, farming in Nicobar Islands is mostly natural, mixed, low input and subsistence. A glimpse of various components of farming is depicted in Fig. 6.1 with reference to Nicobari tribes.

Fig. 6.1 Different components of tribal farming prevalent in Nicobar Islands

A systematic survey and compilation of all the available information with respect to the tribal farming reveals that in Nicobar Islands agriculture is rainfed, organic without depending on any external inputs. Growing of vegetables, fruits and planting of improved varieties and growing improved breeds of livestock are of recent origin. Mixed farming with different degree of specialization is prevalent among the Nicobarese. In this chapter the farming characteristics of Nicobari tribes across different Islands are described in detail.

6.1 Distribution and production of important crops

The area under agriculture is limited to 2% of total geographical area and 98% is covered with forests. The tribes have been growing plantation crops for centuries and it has been reported that they used to exchange coconut and arecanut for rice and cloth etc. with foreign traders from countries like China, Malaysia and Indonesia visiting these Islands. The plantation crops especially coconut (*Cocos nucifera*) occupies 84% of the area under agriculture followed by areca nut (*Areca catechu*). In many places coconut is seen growing alongside forest trees in a natural condition without any human intervention. Nicobarese also depends on forest for getting timber, thatching material, food, fodder and medicinal herbs. Cultivation of annuals are practiced by clearing small patch of forest land as shifting cultivation before it is brought under coconut plantations. In recent times, the annuals like tuber crops, vegetables and fruit crops like banana, papaya, and pine apple are grown in home gardens or in backyards. The distribution of crops (Table 6.1) indicated that coconut, arecanut and tuber crops are grown throughout Nicobar Islands while area under other crops are mainly influenced by suitability of land, climate and social composition of different islands. In Great Nicobar Islands rice is the dominant crop in contrast to dominance of coconut in other Islands. Vegetables are grown in Car Nicobar, Katchal and Great Nicobar. They are produced in home gardens and in back yards with minimal production practices only for family consumption.

Table 6.1 Major agricultural crops grown in Nicobar group of Islands

Island Name	Main crops grown
Car Nicobar	Coconut, arecanut, fruits, tuber crops, vegetables
Chowra, Bampooka	Coconut, tuber crops
Teressa	Coconut, arecanut, cashew, fruits, tuber crops
Katchal	Coconut, arecanut, paddy, red oil palm, vegetables,

Nancowry	Coconut, arecanut, fruits, tuber crops
Kamorta	Coconut, arecanut, cashewnut, banana
Trinket	Coconut
Little Nicobar	Coconut, arecanut, colocasia, dioscoria
Pilomilo	Coconut, colocasia
Kondul	Diascoria
Great Nicobar	Paddy, vegetables, coconut, arecanut, fruits

The other major crops grown are banana, papaya, tapioca and sweet potato. The tuber crops like sweet potato, tapioca and greater yam (Nicobari alu) play an important role in ensuring food security of the tribal people in these Islands. The wastes and sometimes the tubers are also used as a livestock feed. A wide range of medicinal and aromatic plants are also found in the natural habitat which are used by the Nicobarese if the need arise.

Table 6.2 Area and production of major crops in Nicobar Islands

Crops	2007-08		2008-09		2009-2010	
	Area (ha)	Production (in MT)	Area (ha)	Production (in MT)	Area (ha)	Production (in MT)
Banana	319	2535	365	3173	591	3355
Papaya	167	639	168	721	193	803
Cashew Nut	1000	350	1002	327	1000	290
Sweet potato	27	200	25	195	223	190
Tapioca	68	439	64	632	68	545
Arecanut	901	1589	952	1594	945	1291
Coconut*	14516	54	14556	56	14525	59

* million nuts (Directorate of Economics & Statistics, 2011)

The productivity of most of the horticultural crops is quite low (Table 6.2) mainly due to inadequate awareness on scientific practices and primitive methods of cultivation being practiced by the local population. Another feature is stagnation in area and productivity over several years. Except coconut and arecanut all other crops are mainly grown for

family consumption but sometimes a small quantity of marketable surplus is exchanged with other members of the tuhet or with outsiders for purchasing essential items.

6.2 Major agricultural products

Though the area under coconut is higher, the productivity of coconut is very low at 3317 nuts/ha as compared to the national average (6869 nuts/ha) due to old, senile palms and poor management practices (Coconut Development Board, 2012). Off the total production of coconut on an average 41% is used for copra production followed by pig feeding (31%) and edible purpose (20%). Copra production is the major economic activity and it is produced by sun drying as well as by heating in kilns. The crude method of copra making results in production of inferior quality of copra resulting in lower price. The Tribes also produce virgin coconut oil on a smaller scale for personal use in traditional method. It is produced by two ways. In the first method the scrapped coconut kernel is squeezed to get coconut milk, which is then boiled to obtain the oil mostly used for toiletry purpose. In another method, the coconut milk is mixed with hot water in a vessel and kept open under sunlight for separation of oil. However, realization of oil in both the methods is only around 30% of the kernel content.

The tuber crops like tapioca, sweet potato, colocasia and greater yam, banana and pandanus are traditionally grown in their homegardens which found place in their regular diet. In recent times vegetables like amaranth, bhendi, brinjal, tomato, bitter gourd, green chili and bottle gourd were grown in home garden by individual household. The tribes used to shift the place of production once in 2 to 3 years so as to maintain the soil fertility. After two years of production the land was kept fallow for a period of minimum five years to repercurate. They follow 7 to 8 years of shifting rotation for home gardens. As the production is subsistence the output is used for home consumption and no surplus production is achieved. In case of any surplus, it is shared with other members of the *tuhet* or used for purchasing other essential items in barter system.

6.3 Size of holding

It is very difficult to determine the size of holding as there are no land records and existence of different types of land ownership. The size of land holdings with proper records are available only for non-tribal settlements in revenue areas while there are no records available in case of both Nicobarese and Shompens. As discussed earlier certain lands are owned by tuhet head for common purposes and some other land collectively by the tribal society. Only usufructuary rights are given to other members of the tuhet.

The required information could be sourced from household survey, interaction with village captains and from the number of coconut trees under each family. The number of recorded farm holdings of these Islands are 665 with a total land holding of 1643 ha (Table 6.3) where majority of the holdings are marginal (45.7%) with average holding of only 0.17ha, followed by medium (35.2%). The average land area of medium holdings is 4.86 ha and large holdings account for only 0.8% with average area of 34.45 ha which are government lands. Contrary to the popular belief, the Nicobari society also exhibited inequalities in terms of distribution of means of production and social status. Larger the size of holding higher is their influence on tribal affairs.

Table 6.3. Details of Farm holding in Nicobar Islands

Size class (ha)	No. of holdings	Area of holding (ha)	Average holding (ha)	% to total holdings
Marginal (<1)	304	51	0.17	45.7
Small (1-2)	42	65.97	1.57	6.3
Semi medium (2-4)	80	218.02	2.73	12.0
Medium (4-10)	234	1136.2	4.86	35.2
Large (>10)	5	172.26	34.45	0.8
Total	665	1643.45	2.47	100.0

The experience shows that number of coconut trees owned by each household gives reliable information on size of land holding as coconut is an integral part of tribal society. Based on the number of coconut tress owned by individual farm family, size of land holding was inferred and the categorization was done accordingly. The data indicated a wide variation (10-1000 trees) in size of holding with an average of 235 coconut trees per household across the Islands. Majority of the tribal farmers come under marginal category (46%) followed by medium (35%) while only less than 1% are under large category who decides the tribal affairs. The increasing marginal category is mainly due to loss of coconut plantations in natural calamities and increase in population. Owing to this, some of the tribal families were shifted to Little Andaman some time ago.

Analysis of ownership of coconut trees gives much clarity to the resource availability to each family as it is the major source of income for the Nicobarese. The average number of coconut trees held by a large farmer is 10 times higher than the marginal holders indicating a relatively high inequality in distribution of land in terms of ownership of coconut trees. However, only 5.5% of the households have more than 500 coconut

trees which are normally influential in the tribal society, while 56.9% of them own less than the average of 235 trees. Significant differences were found in average number of coconut trees owned by individual households across the Islands. However, in Katchal mean holding of coconut trees exceeded the overall mean of 235 trees mainly because of loss of lives during tsunami in 2004 (Fig. 6.2).

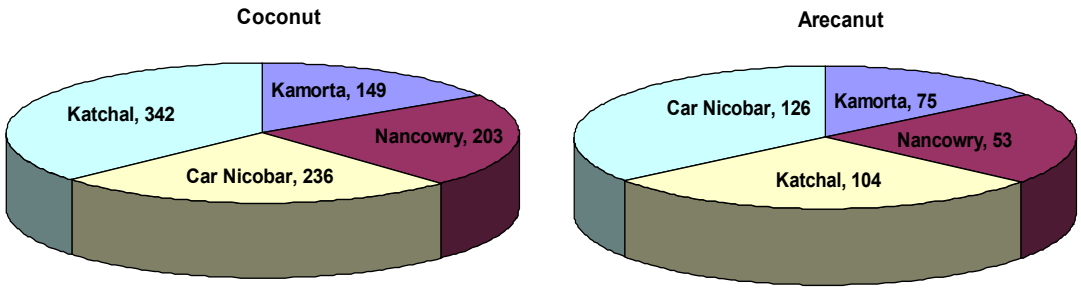


Fig. 6.2 Average holding of coconut and arecanut trees across the Islands

6.4 Composition of livestock and poultry

Livestock, either indigenous or exotic, is the integral part of agriculture and tribal economy. The history of livestock rearing goes back to the settlement of Nicobarese on these Islands. They brought livestock such as pig and poultry with them and thrived, but depended on the natural ecosystem for feed and fodder (Ghotge 2006). European colonizers brought livestock to the Islands for their own interest. Goats were brought in by the Dutch on Teressa Island and are known as Teressa goat. Japanese brought certain birds but couldn't survive for long. Subsequent settlers from Indian mainland brought livestock such as cattle, buffalo and goat with them and began rearing these especially in Great Nicobar Islands. In Car Nicobar cow was introduced after tsunami by government agency however it could not succeed except for very few takers because it is labour intensive and lacks suitable feed and fodder as the requirement is very high. Besides, the hot and humid equatorial climate is unsuitable for the animals. Moreover, the attitude of the tribes also doesn't favour the popularization of cattle in tribal areas. There is no evidence suggesting successful domestication of any wild or native bird for meat or egg purposes. Nicobari fowls might have come along with the migration of the early settlers of these islands. The available evidence suggest that almost all the major livestock component in the islands were introduced from outside. They are of mixed and varied breeds according to their place of origin. Subsequently, under various livestock

development programs, exotic breeds of pig, poultry, and cattle were introduced in the Islands, which diluted the genetic purity of the local / earlier breeds (Fig. 6.3).

6.5 Distribution and nature of livestock farming in different islands

The major livestock in Nicobar Islands comprised of pig (76%) and goat (18.2%) which are reared in extensive open semi-feral system by the tribal community with no intension of business (Zacharia, 2012). Spatial differences in livestock population across the islands (Table 6.4) were observed with largest population of pig and goat found in Car Nicobar Island. With the change in population composition, the livestock composition too changes, as one could see that the cattle and buffalo population was higher in Great Nicobar in contrast to other Islands. Here the majority of the farmers are settlers from Punjab, Haryana and other states who mainly prefer to keep these animals.

Table 6.4. Distribution of livestock population in Nicobar Islands

Sl. No.	Name	Cattle	Buffalo	Goat	Pig
1	Car Nicobar	205	0	7270	27480
2	Chowra	0	0	0	2048
3	Teressa	14	0	114	3089
4	Bompuka	-	-	-	-
5	Katchal	39	0	155	939
6	Kamorta	-	-	120	-
7	Nancowry	244	0	345	1066
8	Trinket	-	-	-	-
9	Little Nicobar	-	-	30	140
10	Pillomilo	-	-	-	-
11	Kondul	-	-	-	40
12	Great Nicobar	1783	22	473	699
	Total	2285	22	8397	35501

(Handbook of Statistics, 2015)

Pig rearing

Backyard poultry

Goat farming

Fig. 6.3 Nature of livestock and poultry farming in Nicobar Islands

Among the livestock pig enjoys a special place in social, cultural and economic status of these tribes. Though pig is considered as a family asset and traditional activity surprisingly about 23.9% of households surveyed were not rearing any pig. Among the households rearing pigs, the average herd size is only 4.3 and in majority (59.6%) of the households the herd size is less than 5 (Table 6.5). The important feed sources for pig are the coconut, kitchen waste, tuber crops and pandanus fruits. Coconut forms an important part of the daily nutrition of pigs where 2 to 3 coconuts are fed to each adult daily or in alternate days accounting nearly 31% of total copra production. As the coconuts are rich source of energy viz., fat and carbohydrates but low in protein and certain micronutrient content. Consequently, the pigs are left to scavenge to meet their nutrient requirements which sometimes induce them to attack chicks or small animals.

Table 6.5. Status of livestock possession by tribal households

Herd Size (No)	Frequency	Percentage	Mean
Pig			
Nil	78	23.9	
1 to 5	195	59.6	
6 to 10	36	11.0	4.3
11 to 20	15	4.6	
> 20	03	0.9	
Goat			
Nil	204	62.4	
1 to 2	39	11.9	
3 to 5	54	16.5	4.6
6 to 10	24	7.3	
11 to 15	06	1.8	

(Swarnam *et al*. 2015)

Quite often, pigs move inside the forest to meet their food supplements from the natural vegetation. The age at first farrowing is 10 to 12 months with the litter size of 6 to 10 with farrowing interval of 8-10 months. Dressing per cent of the carcass is 70-80% and both growers and adults are slaughtered (Jeyakumar and Kundu, 2006).

Goat forms the second largest livestock found in these Islands, which are introduced in later years but only 37.6% of the households are rearing goat with average herd size

of only 4.6 under open grazing on wastelands and tree fodder from nearby forests. The commonly found breeds are Teressa, Malabari and its crosses but Andaman local goat was introduced by the settlers and by the government agencies. Teressa goats are reared by the tribal for meat purpose which is semi-feral in nature under free ranching condition. They have higher body weight (50 -70 kg) and higher prolificacy rate. Grazing in wastelands or community lands, top feeding with green fodder collected from nearby forests are the main feed sources for goat in these Islands.

The cattle are local type representing an admixture of breeds of different parts of India, which were brought to these Islands during different phases of settlements. They are adapted to hot, humid conditions and are mostly grown in back yard condition. The average age at first calving is normally 4.5 to 5.5 years with the average milk production of only 1-3 liters per day. They are mostly reared by non tribal people in Great Nicobar who are migrated from Northern India after Independence.

Poultry is yet another important enterprise in Nicobar Islands providing supplemental income and nutritional security to the tribal. The production system is mainly extensive, low external input, free-range or backyard poultry in small holdings. The birds scavenge and forage on house-hold wastes, shrubs, weeds, crop residues, insects and aquatic plants with no or little external inputs. The birds are looked after by the families specially women and children. Total poultry population is only 56544 birds, where 56.3% of the birds found in Car Nicobar followed by 30.1% in Nancowry group of Islands. In tribal areas majority of the households have a flock size of less than 10 with the overall mean of 12.

The indigenous Nicobari fowl as well as recently introduced *vanaraja* birds are grown by the tribal families. The Nicobari fowl is the locally adapted indigenous germplasm thriving well under stressful and low input production system of these Islands. This bird is particularly resistant to diseases, especially Mareks and Ranikhet and adapted to hot and humid climate of these Islands. It is supposed to be the highest egg producer among all indigenous birds of India and produces about 140 -170 eggs per year and weighs about 1100 to 1400 g at maturity.

6.6 Structure of livestock holdings

Although pig, goat and poultry are the important livestock enterprises found in the study area, but differences can be observed between the Islands in terms of number of households having these activities and herd size as indicated in table 6.6.

Table 6.6.Structure of livestock holdings in Nicobar Islands

Islands	Pig (%)	Herd size	Goat (%)	Herd size	Poultry (%)	Flock Size
Katchal	100.0	5.5	70.0	4.5	90.0	7.6[b]
Kamorta	11.1	3.0[#]	11.1	6.0[#]	88.9	32.8[a]
Nancowry	70.0	2.3	0.0	0.0[#]	70.0	7.2[b]
Hut Bay	80.0	4.8	25.0	3.0	20.0	0.7[c]
Car Nicobar	83.3	4.2	45.0	4.6	91.7	8.9[b]
Mean	**76.6**	**4.3[NS]**	**37.6**	**4.6[NS]**	**75.2**	**12.1[*]**

($p<0.05$) [#] Not included for mean analysis, [*] - Significant at $p<0.05$

In general, majority of the households (76.6%) are engaged in rearing of pig with mean herd size of 4.3 and no significant differences are found in herd size between the Islands. From the table 6.6, it can be inferred that pig and goat are the major livestock found in Katchal, while in Nancowry and Car Nicobar islands, pig and poultry forms the major livestock. In Kamorta poultry is the largest group even with larger flock size compared to other Islands.

Though not much differences are found across the Islands but inequality in crop and livestock production system in the tribal society do exists. As discussed earlier, though coconut is present in every household, but it exhibits highest variation indicating unequal distribution across the islands. As discussed earlier, pig is the largest animal component available with more than 76% of household with least variations. Arecanut is maintained by little more than one third of the household with a mean size of 38, other crop and livestock production varies between 36 to 76% of households. The skewness of the distribution showed existence of inequalities in tribal farming system and this was also evidenced from ownership of livestock and poultry possession across different categories (Table 6.7).

Table 6.7.Frequency distribution of average holding of different components

Category [*]	Average holdings (number)				
	Coconut	Areca nut	Pigs	Goat	Poultry
Marginal (< 100)	68	13	2.7	1.3	6.7
Small (100-250)	188	39	3.2	1.6	7.7
Medium (250-500)	371	59	3.6	2.4	13.6
Large (> 500)	718	65	5.3	1.8	5.3
Grand Mean	**235**	**38**	**3.3**	**1.7**	**9.1**

[*] - Category based on no. of coconut trees

The average no. of coconut trees for the region as a whole is 235 but it varies from 68 to 718 between the different categories of farm families. The number of arecanut trees increases with increasing number of coconut trees owned by the farm families. Similar trend is also observed for the pigs that is an indicator of social status of the tribal households. However, the herd size of goat and poultry is maximum in farm families having 250- 500 coconut trees. Though coconut tree is present in every farm family, others like arecanut, pig, goat and poultry are not found with every one of them and significantly varied between the Islands.

In Kamorta and Nancowry Islands, arecanut is owned by maximum no. of farmers (66.7 – 70.0 %, while tribal farmers of Hut Bay don't have any of it. Farm animals like pig and goat are least owned in Kamorta Islands while poultry forms the major subsidiary activity. Goats are not found among the tribals of Champion Island. In all the Islands, poultry is one of the major subsidiary activities except Hut Bay where only 20% of the tribal households have poultry production.

6.7 Identification of farming system

In Nicobar Islands, out of the total average annual income of about Rs.1.02 lakh nearly 80% is accounted by coconut production alone followed by livestock (17 %) with major contribution from pig (Fig 6.4). Though poultry is reared by them, it is not a major contributor to total family income which might be due to home consumption. However, this pattern is varying in different Islands, depending upon the major enterprise. Based on income contribution from each farm enterprise, coconut based farming was identified as the predominant farming system existing in these Islands (Table 6.10).

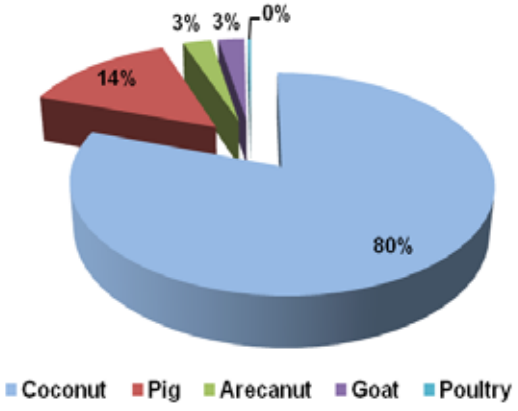


Fig. 6.4. Income contribution by different components

Table 6.8. Average annual income from different farm enterprises (INR)

Name of Island	Average Income (Rs)					Total Income (Rs)
	Coconut	Areca nut	Pig	Goat	Poultry	
Katchal	128392	4032	27500	4800	190	164914
Kamorta	71074	3640	1667	2000	819	79200
Champion	39038	2961	7000	0	180	49179
Hut Bay	98712	0	19250	2350	20	120332
Car Nicobar	73152	3101	17125	3412.5	190	96981
Mean	**82074**	**2747**	**14508**	**2513**	**280**	**102121**

Coconut + pig is the major subsystem found in Katchal, Champion, Hut Bay and Car Nicobar Islands while in Kamorta, coconut+ arecanut +goat+ pig is the major subsystem which is relatively diverse than the former.

6.8 Constraints for farm production

The major constraints expresses by the farmers for crop production in Nicobar Islands are as follows,

- Remoteness and isolation of Islands with limited market availability. As the entire Nicobar Islands are a Tribal Reserve with significant areas under protection in the Great Nicobar Biosphere Reserve (885km^2) and two National Parks. Access to the Nicobar Islands is restricted, and therefore the level of economic activity is relatively low compared with the more densely-populated Andaman Islands.
- Lack of knowledge on scientific cultivation practices especially on vegetables
- Destruction of crops (vegetables) by animals like pig, goat etc.
- Unscientific cultivation, neglect of garden leading to poor yields of coconut. Timely Harvesting of nuts is not commonly practiced. Inferior quality of copra resulted from crude & traditional method of drying
- Poor connectivity and lack of market facilities. Limited market for agricultural products especially perishables like vegetables
- Lack of knowledge on improved cultivation practices, post harvest processing and value addition of coconut
- Lack of land records makes it difficult to avail loans from the banks. Besides community holdings makes the individuals to restrain from taking up vegetable cultivation and other new agricultural enterprises

Conclusions

Coconut based farming system with pig as the major livestock component is generally practiced in Nicobar Islands. Farming is rainfed, low input, mixed and organic by default. Coconut is the chief marketable surplus item and other products are mainly for home consumption. There are inter island variability in land use management, productivity, size of holding and farming system components which are related to the existing social systems. It has been observed that most of the farm animals in these islands are free from some of the deadliest diseases prevalent in the main land and elsewhere. Therefore, utmost care is essential while introducing any animals or animal products into these islands to prevent any accidental introduction of animal diseases. This is also applicable for their traditional food crops as well. Any such introduction of diseases may turn threatening under favourable climatic condition and wipeout the precious resources of the tribes. Efficient organic waste recycling, improving the health care of local animals, rainwater harvesting, judicious integration of various farming system components and diversification of tribal farming system are viable technologies for enhancing and sustaining the farm productivity in Nicobar Islands.

7. THE LAND AND SUBSISTENCE FARMING OF SHOMPEN TRIBES

The Shompens are basically hunting, gathering, fishing tribe residing in the forests of Great Nicobar Island. They also practise little horticulture and pig rearing. Unlike other islands, Great Nicobar has all the basic resources in plenty and the largest island in Nicobar group. But the resource availability and its use by the tribes are largely decided by their social structure and technology. The Shompen tribe is organized into different bands, as discussed earlier a band consists of 25-30 persons representing 8-10 families. A band in the Shompen society is also identified with its territorial limits, in which their member families freely move and utilize the resources. But, there is nothing like ownership of territory as reported, however, the ownership of pandanus groves and certain parts of the forest around them is well recognized by other bands. Based on the movement of Shompen bands, territorial spread and their interactions, four Shompen zones / territories can be recognized in the Great Nicobar Island (Awaradi, 1990). They are,

- Northern zone – This covers Trinket Bay, Laful Bay and Zhvuh Nalla
- North-Western zone – This covers the Dogmar and Alexandra river basins
- Central zone – The upstream of Galatea river basin and areas surrounding the Shompen Hut complex
- South-Western – This comprises Kokeon, Koshin and Pulobha village region.

Fig. 9.1. Settlement pattern in Great Nicobar

We could collect information from Mawa Shompens and their Nicobari contacts about the characteristics of their farming. In Shompen society the territorial limit and size of human

population of each band largely decides the resource availability though there are not much restriction on hunting of pig and other wild animals. All the activities of band members are governed and regulated by the band headman. It is headed by an experienced male member and function within the tribal tradition. Since the Shompen tribe concentrate on the daily activities, on a common economic resource with common rights, there are hardly any conflicts among the families. Formation of smaller groups and task force by the band headman is also reported. The gains of the group would be equally shared by the base camp to which these group members belong. In addition, another group formation is also reported which is decided by the availability of food resource in a particular place. Thus, it is not necessary that all families of a band always stay together.

Shompens are the hunting-fishing arboriculturists, practicing natural apiculture also. Hunting and arboriculture are complementary to each other while the fishing and apiculture are the supplementary activities in their diversified subsistence economy. The practice of arboriculture like agriculture would have led the community to a settled life, but Shompens continue to lead a nomadic life due to other causes.

The pandanus is the single most important plantation crop as it is a major source of food for Shompens. They plant and care pandanus groves in suitable sites but, they are not known to apply any kind of inputs. Though Shompens recognize pandanus in different varieties based on their morphological features and colours of the dough, they categorize them into two broad groups viz. summer and monsoon varieties, while the botanist have reported *Pandanus andamanusium* and *P. odoratissimus* from the Shompen reserve forest area. Each band of Shompens has a number of pandanus plantations within its territory in such a way that at any point of time they would not face dearth of pandanus. In general, it is raised as community plantation by the bank, but individual could also claim personal rights over the fruits of few trees by putting up a contrivance. The Shompens are known to help the honey bees against rain in the forest by facilitating them to build their hives. Shompens locate such hollow tree trunks by resonating with blunt edge of the machete, cut an opening into the hollow trunk and leave it as such. In due course, the bees may locate this tree and build their hive therein. Later, the Shompens comeback and harvest the honey.

Another important component of Shompens natural farming is pig. On an average the pig herd size available for each family is around 8.0 with only limited number of coconut trees available in the territory surrounding the Nicobari villages. Collection of honey and hunting of wild birds are accessible for every band and the benefit is shared

among them. However, the Keyat Shompens (forest dwellers / hostile) mainly use it for own consumption and no marketable surplus is available.

Though modern crop cultivation practices have not yet entered into the Shompen territory, the land around their settlement is used for cultivation. Shompen band clear a small patch of forest about 100-150 m^2 before raising their pile of huts. The clearance of the dense forest cover results in opening of the continuous tree canopy allowing the sun light to reach the ground surface so that direct sun light is available at such camps where they can grow some edible plants which already discussed in chapter 4. They are known to possess gardens enclosed in zigzag fences, where they cultivate bananas, yams, and other tubers. They also raise pandanus, colocasia, lemon, tobacco, betel nut, tapioca and coconut. Unlike other Nicobar group of islands, Great Nicobar is bestowed with many perennial rivers, streams and creeks.

Most of the Shompen bands are located along the rivers and streams. These are rich in aquatic life particularly fishes which the Shompen consume and the streams are the source of freshwater for them. Almost every Shompen family has access to fish resources and seldom the excess catch is bartered with Nicobarese and non-tribals with the benefit sharing of all the members of the band. Pandanus groves are located and maintained in the coastal areas and sides of the creeks whereas yam, papaya, banana, lemon and tapioca are maintained around their camp. Betelnut plantation is generally raised by the side of the streams.

Shompens, to certain extent, exchange their surplus with outsiders particularly with coastal Nicobarese with whom they maintain historical relations. Some Shompen bands from Northern region visits Campbell Bay invariably with honey, lemon, arecanut, resin, megapod bird, sea shells etc., and exchange it for iron implements, tobacco and some food grains. As reported by several researchers and observers, the terms of trade is not in favour of the Shompens.

Conclusions

The subsistence economy of the Shompen is marked by hunting, gathering, fishing and little horticulture or gardening with primitive technology. Although pandanus forms the basic diet of Shompen they don't practice scientific cultivation. Coconut is known to them but neither have they produced any economic produce nor they attempted to bring some area under coconut. Though the Shompen band recognises their territorial limit, there is no clear cut demarcation and strict enforcement of restrictions on their movements. They do bartering with Nicobarese and rarely with outsiders to exchange for spear, iron implements, cloth and other essential commodities.

8. SOCIAL ECONOMY OF TRIBAL FARMING

The island ecosystem is unique not only in its natural endowment also by its socio-economic aspects. The interdependence of different subsystems including man-nature interaction of an island is stronger than continental territories. In these islands the economic structure and leadership are deeply interconnected and several aspects of this are evolved within the society over a period of time. Similarly, the economic system has relationship with social institutions like family and marriage. The social structure of the Nicobarese society being cognatic its ramifications with their system of production, distribution and consumption open up certain problems to debate. First, how a society without any bias on linearity control its material resource and how its production is socially organized; and second, how the society as a whole interact with its natural environment which is utmost important for their wellbeing. Similarly how the resources and products are equally shared among the constituting families of Shompen band which are semi-nomadic within their territory. Alongside with the progress of their economic activities the social structure got evolved which became inseparable in a tribal society. The analysis of the social economy reveals the link between the social structure and tribal farming.

Social control over farming

In Nicobar group of islands, as discussed earlier, the extent of land is limited and people living there utilize it to derive their livelihood in different ways which forms part of their social system. In Car Nicobar, individual can't alienate, accumulate, and usurp any property. Owing to their geographical position, the Nicobarese live under certain limitations, to the extent that they have to satisfy their basic physical needs by exploitation of the natural resources available within their small islands. Their mode of economic operation and technology has been conditioned by the nature of soil, monsoon, flora and fauna in a particular way. Moreover, an individual Nicobari would not find his place in the society unless he works as one of its corporate members.

Normally a member of an economically poor family leaves his or her house, after marriage, to join the family of the mate who is economically better. This system tries to maintain some kind of equitable distribution of resources among the tribal families. In some occasion the head of the joint family with excess land gives land for cultivation to other *tuhet* or to persons from other village. Village or tuhet gardens are maintained to grow tubers, fruits and some traditional vegetables, the produces are shared by its members. Though the head of the joint family is the custodian of all the property of his

group, he cannot dispose them arbitrarily, but caries the onus of giving usufructuary gifts and putting the land to best and profitable use. Sometimes, the village head, or head of a tuhet who is short of man power shares out some portion of garden land to a large friendly or related tuhet in expectation of getting help in cultivation and planting. This ensures the sharing of labour and land for common benefit. In a well-knit *tuhet*, more so in a tribal village, every individual enjoys common share in land, garden, coconut plantation and herd of pigs.

People's aspiration and production system

Tribal farming as an economic activity suggests whether primitive or developing has an aspect of dynamism or change-the viability of adjusting to situations of demand and supply. In recent years though not in comparable terms, an element of aspiration linked to production system among these tribes are noticed. The advantage of ethnographic treatment of the norms of production and consumption, conservation and distribution is that it has been the proven tool for delving into the inter-relationship of these aspects in a substantive economy and their adjustment to environment and changing times (Mann, 2005). Formation of tribal cooperatives to facilitate the farm products sale, whether controlled by society as one unit or a group of tribal, is generally perceived as the evolving socio-economic aspects of tribal society. This has more chance for evolving or progressive development within the tribal social system.

But in recent time, due to the spread of education and employment in government and service sectors, provided opportunities for some of them to make individual choices. However, the social control over the land resources and other production systems remains the same but certainly the new found economic wellbeing has relaxed the social control over individuals who live mostly outside the Nicobar Island. At the same time, appraisal of tribal socio-economic system with the modern concept of land tenure, landlordism, wealth, landless labour and other economic models of production of land may not sound good in its all aspects as suggested by some authors. In a tribal society with limited resources in an island ecosystem, money is not all about, and any change over the evolved system should come from within and sufficient time should be given to readjust itself. In spite of all these changes and opportunities majority of the Nicobari tribes still depend on farming to meet their basic needs. Contrary to this the wind of change has yet to touch the Shompen bands who continue to live within their primitive socio-economic structure without any significant progressive development.

Variations in socio-economic aspects of Nicobarese

In many occasions the natural endowment of an island largely influences the socio-economic aspects of the decision made by the inhabitants. There are variations with respect to soil, terrain, physical size, vegetation composition of different islands of Nicobar group. The Nicobari settlements are found in three groups of islands viz., Northern group, Central group and Southern group which are related to the time of their migration and settlement. A major concentration of Nicobari population is found in Car Nicobar, Chowra, Teressa and Bampoka islands while the Shompens are found only in Great Nicobar. All the Nicobarese speak their own language known as Nicobari, though some dialectic variations exist between the three different groups of islands. Majority of the Car Nicobarese embraced Christianity while traditional religion is more prominently marked in Chowra and other islands of central and southern group. Nicobarese residing in Chowra Island are considered having superior spiritual power, and they help ward off evil spirits.

Apart from religion and language, variations in land ownership are also observed among the islands. This is more important as it significantly influences the farm system and production apart from the benefit sharing. The pattern of land ownership varies with some kind of quasi-feudalism (as described by the mainstream population) in the northern islands, individual ownership in central islands, and communal ownership in the southern islands. Across the Nicobari settled islands, there are certain variations in the production system of the tribal society. In Kondul and Great Nicobar, all the plantations are communally owned whereas in Car Nicobar the production system is some kind of quasi-feudalism. In contrast, private ownership is permitted in central group of Islands but they cannot sell it out to outsiders. The four Negrito Andaman aborigines represent hunting and gathering stage of human existence, the Nicobarese are chiefly horticulturists and also involve in pig herding and raising of poultry. Shompens of Great Nicobar are in-between; they raise pandanus, lemon, arecanut and go for hunting and fishing.

The semi-nomadic system of Shompens

As discussed in the previous chapter, the Shompen social system and its control over the production is quite different from that of Nicobarese. The Shompen tribe is organized into different bands, and each band consists of 25-30 persons representing 8-10 families. A band is also identified with its territorial limits, within which their member families freely move from one place to another in a semi-nomadic way to properly utilize the resources. Although the Shompen family moves with their territorial limits, all the

activities of band members are governed and regulated by the band headman. The Shompen tribe concentrate on the daily activities, on a common economic resource with common rights, they also maintain and care their food resources. In order to carry out such a task, formation of smaller groups and task force by the band headman is also reported. The gains of the group would be equally shared by the base camp to which these group members belong.

The interrelations and economy

Although these islands are scattered and surrounded by sea, among Nicobarese of different islands, there has been a strong symbiotic relationship, especially in the economic and religious spheres. The specialization of particular islanders in certain economic aspects and the specific resource helped certain groups to develop expertise in particular art and craft. The suitable timber for ocean going canoes is available in Great Nicobar and Kondul whereas Nicobarese settled in Chowra Islands are experts in pottery. Now a days the major portion of the Nicobari farm products particularly coconut is sold to the mainstream business firms through tribal cooperatives. Similarly the food requirement of the tribal society is supplied through government controlled public distribution system. Although the Shompens are left behind in the development when compared to the Nicobarese, they do barter trading with the Nicobarese of Great Nicobar Island. The trade is aimed to obtain their basic requirements and small tools but not to accumulate economic wealth. This kind of inter-island dependence and cultural relationships are, to some extent, still observed.

Conclusions

The resource endowment, settlement pattern, population, level of exposure, contact with outsiders and influence of change agents, all decides the socio-economic aspects of tribal farming in Nicobar Islands. The nature of farming and benefit sharing differs among the Nicobar Islands, but what is more important is the factor influencing the socio-economic aspects of tribal life which needs to be properly understood and used to bring the desired changes in the tribal farming. In many ways the social control over the land ownership and farm production in a tribal society got evolved to ensure the wellbeing of the tribal society as a whole with environmental protection. In general the social economy of the tribes in different islands varies, but it has been instrumental in maintaining the island production system as one unit with shared benefits among the tribes.

9. AGRO-BIODIVERSITY OF TRIBAL FARMING SYSTEMS

The variety of life forms on Earth is commonly referred to as biodiversity. The number of species of plants, animals, fungi and microorganisms, the enormous diversity of genes in these species and the different ecosystems of which they form part are all constitute biodiversity on Earth. Biodiversity for food and agriculture includes the components of biological diversity that are essential for feeding human populations and improving the quality of life. It includes the diversity of crops and their wild relatives, trees, animals, microbes and other species that contribute to agricultural production. This diversity exists at the ecosystem, species, and genetic level and is the result of interactions among people and the environment over thousands of years. The use of agricultural biodiversity can make agricultural ecosystems more resilient and productive; and can contribute to better nutrition, productivity and livelihoods.

The Nicobar group of islands situated between two major biodiversity hot spots viz., the Indian subcontinent and the Malaysian-Indonesian region, it is hardly surprising that the Nicobar Islands manifest biodiversity of extraordinary range within a limited geographical area. The Great Nicobar Biosphere Reserve is unique of its kind. These diversities also help to sustain the tribes by providing them with food, shelter and resilience against climate change.

9.1 Crop diversity

Nearly 2100 species of Angiosperms have been reported from the islands, of which 11% are strictly endemic to the islands (Balakrishnan and Ellis 1996). The agro-biodiversity of these islands ranges from medicinal plants, indigenous orchids, vegetable crops of different nature, tubers and economically important plant species like timber yielding plants.

Rice is the major cereal crop though limited to southern group of Nicobar Islands. There are around 11 cultivars of rice grown in these islands but in true sense cultivars, which we designate as local, are the once introduced from elsewhere at different elevations of time. They are the truly adapted genotypes, which have endured many years of the selection pressure in this wet humid tropic. A long duration rice variety with good straw yield locally known as C-14-8 provides animal feed and well adopted to the lowland farming system.

Medicinal plants are the integral part of rich biological diversity exists in Nicobar Islands. The ethno medicines of Bay islands involve a diverse range of products derived from the surrounding flora and fauna. A number of studies have indicated that a large number of plant species are used by ethnic tribes for various ethno-medicinal properties. Orchids represent the most highly evolved family of orchidaceae and it has emerged as the leader in the international floricultural trade. Andaman and Nicobar islands possess about 110 species in naturalized state, of which several species are endemic to Nicobar region. Several vegetable species are found in the tropical rainforest and in the wet lands. The tribes are known to consume and conserve them in its natural state and sometimes grow in their home garden (Fig 11.1). However, commercial utilization of them requires adequate knowledge of its habitat, its propagation and ways to conserve them.

Fig.11.1 Vegetable crop diversity found in the tribal areas

The Nicobar Islands have remarkable diversities in tuber crops (Fig. 11.2). These crops are widely adapted to humid tropical climate and are important energy source used in their diet. Tubers are cultivated / maintained from time immemorial by the tribes.

Fig. 11.2 Diversity of tubers and other crops found in tribal farming

Crop genetic diversity has a critical role to play in increasing and sustaining production levels and nutritional diversity of tribes living in different agro-ecological conditions. The farming system in Nicobar is not so intensive but mixed and maintains crop diversity. In addition to the certain earmarked locations of different islands the tribes maintain several economically important crop plants in natural state similar to the community gene banks. The social structure and land use pattern of the tribes enables them to maintain, allow them to evolve rationally and select the improved varieties. This is important for improving crops, promoting their resistance to pests and diseases, or adapting to the effects of climate change.

IMPACT OF INTRODUCTION ON ISLAND BIODIVERSITY

In spite of continued interactions with outside world for several centuries, the major floral and faunal biodiversity of the Nicobar Islands are still intact. The tribes derive their livelihood and other services from the wild floral diversity. The Nicobarese mainly depend upon coconut palm for consumption and exchange it for other essential items during the historical times. They also raise large sized and globular pandanus, papaya, yam, banana and some vegetables. The citrus fruits are grown in Teressa, plantations of coconut and rubber is found in Katchal which were introduced by the Agricultural Department of Andaman and Nicobar Administration. Nicobarese are known to maintain large herd of pig, fowl in the backyard and in recent times improved breeds of poultry and goats are being introduced by the government agencies. In addition, some of the recent introductions are guava, cashew, lemon and pineapple and cucurbits due to which the consumption pattern of tribes have undergone tremendous changes. Eupatorium was introduced by the Japanese, neem by the Indians and Casuarina by the Danes. But, the tribal reserve of Great Nicobar where Shompens live is still in its original form and the inhabitants derive their food by gathering and hunting in the forest.

9.2 Faunal diversity

The islands are supporting over 8,386 species of animals comprising both terrestrial and marine waters. The Nicobar Islands harbors rich faunal diversity. The crab eating Macaque or Nicobar monkey, *Macacafasciculari sumbrosa* is the only primate endemic to Southern Nicobar Islands. The rich fauna of these islands especially insects, most of which like other areas in the tropical region remain unknown. According to the Zoological Survey of India, 1500 to 2000 species of insects have so far been documented from these islands.

Predators and parasites which attack pest insects or pathogens on crops, or plant-feeding insects which attack crop weeds contribute to pest regulation. This is vital for the stability of tribal farming system which doesn't use external chemical inputs for pest control in these islands. Beyond these direct trophic relationships, a web-like pattern of interactions amongst diverse life-forms can deliver additional benefits. For instance,

crop production may benefit from benign micro-organisms which colonize crops and their habitats so that pathogens do not establish, or from non-crop plants which are attractive to pests and thereby reduce their numbers on crops. Taken together, this directly- and indirectly-acting biodiversity may create “pest suppressive” conditions.

9.3 Soil diversity

Soil biodiversity is as important as the above ground floral and faunal diversity. The diverse organisms perform a number of vital functions that regulate the soil ecosystem, including decomposition of litter and cycling of nutrients; converting atmospheric nitrogen to an organic form, and reconverting this to gaseous nitrogen; and altering soil structure. The soils of Nicobar Islands support innumerable groups of microorganisms several of them of which are not known. The tribes of these islands never disturb the soil except for preparatory work in vegetable garden. They leave the coconut husk and fallen leaves on the ground. This adds to the soil organic matter content which in turn act as a carbon source for soil organisms. A thick dark coloured surface layer is often seen even in the coastal sandy soils where coconut plantations are maintained. They never expose the soil directly to rainfall and the land is always covered with some form of vegetation. Several agriculturally important groups such as growth promoting bacteria, N fixers, phosphate solubilizers and decomposers are documented from Nicobar Islands. Maintaining this diversity of microbes is vital in supporting organic farming practiced in Nicobar Islands. Diversity in deliberate plantings on-farm- through crop rotations, crop species mixtures, permanent soil cover crops employed in conservation agriculture or agro-forestry are often used techniques to increase yield and improve soil fertility.

9.4 Biodiversity of livestock and poultry

The main livestock of these islands are pig, cattle, goat and poultry. Though North, South and Middle Andaman have major chunk of livestock in Andaman group of islands but Car Nicobar and Katchal are the centers with more concentration of livestock in Nicobar group of Islands where pig and goat are dominant apart from sizeable number of Nicobari fowl. Teressa goat is found in Teressa Island, while pig is found throughout the Nicobar Islands (Fig. 11.3). This distribution clearly points out the food habits and nature of farming of these regions. The wild pig (*Sus scrofa*), constitutes the maximum number amongst the native mammal, with two subspecies, one in Nicobar group and the other in the Andaman group. About 80% of the poultry population in these islands are local which means non-descript and only 20% of the total poultry birds are high yielding or exotic breeds. It is unevenly distributed with the largest concentration in North

Andaman (31%) followed by Car Nicobar (22%), South Andaman (20%) and Middle Andaman (10%) and rest of the islands have less than 10%.

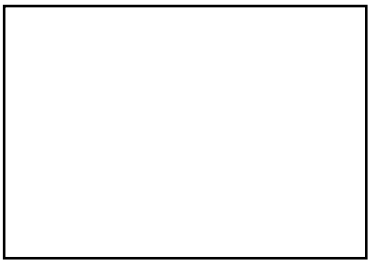
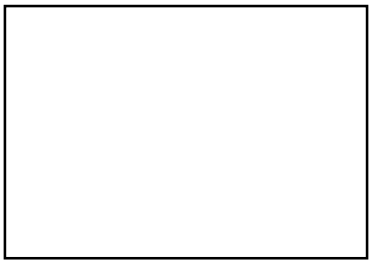
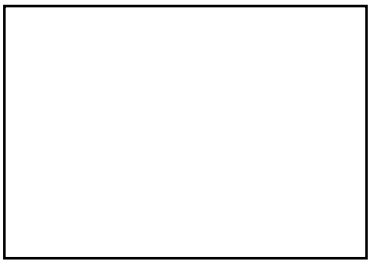


Fig. 11.3 Nicobari fowl



Teressa Goat



Nicobari pig

This kind of livestock distribution is mostly attributed to religious faith, social need and resource availability. Even in the present day context it is largely decided by the individual choice and tribal culture rather than economic considerations. One could still see large social gathering during pig festival and community feast and there are demand for livestock for gifting during auspicious occasions. Chowrites maintain local birds to be sacrificed to please the good spirits before venturing into sea and maiden sailing of new canoes.

9.5 Seaweed resources of Nicobar Islands

Seaweeds are the macroscopic algae which form an important component of marine living resources and are mostly available in the intertidal zones of the sea were suitable substrata are available for growth. Seaweeds are used as food, fodder, fertilizer and have wide applications in a variety of industries. They are also important sources of protein, iodine, vitamins, minerals and substances of antibiotic nature. There is no report of use of sea weeds at commercial scale anywhere from Nicobar Islands though it is available in large quantities. The tribes are known to use certain species during some special occasions and in some medicinal preparations. The use of see weeds by the Shompens is yet to be assessed. This has the potential to be used as animal feed and extraction of certain alkaloids.

AGROBIODIVERSITY CONSERVATION

The natural undisturbed mode of conservation under ***in-situ* wild conditions** and the conventional undisturbed mode of maintaining the diverse populations under the traditional farming situations are duly recognized as the supplement genetic resource conservation approaches. Within the biosphere reserve area of Great Nicobar several horticultural important plant species are conserved. It is also observed that in other Nicobar Islands several important plant species are occurring in the wild.

The *in-situ* **OnFarm conservation** is the continued maintenance of plant populations within their agro-ecosystems to which these have been adapted. It is followed for the naturally occurring plant species, progenitors of crop plants, forest trees and other wild species. The Nicobari tribes continue to maintain several species of tubers, vegetables and fruit crops within their agro-ecosystem to derive their nutritional requirements. Shompens are known to maintain pandanus and tubers in its natural state. Both these tribes maintain several livestock species either in semi feral or in wild conditions. These are all valuable biodiversity resources available with them which are well adapted to the tropical and coastal conditions. It provides resilience even to the perceived climate change.

Conclusions

The agricultural biodiversity of Nicobar Islands can provide native tribes with more crop options, nutritional security, and diverse diet; helps to buffer the effects of extreme events such as droughts or floods. Greater on-farm diversity of crop plants, greater closeness in terms of spacing between the plants providing coverage of bare ground and more perennial cultivation may be measures lending greater resistance to invasion of farming systems by noxious species, and assist in weed management. Diversity of livestock provides greater opportunity for livelihood support, nutritional security and stability of farming systems. This is one of the major assets of tribes which are passed on to the next generations. Pollinators are essential for orchard, horticultural and forage production, and contribute to improvements in quality of both fruit and fiber crops. Both these tribes particularly Shompens are known to promote honey bees by facilitating bee-hive formation in the wild. Healthy pollination services are best ensured by an abundance and diversity of pollinators, in large part provided by wild biodiversity. The wide agro-biodiversity has provided not only food for the tribes but protected them from climatic variations in the past and will continue to do so in the future.

10. TRADITIONAL KNOWLEDGE ON FARMING AND HEALTHCARE

Traditional knowledge is the acquaintances about particular thing that people in a given community have developed over time, and continue to develop. It is based on the experience, often tested over centuries of use, adapted to local culture and environment, dynamic and changing (NAARAP 2009). Indigenous knowledge is primarily inherited from the ancestors through generations of the community which is the main source of knowledge on utilization and management of resources. It is also referred as traditional knowledge, local knowledge, community knowledge, rural people's knowledge and farmers' knowledge (Mahalik and Mahapatra 2010). This knowledge is developed from experience gained over the centuries and adapted to the local culture and environment, transmitted orally from generation to generation and collectively owned by the community. This may be in the form of stories, songs, folklore, proverbs, cultural values, beliefs, rituals, community laws, local language, and agricultural practices, including the development of plant species and animal breeds. Sometimes it is referred to as an oral traditional for it is practiced, sung, danced, painted, carved, chanted and performed down through millennia. Traditional knowledge is mainly of a practical nature, particularly in such fields as agriculture, fisheries, health, horticulture, forestry and environmental management in general.

10.1 Indigenous knowledge on farming practices

The tribes of Nicobar Islands practise natural farming and known to possess wealth of information which they pass on to the next generation. As far as Nicobarese are concerned, besides coconut plantation they have three types of gardens for growing fruits and vegetables. It helps to fulfill dietary, economic and social needs of different cultures in the islands (Gillespie *et al*., 1993) and provide them with supplementary food, fruit, fodder and fuel.

Gardening

A village garden is present in each village which is the common property of the villagers. At next bottom level each tuhet have "Tuhet garden" in common area of the tuhet and belongs to all tuhet members. At the lower level each family/household maintains the garden for their family benefit. The crop combinations found in the home gardens of a region, are strongly influenced by the biophysical and socio-cultural factors besides

the specific needs of the household and nutritional complementarities with other major food sources (Kumar and Nair, 2004). In the home gardens of Nicobar region indigenous vegetables, tuber crops like tapioca, sweet potato, colocasia, greater yam or Nicobari alu are grown besides fruit crops like papaya, banana, pine apple and pandanus. Jack fruit, mango, silk cotton, curry leaf are also found in home gardens (Pandey 2007). The medicinal herbs also found place in their home gardens. The tribes used to shift the location of home gardens after two to three years of cultivation to allow the soil regeneration and sustain the productivity of the soil. The follow period will range from 5 to 6 years. A systematic gardening combined with establishment of village coconut garden is noticed among the Nicobarese of Car Nicobar. A small patch of forest which is village common land is cleared, planted with selected coconut seedlings and the interspaces are utilized for tuber and fruit crop cultivation up to 4-6 years. The benefit is shared collectively by the villagers. So it is some kind of establishing coconut garden combined with shifting cultivation so that the soil productivity is sustained and available land is well utilised essentially with benefit sharing among themselves.

Coconut plantation

Throughout the Nicobar Islands the coconut plantations are unmanaged with little cleaning practises. Nicobarese collect the matured, fallen nuts, remove the husk before taking it to their home for further processing. The individual family divides their coconut garden into three segments. In the first segment nearer to their settlement is normally used for tender coconut and the second segment away from their home is used for collection of nuts for copra production and sometimes used for toddy making. In addition, they maintain coconut in a natural state away from settlements and other disturbances allowing it to breed and grow naturally (Velmurugan *et al*., 2015).

Collection of nuts

Sometimes the nuts are collected by all tuhet members collectively by offering mutual assistance which has been the hallmark of Nicobarese social economy. Now they are well aware of the benefits of timely collection. The collected nuts are stored in a safer place or tied together and kept hanging from a rope in the coconut garden itself. During summer months or after rainy season the dehusking was done by traditional dehuskers made up of small iron rod. The copra was dried by burning the coconut husk and other biomass for two to three days until the moisture content is reduced to safer level (Fig. 10.1). Only men involve in this collection, dehusking and drying of nuts.

Collection of nuts, tying and hanging to avoid sprouting

The broken coconut is arranged on the stage and burned from below using coconut wastes

Fig. 10.1 Traditional method of copra making

Oil extraction

The virgin coconut oil is extracted by traditional equipment called K*intantavi-i* (Fig. 10.2). There are two methods of extracting the virgin oil *viz.* sun dry method and hot water extraction method. In the first method the scrapped coconut kernel is pressed in K*intantavi-i* to get coconut milk, which is then boiled to obtain the oil and mainly used for toiletry purpose. In another method, the coconut milk obtained by pressing scrapped coconut in K*intantavi-i* is mixed with hot water and kept open in a vessel over sunlight for separation of oil. However, realization of oil in both the methods is only around 30% of the kernel content. In the process mostly women are involved and children assist them but eventually learn the process.

Scrapping matured fresh coconut

Pressing in *kintantavi-I* for milk and sun drying for extraction of virgin oil

Virgin coconut oil

Fig.10.2. Methods of extraction of virgin coconut oil by indigenous method

10.2 Storage bins for seeds and tubers

The storage of seeds of vegetables, fruits and other crops in tropical humid climatic condition is a serious challenge to the tribes. They store it for seed purpose and future consumption. Different methods and materials are available with them for this purpose (Fig. 8.3).

Coconut shell for storing annual seeds

A well matured large size coconut shell is used for storing the vegetable seeds. After dehusking of selected coconut a hole of 2.0 -2.5cm diameter is made at the posterior end for removing the water and the endosperm. Then the shell is sun dried in open condition. The exterior of the shell is polished by scrapping the shell on a stone. This is used for storing the seeds of various annual crops like amaranths, chili, brinjal, radish, okra, pumpkin etc. After drying the seeds to safe moisture content (less than 10%), they are put into the dried shell / bin and the hole is closed by bamboo sticks to prevent the entry of air and any damage by rats. The seeds can be stored for more than a year by this method.

Bamboo basket/bins for tubers

The tuber crops play an important role in tribal community. The shelf life of tubers is very limited in hot humid conditions of Nicobar Islands, hence they should be stored in a cool dry place and should be free from dampness. The tribals use bamboo baskets/ barns (Fig. 10.3) for storing the tubers of sweet potato or *Nicobari alu* for seed as well as consumption purposes at later time. The yam barn is very common in Nicobar to store the tubers. Basically it consists of ring walls of vertical pieces of bamboo, each 5-10 cm in diameter, one meter high and set about half meter diameter. The vertical wall is often made of split bamboo. It is the experience of Nicobarese that the structure reduces the risk of attack by termite. Inside the barn the tubers are kept individually and arranged vertically to allow maximum air circulation.

Fig. 10.3 Storage bins used by Nicobarese

10.3 Fishing crafts and gears

In Nicobar Islands fishing is done by indigenous and non-mechanized boats made by tribes themselves. The traditional fishing boat is called *hodi*, is an outrigger dugout canoe made of jack fruit (*Atrocarpus heterophyllus*) locally called as To-kavo-ka (Fig. 10.4). These boats operate in near shore waters and they cannot operate in high seas due to their smaller size, lack of mechanization and poor endurance in high seas. Moreover the storing capacity is also low making it difficult to stay in seas for more days.

Fig. 10.4 Making of traditional fishing craft

The traditional fishing gears used by tribal fishermen are spears, harpoon, bow and arrow, hook and line and trolling line. The details of which are given below (Table10.1) as documented by Zamir Ahmed *et al*. 2012.

Table 10.1. Traditional fishing gears used by Nicobarese

Sl.No	Name of the gear	Remarks
1.	Linrech / Chok (Spears)	• It's a primitive activity most popular among the tribes. • Usually operated during calm season and low tides in shallow waters. • Octopus, tuna, barracuda, caranx, seer fish, groupers and sharks are caught by this method. • Needs precision and experience
2.	Hand lines	• A 3 to 20 m long monofilament line with one or more barbed hooks. Thin steel rods are used for making hooks • Artificial baits either live or dead baits like earthworms, dead fish, squid, cuttle fish flesh, hermit crab flesh are used for attracting the prey.

3.	Trolling line (Inruonthakuaha)	• Is very common method of fishing among the tribes used to catch fast swimming pelagic carnivorous fishes. A 2-4 m long movable fishing lines are towed to the outrigger pole from behind or side of the hodi.
4.	Bow and arrow	• Bow and arrow made of bamboo are used in shallow and calm waters to catch the slow moving fishes. Not commonly used at present.

The Shompens use soft wood and iron for making various tools for hunting, fishing and gathering, domestic articles, ornaments and transport crafts. The various crafts used by Shompens are given in table 10.2.

Table 10.2. Type of crafts used by Shompens

Sl. No	Name	Description and Use
1.	Plucker	Long pole with knife at one end used to pluck fruits from trees
2.	Bar carrier	Wooden bar to carry loads on the shoulders
3.	Gouge	A short pole with chiseled end on one side, which is used to collect larvae (loh) from the decaying wood for food.
4.	Javelin	Is a wooden pole made of arecanut strips with sharp ends. It is used as a weapon in battles.
5.	Ben Trovoto/ Bark utensils	It is a bark cooking vessel made of Areca catchu L, Anthocephaluscadama (Roxb), Achinensis (Lamk) etc. which are comparatively fire resistant.
6.	Brochette	Is a thin wooden rod of 1.5 to 2 ft , used for catching fish.
7.	Container	Made of bamboo to store water.
8.	Bark tub/Bath tub	Is a single piece bark made of tray of 60 x30 cm. Used as bath tub for babies. The coconut shells are used as mug.
9.	Fire generators	The resins collected from forests are used for igniting fire in a hearth.
10.	Ornaments	Ear rings made of wood are used by some groups/bands of Shompens.
11.	Hodi	Outrigger canoes for inland and maritime navigation. The plants of *Amoora wallichi* king, *Barringtonia asirtica* (L) Kurtz, *Autocarpus chapleosha* Roxb, *Calaphyllum sonlattri* Burn, *Sterculia macrophylla vent* are used for the outrigger.
12.	Spear	Hunting device made of wooden handle and iron head. Used for fishing and hunting wild boars, monkey etc. and also used as a defense weapon.

(Arora, 2010)

10.4 Animal Production

Livestock are integral part of tribal farming and occupy prominent position in tribal culture. Pig is an important farm animal reared by the tribes of Nicobar. The copra and kitchen wastes are fed to the animal daily. Feeding trough is made by well matured larger bamboo canes with longer internodes (Fig. 10.5). The selected cane is cut open vertically in two equal parts and the sides are scrapped to smoothen it to use as a feeding trough. Similarly bamboo drums are used to raise sounds or giving signal to call the pigs for feeding. The well matured bamboo cane with short internodes is taken to make a drum. The small hole is made at the internodes. Each individual family has a unique rhythm or beat to call the pigs of the family for feeding. To identify the pigs from a *tuhet*, ears of piglets are notched at different positions in varied sizes and shapes. The pattern of ear notching varies for different *tuhets* and each *tuhet* has its own pattern for identification of pigs.

Fig. 10.5 Feeding of pigs

10.5 Important terms in Nicobari language related to farming

Over a period of time the Nicobari tribes gained experience in farming and learned off-farm activities suited to their conditions. They have identified plants and animals useful for various activities and developed techniques for natural resource management. With this experience they started using specific word / group of words to convey the information to other members of the tribal society. These words are documented while talking to the tribal elders. In some occasions specific words for particular activity or farm operation was asked to them. These are telling examples of rich farming knowledge of the tribes. Some important terminologies related to farming activities (Table 10.3) are given below;

Table 10.3 Terminologies in Nicobari language and its equivalent in English and Hindi

English	Nicobari	Hindi
Air	KufÖt	वायु
Animal	Tõrēula	पशु
Banana	TanyukngÖ	केला
Brinjal	Bahen	बैंगन
Coconut	Kuk (Kiltôchů) (chilka)	नारीयल
Cultivation/Ploughing	InulōTumlat	खेती
Deficiency	Kanunen	अभाव
Disease	Invāh	बीमारी
Earth Worm	KamlÖkÖTumlat	केंचुआ
Erosion	HanemÖTumlat	कटाव
Family	MinkÖunÖ	परविार
Farming	TineuchÖ	खेतीकरना
Fish	Kāk	मछली
Food	Nga-a	आहार
Fruits	KulÖlTanyukngÖ	फल
Glyricidia	TÖanhchōn	जदिाबल्ली
Goat	PokÖre	बकरी
Health/Healthy	KanôlôAlaha	स्वास्थ्य
Heat	RanachÖ	गरमी
House	Pati	घर
Human	Tarik	मानव

Insect	KamlÖÖkÖ	कीट
Integrated	TÖ-HēngÖmūlÖ	एकीकृत
Leaf	Rôychôn	पत्ते
Lemon	Limòng	नीम्बू
Loss	Yamengen	हानी
Maize	MilÖh	मकई, ज्वार
Money	Rupee	रुपया-पैसा,मुद्रा
Namaste	TalÖk Peuheu (Morning) Talõk horap (Evining)	नमस्ते
Nicobari Fowl	TokiniÖthayÖm	नकिोबारीमुर्गी
Nutrient	InkôlôAlaha	पुष्टकिर
Pig	Ha-un	सूअर
Pine-apple	Firung	अनानास
Poultry	ChukimhayÖm/ Niwbariþoun:TokiniÖt	मुर्गी
Quality	TÖkeung	वशिषता
Rain	kumrah	बारशि
Ralling/fencing	KinlôngÖ	रेलगि
Recycle	Chinvi.ŕÖ	पुनःइस्तेमाल
Sakthi/Energy	knmlex	शक्तिं
Seeds	Kari	बीज
Sesbania	TÖcharichōn	ढंन्चा
Shed	PatiTÖreula	छपपर
Soil	Tumlat	मृदा

Solar Heater	Inŕaich (LamÖktÖkůÖtavůÖi)	सौरगर्मयांत्र
Thank You	Tolngoǿ	धन्यवाददेना
Time	Rē-taka	समय
Vermicompost	Lane-en Taneuch	केंचुआखाद
Waste	TÖye-neng	अपशष्टि
Water	Mak	पानी
Water tank	ChukMāk	पानीकुण्ड
Yield	Poyen	उत्पादन

10.5 Knowledge on human health care

The tribes of Nicobar region have wealth of knowledge on farming, health care and also known for their traditional handicrafts made of coconut shells and bamboo. Some of their knowledge on healthcare using locally available plant species is well documented. Some of the plants are grown near their settlements and many others in the natural state. The Nicobarese perceive health as a condition or state of performing personnel as well as economic activity in daily life and the cause of illness to various factors pertaining to seasonal, natural and supernatural. The natural causes are attributed to consumption of contaminated food and water, unhygienic habits. They have strong opinion of super natural powers which are attributed to action of evil spirits, witchcraft, and sorcery. The traditional healer in the Nicobari tribal society is called shamans (Fig. 10.6). Nicobari tribe from Chowra Island are considered to be high in spiritual power hence mostly act as a priest or practise as Shamans.

Fig. 10.6 Traditional healers of Nicobari are called 'shamans' they mediated between the supernatural and the villagers

They generally identify the nature and type of disease after inspecting the affected bodily parts and verbal explanation from the patient about the nature of suffering. In some cases, the native medicine practitioner keeps some wild herbs under the pillow of the patient. By doing so, they believe that name of the disease may be recalled in

dreams. Based on the symptoms, prepare herbal medicine in different ways ranging from crushing in motor, concoction or liquor, frying in oil, and mixing herbs in warm sacrificial blood and consumed orally or applied over body (Prasad 2013). Some of the vernacular names (Nicobari) of common diseases prevalent in the region along with their local or traditional remedies are given in Table 10.4.

Table 10.4. Some common health problems in Nicobari language and their remedy

Native Name	Common Name	Native Remedy
Chokvoing(Katcal) *Laneentochokelon* (Car Nicobar) *Ellenreinnyab*	Stomach ache Stomach pain	To get immediate relief from the stomach ache, an herbal concoction is prepared with *sanuk* (*Ganophyllum falcatum)* and *kalinaich* leaves by smashing in *sanongranum* (wooden or metal mortor). The concoction made with *panrapö, ollka, chanrevö* (*Lepisanthes rubiginosa*), and *tokurot* also used for relief from the stomach – ache. This process is continued up to three days regularly in the morning and evening. During this treatment, the patient is given soft foods like roasted banana and tubers. They are barred to eat fish, oil, and spicy foods during treatment.
Punâyö or vwöi	Fever	The herbal leaves known as *roiarek, roimitakngöreuyö* are thoroughly crushed in *a wooden mortor* and mixed with coconut oil. The resultant pastry or mixture is added to a bucket full of water. The patient is instructed to take bath in herbal mixed water for two days. Further, the patient is also advised to gargle with the same water twice a day. By doing so, Nicobarese believed that body temperature will be reduced. In case of high fever caused by malaria and typhoid, the method of treatment is different. The leaves of *arek* and *mitakngöreuyö* are hand crushed and mixed with fowl blood. The mixture is also added by wild leaves known as *roikimeuy, roikachamai, roimisiyanga (Ocimum tenuiflorum), matoak (Curcuma longa)* in the form of pastry. Thus prepared mixture is applied on the patient body for a period of eight days continuously.

Ehe	Cough and cold	The leaves of misiyanga (O*cimum tenuiflorum* or tulsi) are smashed in medicine mortar and mixed with ginger pastry. Water is added to the mixture and boiled for some time. The extracted liquor is administered orally to subside cold and cough.
Chok-Kui	Headache	The leaves of *lonuon* are smashed and it is added with *umvou* (Lime) to make it pastry. It is applied on the forehead. In case patient experiences body pain, advised to take bath in sea water.
Chakarat	Backache	The leaves of *ingnak* (*Lawsonia inermis*) are powdered and water is added to make it a pastry. This mixture is applied all over the pelvic girdle to get relief from backache.
Chokkanad	Tooth ache	The leaves of *paniyamma* are chewed to get rid of the pain.
Elnangmat	Ear ache	The jelly like portion of aloe veira plant is extracted and squeezed strongly with two palms to extract its liquid. Few drops are slumped in the ear to cure acute pain.
Chok mat	Eye congectiveness	The leaves of *lurong* (*Morinda citrifolia L.*) are roasted on fire and smashed in palm along with few drops of water. The resultant paste and liquid is applied to affected eye.
Isi-ah or ueoav Isav	Loose motion or dysentery	The leaves of *tinyam* and *muyeuo* are crused in *sanongranum* and soft flesh of tender coconut is mixed thoroughly and applied on the stomach. The patient is barred to consume sour items like mango, lemon etc. Only boiled L*aal khela* (red banana) is given as food. In some cases, the leaves of *takiting* and *takurotang* (*Lepidopetalam montanum*) are smashed together and mixed with cold water. After filtering it, the liquor is given to dysentery patient.
	Constipation	*Lanan kaap* (*Ipomoea per-caprae*) are small plants widespread in seafront or beach. The tiny leaves of these plants are smashed in palm and its pastry is applied on the stomach of the child. By doing so the child defecates freely. The same leaves are also kept under the pillow of the patient who is affected with giddiness for relief.

Unhaa nömö	Asthama or Bronchitis	The saliva of alow (Hawabill bird) is extracted up to a half cup and mixed with water (quarter cup) and the resultant pastry is boiled. The concoction is given to patient for a period of seven days to get relief from bronchitis. The medicine locally popular as *likup* (*Ocimam sanctum* L.) is prepared with powder of *kanap rev* (crocodile teeth), water and honey are given for asthma patient. The concoction prepared with the smashed *roi matka* is also used for its treatment.
Kaleron maham	Blood Pressure	To reduce high blood pressure, the drumstick (*Moringa oleifera*) leaves are pounded and the juice is administered to patient orally. The dose is depended on the age of the patient. The excess consumption may lead to side effects.
Kuon maham or *hilon*	Jaundice	The leaves of *umhok* and *kal* are crushed and mixed with sacrificial blood of a pig. This mixture is applied to upper portion of the patient. *Kinfio-hayom*, *kanap-page* are crushed in palm and mixed with fresh cow or goat milk. This medicated drink is given to jaundice patient for cure. This patient is barred from eating fish during that time. Only green vegetables, papaya, red banana and sugarcane are used as food.
Hange-ere or key	Epilepsy	When the affected person experiences shivering, immediately he was forced to sit in front of fire to get rid of it. Later on concoction prepared from the smashed leaves of *tavungnai* and administered orally in raw form.
Chavilong elmat	Giddiness	In case any individual experiencing giddiness during day time, he is asked to lie down and the *singera* leaves are kept under the pillow for a while. By doing so, they believe that giddiness is immediately relieved and can resume routine work.
To-suktore	Injury	To attach broken limbs, the *lurang* root is scrapped with cane scrapper and added little bit of water. This mixture is applied at broken place and kept small bamboo or coconut splits as a support to applied pastry and tied properly with *beth* (cane) strings to limb as bandage. It is removed after one week.
Ohokinmonö	Limbs fracture	

Pishih	Itching	Fresh turmeric roots are scrapped by using cane scrapper and added to *ngonado* (coconut kernel) to make a pastry and applied on the skin where itching rashes are spread. After some time, the patient is asked to take bath with sea water.
Kâpö to pcch	Snake bite	This is widely known to all, so that they can immediately take the medicine. The wild leaves known as *roi chualö* is crushed in mouth for some time and taken out. And dried tobacco is added to this mixture and again chewed for some time. Thus chewed leaf pastry is applied on the bitten place as first aid to prevent spreading of the poison to other places and as pain relief. Later on the smashed *roi pongamiol* are mixed with coconut milk and applied on the bitten spot of the patient.
Kâpö to kuikuvoko	Centipede bite Wild pig bite	The *dried hukyak* (cane leaves) are burned in fire and the ash is applied. Later on light massage is done with palm over the spot for some time. Thereafter no solid food is given to the patient for one hour. In some cases, tobacco ash is also used for its cure. The ash extracted from the burning of tobacco leaves are mixed with coconut oil and applied on the spot. The leaves of *chukiyavö are* used are crushed in medicine mortar and applied on wounds caused by the wild pig bites and cuts due to knife.

Even though the Shompens of Great Nicobar practice hunting and gathering, they do have the wealth of knowledge on plants growing in the forest and their medicinal values (Arora, 2010). This knowledge the tribal people have come to possess in course of their millennia long interaction with nature. Detailed ethno botanical information about the Shompens is given in table 10.5.

Table 10.5 Medicinal plants used by Shompens and local name of the ailments

Scientific name	Local name	Uses
Actoplanes canniformis K.schum	Amokyoang	Stem and root decoction taken orally in fever
Alstonia kurzii Hook.f.	Tachoroi	Vapour of bark, root or leaf inhaled for curing fever

Alstonia macrophylla Wall.	Tachoroi	Vapour of bark, root or leaf inhaled for curing fever
Ardisia solanacea Roxb.	Kanheyo	Root boiled in water and taken internally for washing uterus after childbirth; root decoction also taken orally to remove blood clot and cure internal haemorrhage
Citrus medica Linn.	Limong	Raw fruit as an antibiotic
Costus speciosus (koeing) Sm.	Manola	Leaves are used for curing stomach disorder
Croton argyratus blume	Mintuna	Seeds as laxative and used in stomach disorders
Dischidia bengalensis Colebr.	Talima	Leaf pounded and applied externally for reducing pain on humps and sores. Twigs are made into paste applied externally for healing of fractured bone
Garcinia nervosa Miq.	Kintul	Leaf paste is applied on body to relieve body pain, roots used for washing uterus after child birth
Glochidion calocarpum Kuna	Kinsan	Seeds or bark pounded and applied externally in skin diseases; decoction of leaf taken orally for curing fever
Leea grandifolia Kurz	Takteyu	Leaves eaten in fever
Macaranga nicoborica N.P. Balakr & P. Chakrabory	Panah	Leaves used for curing stomach disorder
Mallotus peltatus Mull. Arg.	Kisoh	Leaves for curing stomach disorder and menstrual pains
Melastoma malabathricum Linn.	Kiyang	Leaves, stem and roots used to heal wounds
Myristica elliptica Wall.	Kinhanmo	Seed or bark pounded and applied externally for skin diseases
Ophiorrhiza nicobarica N.P. Balakr		Fresh leaves paste for curing wounds
Phyllanthus amarus Schumach. & Thonn.	Kingthyem	Leaves used for general health complaints
Semecarpus kurzii Engler	Pep	Fruits used to cure injuries

(Source: Elanchezhian et al. 2007)

Conclusions

The tribes of Nicobar Islands have abundance of local expertise in plant and animal genetic resouces that have been in use over a considerable period of time and evolved with the constant use of forest resources. Nicobarese and Shompens use various plants or plant parts as a source of food, shelter, clothing, medicine, timber and for other miscellaneous purposes. They completely depend on the forest, plantation and marine resouces for their livelihood and developed skills to exploit, knowledge to use and information to access them. In order to understand, conserve and better manage the biodiversity of the islands greater and organised efforts are required to miticulously document the traditional knowledge of these tribes. This needs to be evaluated scientifically and upscaled for greater benefits. Moreover, a tropical gene garden should be established to conserve endemic and endangered species and preserved for posterity. These measures are expected to ensure the livelihood security of the tribals and provide an opportunity for bioprospecting from these valuable resources.

11. SCOPE OF INTEGRATED FARMING SYSTEMS IN NICOBAR ISLAND

11.1 Status of agriculture

The land use pattern of Nicobar Islands indicates that plantation crops especially coconut occupies 84% of the area under agriculture (Fig. 11.1). In addition, fruit crops such as banana, pineapple and papaya covers an area of about 4% and there was no substantial area under vegetable production in these Islands. Though tuber crops occupies significant place in the tribal society but covers only 1% of area under agriculture (DES, 2011). It is mostly maintained in the interspaces between coconut trees or in its natural state in the forest which are mostly unaccounted. The crops viz., sweet potato, tapioca, greater yam, pine apple, banana, and pandanus are grown in home gardens to a limited extent. Among the livestock pig, goat and back yard poultry forms the important animal wealth of the tribes inhabiting these islands. This is reflected in their food consumption pattern and social activities where these crops along with coconut and pig play an important role. With increasing population and the need to ensure food and nutritional security, it is imperative to evolve a suitable strategy for augmenting production of agri-horticultural crops, livestock and poultry within the limited resources of different islands.

Tribal settlement amidst thick coconut plantations

Scattered organic wastes&
Free ranching of farm animals

Fig. 11.1Nature of different farming system components in Car Nicobar

The remoteness and limitations of market availability for the farm produce should be considered while formulating suitable farm strategies for development. Integrated farming systems (IFS) provide a possible solution to meet the demand for various agricultural commodities at the same time supports the stability of agro-ecosystem existing in the tribal areas. Integration of various agricultural components *viz*., cropping, animal husbandry, fishery, forestry etc. not only supplement the income of the farmers but also help to increase the family labour employment.

11.2 Rationale for Integrated Farming System

In Nicobar group of Islands the productivity of crops and animals is low as compared to the national average. However, in tribal farming system the main focus is on stability and sustainability rather than economic gains alone. Primarily it should provide them with balanced and nutritious diet. The following points justifies the importance of Integrated Farming System in Nicobar Islands,

- The integrated farming system approach introduces a change in the farming techniques for maximum production of appropriate cropping pattern and takes care of optimal utilization of resources of the Island
- The farm wastes of the Islands are better recycled to meet the nutrient requirement of different crops in the integrated system
- A judicious mix of agricultural enterprises like poultry, piggery, etc. suited to the tribal society and Island agro-climatic conditions of the islands would bring prosperity in the farming
- It also help in diversification of farming activity, engage family labour and provide stability in the tribal farming systems

11.3 Advantages of Integrated farming system

The IFS is part of the strategy to ensure sustainable use of the natural resources for the benefit of present and future generations (Preston 1995). The advantages of adoption of IFS in Nicobar Islands are,

- As the land is very limited in supply IFS improves effective utilization of available land and increases the productivity
- It provides diversified products for family consumption, sharing with other members of the tribal society and marketing
- The adoption of IFS improves soil fertility, water infiltration and reduces erosion by appropriate crop rotation and cover crops

- It reduces weeds, insect pests and diseases from appropriate crop rotation
- IFS is the best suitable method to adapt to the climate change and variation impacting the Islands as the stability of the agro-ecosystem is inbuilt in the IFS.
- Nutrient requirements are met by composting of crop residues and livestock wastes. It also provides scope for organic cultivation which are healthy for the tribal way of life
- Higher net returns to land and labour resources of the farm family and provides environmental safety

11.4 Scope of IFS in Nicobar Islands

In Nicobar Islands coconut is the major crop contributing 70 to 80% of farm income, followed by pigs to the extent of 15 to 20%. The fruit and vegetable production is insufficient except for tuber crops to some extent. Other requirements are mainly met by importing from mainland India or from Andaman Islands. The protein requirement of the tribal population is mainly met by animal sources like pig, goat and poultry. The major food crops like rice and wheat are not grown in these islands and the entire quantity comes from the main land and distributed through public distribution system. The market availability is limited for the perishable products as these Islands are located in remote areas. Besides, these tribes are practising a form of shifting cultivation for growing tuber crops with a rotation of 5 to 7 years affecting soil quality. Although all these components are already exist in Nicobar Islands but they lack proper integration with the farm production system. The integration of various agricultural enterprises *viz*., crop, animal husbandry, forestry etc. not only supports the nutritional requirement but also help in increasing the family labour employment especially of tribal women. The soil nutrient requirement is met by composting the organic residues produced on farm, where coconut residues are available in plenty. Farming enterprises such as coconut, crops, pigs, goat, poultry and multipurpose tree species carefully chosen and integrated in a system approach, provide opportunities for greater diversification besides increasing nutritional security and farm income than a single enterprise farming, especially in tribal areas.

11.5 Components in IFS

Crops

The crop activities in the IFS consist of vegetable and fruit crops, plantation crops (coconut, banana, and plantain), root crops (cassava, greater yam, and sweet potato),

SCOPE OF INTEGRATION OF PIG IN IFS

Among the livestock pigs enjoys a special place in the social, cultural and economic status of tribes of Nicobar Islands. Shompens are hunters whereas Nicobarese rear pigs in traditional way (extensive farming system) and feed them daily or alternate days with 2 coconuts per adult pig per day. The coconuts are rich source of energy i.e. fat and carbohydrates but low in protein content. This condition forces the pig to scavenge and sometimes induce them to attack chicks or small animals to meet their protein requirements. The scarcity of locally available feeds hinders intensification of farming system. The scientific interventions like reproductive management, piglet care, hygiene and disease control can be effectively done by intensifying the farming system for having better control on animal. For this purpose following steps could be taken.

(i) Encouraging feeding of coconut by-products

In Nicobar it is estimated that approximately 40% of the total coconut produced are being directly fed to the pigs whereas only 30% are converted to copra and marketed. This practice is incurring huge economic loss. The copra cake or by-product after extraction of virgin oil along with Azolla and other horticultural by-products could be fed to the pigs and the pig manure could be converted into high grade vermicompost which may be applied to the field for increasing the productivity of plantation and other horticultural crops.

(ii) Intercropping in the Plantation

Pigs are very fond of tuber crops, therefore, tuber crops like Tapioca, Colocasia etc. could be intercropped in the existing plantations wherever interspaces are wide. The pigs can be fed with either surplus tubers or the boiled fine chopped leaves along with Azolla and Noni. This may certainly help in saving coconut fed to the pigs and will also provide the required nutrients to the pigs in semi-intensive farming system.

(iii) Cultivation of Azolla

Azolla (*Azolla pinneta*) is a rapidly multiplying floating water fern belonging to the family Azollaceae. In Nicobar it can be cultivated in the backyard condition by creating pit in shady areas with 3m x 2m x 0.2m dimension. The bottom should be covered by gunny bags to avoid root penetration from other trees or plant and the pit should be lined by Tarpaulin sheet over which soil is applied for water retention. Cow or goat dung should be mixed in water and poured in the pit before inoculating with fresh Azolla.



tree crops (M*oringa, Sesbania*) and fodder crops. The selection of crops should be dependent on preferences based on family consumption, soil type, rainfall and type of animals raised.

Livestock

The livestock activities in IFS consist of poultry, pig and small ruminants. The selection of livestock is also dependent on preference based on family consumption, potential market, and availability of resources. Fodder availability particularly during dry season limits the expansion of livestock farming.

11.6 Suitable models for Nicobar Islands

The IFS model for Nicobar Islands should consider their physical isolation and resource availability; it comprises essentially the following subsystems,

- Crop production (Coconut, root crops, fruit trees and vegetables)
- Fodder trees
- Livestock – Pig, poultry and goat
- Compost/vermiculture

The role of each subsystem could be,

i. Coconut: The average holding of coconut trees in Nicobar Islands is 235 per household. With average production of 40 nuts per tree, the total production could be 9000 nuts per year. 20 to 30% of nuts could be used for livestock production especially pig and poultry. The rest is available for sale or for oil production. The residues from the plantation viz. leaves, husk is converted into compost through in situ composting. The waste after oil extraction is available for feeding pigs, poultry and goat.

ii. Fruits and vegetable crops: Considering the limited land availability and dietary requirement, a home garden of 400 m^2 in a fenced area for raising tuber crops, seasonal vegetables and fruit crops (banana, pine apple) could meet the family requirement (Fig. 11.2). The excess production could be used for sale or for feeding pigs.

iii. Permanent/Semi-permanent crop: One or few number of fruit trees – Pandanus, lime, guava, papaya, noni, drum stick and others grown in the homestead garden as boundary planting could be used for home consumption and for sale as fresh fruit/processed or as a pig feed.

iv. Fodder trees: Crops like *Sesbania grandiflora* (agathi), *Leucaena leucocephala* etc. would be a source of feed for livestock and also acts as green leaf manure or used in composting (Fig. 11.3).

Fig. 11.3 Biofence and fodder

v. Poultry: A farm family would maintain a dual purpose flocks such as Vanaraja or local Nicobari fowl under backyard condition. A total of 20-22 birds comprising 5-6 adult layers, 1 adult rooster, 5-6 young pullets and a young rooster and 10 chicks and 1 hen will allow farm family to produce an average of 25-32 eggs per week. The birds can be fed with coconut, morinda and other leguminous leaves. The local hen would be used mainly as brood to set the eggs. 15 to 20 eggs would be set every 3 months to maintain the stock size.

vi. Pig: A farm family would fatten 4-5 pigs per year. The pigs are kept in open ranch system and coconut, root cropa and noni could be used as feed.

vii. Goat – A total of 3 adults (2+1) with minimum of 4 kids could be maintained by a farm family without any additional cost. The green fodder grown as biofence and cassava tubers could be used as feed.

viii. Compost/Vermicompost: This will provide organic manure by effectively utilizing farm wastes

11.7 Homestead based Integrated Farming system model

After tsunami in 2004 the tribal settlements were constructed in groups away from their coconut gardens and coastal areas (*el-panam*). Considering the remoteness, dietary intake, limited land availability and market for the farm produce, a small scale homestead based IFS model (Fig. 11.4) comprising homestead garden (400m^2), backyard poultry (25), goat (2 no's) farming and composting were evaluated on participatory approach in farmers' field at Car Nicobar (Swarnam *et al*. 2015).

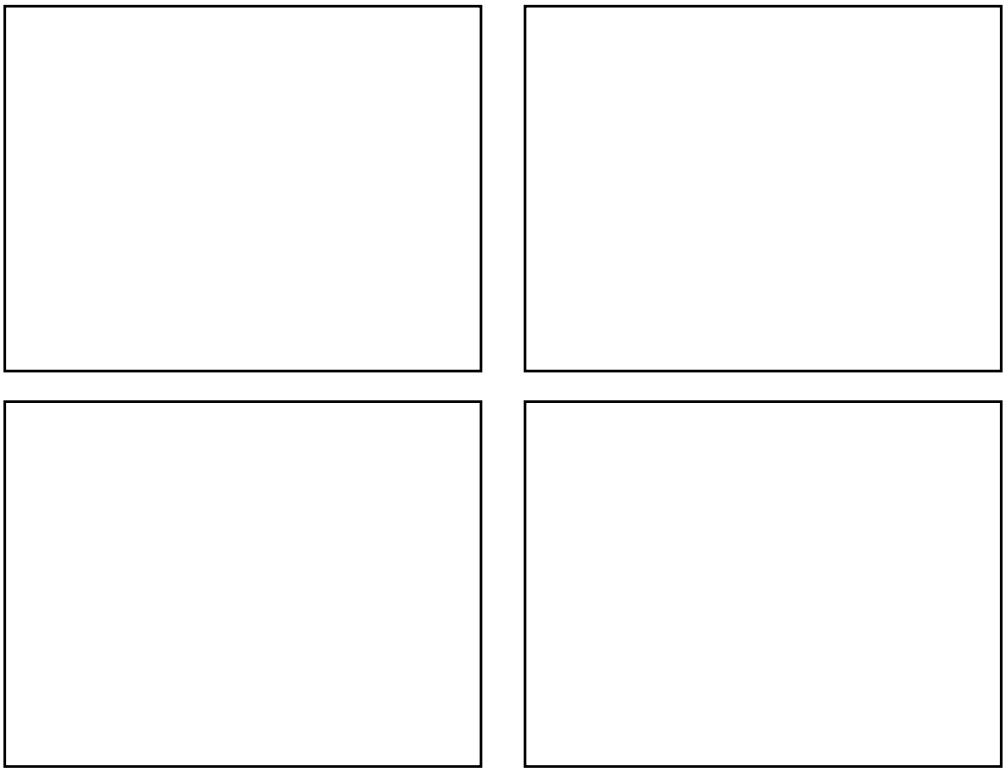


Fig. 11.4. Homestead based IFS model at Kinmai village in Car Nicobar

The model aims at improving nutritional security of the tribal household besides improving the farm production. In the fenced area seasonal vegetables *viz.,* okra, brinjal, tomato, green amaranth, cucumber, bitter gourd and bottle gourd are grown. Besides banana, pine apple and papaya are also grown. *Sesbania grandiflora* (*Agathi*) a multipurpose legume trees can be used as a biofence, green fodder and green leaf manure. The fruit trees like lime, noni (Morinda), pandanus and guava can be integrated in the IFS model.

TUBER CROPS IN INTEGRATED FARMING SYSTEMS

Wider diversity, adaptability, great flexibility in planting and harvesting and rich source of energy makes tuber crops most preferred in tribal farming system to provide food and nutrition security. More particularly cassava, sweet potato and yam can be included in plantation based farming system of Nicobar Islands.

Cassava

In young coconut (*Cocos nucifera* L.) plantations plenty of sunlight, soil and water resources are left out which can be used by intercropping with short duration cassava (H 165 and Sree Jaya). The average crude protein content of the cooked pig feed ranges from 6.5-8.5% which is less than the recommended level (12-18%). Similarly the quantity of dry matter offered to pig per day is much lower than the recommended level. Tapioca is a carbohydrate source which has considerable potential as feed.

Sweet potato

Sweet potato is an insurance crop against natural calamities and has great flexibility in adjusting any cropping system. Retaining sweet potato in rainfed Nicobar Islands is essential to sustain the tribal farming systems. Sweet potato can be intercropped with okra and red gram at the same time it will not significantly affect the yield of coconut. The advantage of less management required for sweet potato cultivation makes it most suitable to provide nutritional security to the tribes of Nicobar Islands.

Yam

Similar to cassava in young and interspaced plantations, yams and aroids can be promoted. Among the yam types, white yam (D. rotundata), lesser yam (D. esculenta) and greater yam (D. alata) are suitable. Like other tuber crops, *Dioscorea* tubers are also rich in carbohydrates which are mainly in form of amylopectin. However, this crop contains high level of tryptophan but deficient in lysine and methionine. The leaves are good source of protein (10.82%) but the level was lower than tapioca and sweet potato leaves which can be used as a feed.

11.8 Impact of IFS on nutritional security

The main aim of any IFS model meant for Nicobar Islands should be aimed at increasing the nutritional security of the tribal household within the limited resources. The interventions carried out in the tribal areas significantly increased the production of vegetables, fruits, tubers, meat and egg. Considering the recommended dietary requirement of ICMR guidelines, the impact of the IFS model on nutritional improvement is given in the table.

Table11.1 Nutritional security achieved through homestead IFS at Car Nicobar

Food item	RDA/ person (g)	Requirement		Production (kg)		Nutritional Security
		Family (5person) (g)	Annual (kg)	Before Intervention	After Intervention	
Cereals*	400	2000	730	-	-	-
Pulses*	80	400	146	-	-	-
Vegetable	150	750	274	-	450	Surplus
Greens	50	250	91	50	100	Surplus
Fruits	100	500	183	150	500	Surplus
Tuber	100	500	183	240	300	Surplus
Meat	50	250	91	200	400*	Surplus
Egg no. (week)	3.5	17.5	910	140	1120	Surplus

* Not produced due to non-suitability of land, met through PDS & import

On an average farmer could produce 450 kg of seasonal vegetables, 100 kg green leafy vegetables to meet their family requirement. Though the tribes grow banana, papaya, pineapple and pandanus from time immemorial, the improved varieties further increased the yield exceeding their family requirement which could be shared among the members of the tuhet. Similarly improved varieties of sweet potato and tapioca resulted in higher yield of the tuber crops. Before intervention, only few birds of local Nicobari fowls were grown by women in their backyard without any management effort and night shelter. After intervention 20 birds of vanaraja are maintained in poultry shed made of locally available materials. The egg production increased to meet the family requirement with some surplus. The goat farming improved the family income and provided employment opportunities to the tribal women. Composting was done by using

organic residues generated within the farm and used for raising the crops. The resource flow model for homestead based IFS are given in Fig. 11.5.

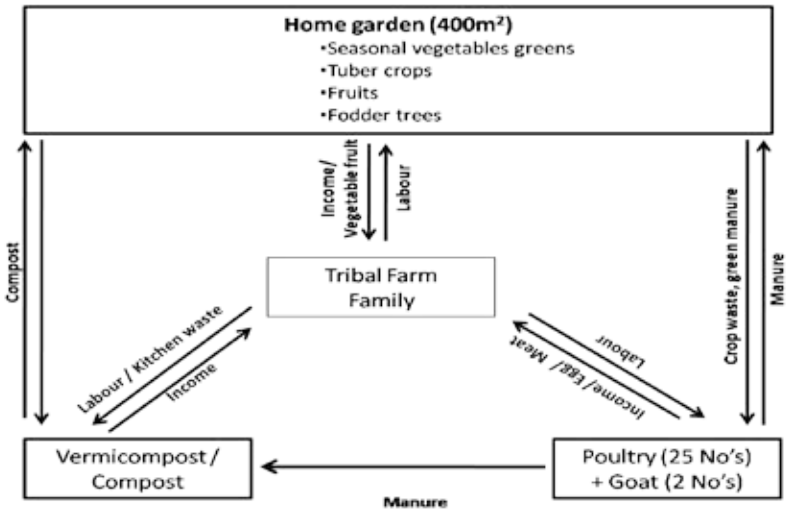


Fig 1. Resource flow model of Integrated farming system

Fig.11.5 Resource flow in Homestead based IFS

The results suggested that homestead based IFS is best to ensure the nutritional security of the tribes rather than going for large scale production units. This model also favours the involvement of women and other member from the tuhet, leading to greater social acceptance.

Conclusions

In order to ensure the success of the IFS model it is very much desirable to have rainwater harvesting structures within the homestead garden.

- Because of limited water availability scarcity is experienced during dry season. Therefore, water harvesting and its efficient utilization will further enhance the effectiveness of the IFS model.
- In Nicobar region resources are not so scarce but due to lack of integration of various components the productivity and stability of the system is very low. IFS undeniably ensures livelihood only if properly integrated into the traditional style of Nicobar region
- The integration of suitable components will help to achieve stability, nutritional security in addition to economic return from the tribal farming system
- It is proved world over that IFS is the best suited agricultural system in the changing climatic scenarios and needs of the people

12. STRENGTHENING TRIBAL FARMING THROUGH ORGANIC PRACTICES AND VALUE ADDITION

12.1 Introduction

Organic production system is not new to India and Nicobar islands which has been in practice since ancient time. But, the level of production achieved through organic practices is not comparable with the organic production elsewhere practiced in the world. Though tribes of Nicobar are known to use only organic inputs in low input plantation based agriculture but the adoption of modern organic practices are still at its primitive stage. Similarly tribes produce several semi-finished and finished agricultural products through post-harvest processing and add value to it. The level of technology adoption is at infant stage and the quality standards are inferior to same products produced in the mainland India. Therefore, there are large scope for improving the production and quality of products of tribal farming through adoption of organic farming practices and post-harvest processing methods.

12.2 Organic farming

Growing awareness of health and environmental issues associated with the intensive use of chemical inputs has led to interest in alternate forms of agriculture in the world. Organic agriculture is one among the broad spectrum of production methods that are supportive of the environment and healthy products which are suited for the tribal areas. FAO (1999) suggested the use of management practices in preference to the use of off-farm inputs because regional conditions require locally adapted systems. This is accomplished by using, where possible, agronomic, biological and mechanical methods, as opposed to using synthetic materials, to fulfill any specific function within the system. In the tribal areas agrochemicals use for increasing production is not economically and ecologically viable option. Therefore, it is imperative to optimize the use of locally available resources particularly at farm level and maintain the balance between production system and environment by using organic inputs.

Potential

The soils of these Islands are generally acidic in nature, medium to high in organic carbon content (0.7 to 1.8 per cent) and available nitrogen. The island is free from several pest and diseases which are prevalent in mainland India. In these islands plantations and spices such as coconut, pepper, cinnamon, clove, banana etc. are grown organically and supplied to the

local consumption market without certification. Only organic inputs in low quantities are used in Nicobar Island therefore, it can be classified as organic by default though their significance and extent has been rather under estimated. In India, three priority zones (category-I, II and III) are recognized for the promotion of organic farming by Government of India. Andaman and Nicobar Islands comes under category – I which is the top priority areas for promotion of organic farming in the rainfed areas for potential crops where fertiliser and agro-chemical consumption is already very low. These conditions favour conversion of existing production system especially plantation into organic as these islands are highly favourable for organic production. In addition significant area of marginal and degraded land can be reclaimed and brought under organic cultivation as the cultivated land is diminishing. Besides, poultry, pig and cattle can be integrated with the crop components which provide scope for efficient resource recycling and stability to farm income.

However, despite repeated efforts to improve the yield of crops the productivity of most of the crops in the island is low mainly due to lack of awareness, non-adoption of production technology, inefficient organic waste recycling and inadequate supply of essential nutrients. Thus by providing organic production technologies for nutrient, plant protection, post harvest operations and other cultural practices the productivity can be significantly increased. The expanding tourism sector of this island has huge potential to support organic products while its proximity to the South-East Asian countries can be an advantage to export organic products. If the potential of production system and market demand is properly linked with adequate policy support the organic farming has greater potential to grow in this Island.

Technological gap

Based on 160 field experiments, the average yields of all crops grown organically were only 9% lower than those grown conventionally. A compilation of data from different experiments conducted in these Islands indicates that the productivity in organic farming is 10-40% lower than the conventional farming and 5-15% lower than the organic farming under experimental conditions. On marginal soils, in less favourable climatic conditions and under permanent or temporary water stress conditions of these Islands, generally, subsistence or low input agriculture is practiced wherein organic agriculture can at the best enhance food productivity while it improves the soil condition. However, organic techniques are still poorly developed for some areas of crop and livestock production suitable for these islands. Therefore proper technology has to be developed or modified to suit the existing conditions.

Technologies for organic farming

The key characteristics of organic farming technology suitable for the Island conditions should include the followings;

- Protect the long term fertility of soils by maintaining organic matter levels, encouraging soil biological activity, and careful mechanical intervention;
- Nitrogen self-sufficiency through the use of legumes and biological nitrogen fixation, as well as effective recycling of organic materials;
- Provide crop nutrients from relatively insoluble nutrient sources by the magnified action of native soil micro-organisms;
- Weed, disease and pest control should primarily rely on crop rotations, natural predators, diversity, organic manuring, resistant varieties;
- Pay full regard to livestock evolutionary adaptations, behavioural needs and animal welfare issues

Initiation of organic production

In organic farming system, certain minimum requirements are to be met to fulfill its objectives. Then only the farm is certified as organic. The organic production suitable for the island conditions involves two steps, conversion and integration.

i) Conversion:

At first the farm has to be converted into organic farming system from conventional system which is known as conversion. The farmers should have a conversion plan prepared if the entire field is not converted into organic at a time. In the long run the entire form including livestock should be converted into organic. Generally, the conversion period is two years for annual crops and three years for perennial crops. However, the conversion period can be relaxed based on the verification by certification agency if the requirements are fully met. During conversion, steps should be taken to maintain bio-diversity, viz. swamps, grass lands, forests, etc.

ii) Mixed / integrated farming:

Animal husbandry, poultry, fisheries, etc. should be suitably integrated or practised in addition to crop husbandry for better resource use and recycling in organic farming. 8-10 layers, 3-4 pigs and 2 dairy animals can also be maintained in the organic integrated farming in one ha of land. In a predominantly coconut based farming system cultivation of three or more crops having different morphological characteristics so as to intercept

solar radiation at different levels and exploit different soil zones called multistoried cropping system can be implemented. The given fertilizer requirement can be met through organic means through effective recycling of the plantation and other plant and animal wastes within the garden.

Mixed/inter cropping in arecanut plantation has ample scope. Approximately 60 per cent of the light is intercepted by an adult areca palm. By growing intercrop, the level of light interception could be increased to about 95 per cent. Intercropping also leads to increased availability of organic matter for recycling. In addition, the interspaces of plantation crops can be effectively used for growing vegetables and legumes to augment the production. It favours biomass production which can be mixed with animal waste for efficient recycling and supply of nutrients to plantation crops (Gangwar, 1987).

12.3 Post-harvest processing and value addition

In integrated farming or improved tribal farming system round the year agricultural products are expected that can be properly utilized through optimum processing technique for getting value added products. However, in Nicobar Islands agricultural products are prone to attack by many microbial organisms like bacteria, fungi and mold due to long monsoon season and typical agro-climate, (temperature of 30-33°C and relative humidity of 85-90%) coupled with inadequate drying and storage facilities causing losses in quality and quantity to the valuable produces. Improved marketing, enhanced nutritional and economic value of perishable products can be achieved through processing from low grade raw commodity to more nutritive food items which are described below.

Coconut

Coconut is the prime agricultural produce for tribal farmers of Nicobar Islands. Coconut is usually bigger with thicker kernel and husk. Fresh coconuts are filled with the goodness of coconut water and are high in proteins and energy. Using copra dryer of both electrical and biomass type, good quality copra can be obtained. Production of virgin coconut oil can be obtained from dried copra cultivated organically. This will fetch better prices in the domestic market. Production of desiccated coconut for use in the preparation of sweets, confectionery and curry preparation is another valuable product. Coconut shell powder that is used for making thermostat, handicrafts items, toys and bowls can be produced in Nicobar Islands which are not related to the copra quality. Coconut husk can be used for extracting fibre, making of coir, pith and chips.

Coir is primarily in demand for producing mats and pith and chips for its hydro superior absorbent capacity making coconut husks an excellent medium for growth of plants.

Spices

Among the spices, cinnamon, nutmeg, clove and black pepper can be cultivated as intercrop by utilizing the spaces between coconut and arecanut trees. Despite of congenial environment for cultivation and production of spices, the Island has not been able to push its product to the export market mainly due to the use of traditional sun drying method which is not promising. Recent advances in product diversification have necessitated harvesting of the produce at different stages of maturity to meet specific needs of the end product. Hence, in order to promote post-harvest processing of spices, drying by means of mechanical dryers with the controlled processing condition, and packaging facilities will be essential for the production of better quality spice products. After harvest, mainly women can take part in picking/harvesting, grading, drying, peeling and packaging. Once, the safe moisture content (7-8 %) is reached, the product has to be packed through LDPE/HDPE/PP type packaging material for long storage life and adding value to the end products. Then, the product may be directly sold to the market as the source of revenue generation.

Tuber crops

Tropical root and tuber crops (cassava, sweet potato, yam and colocasia) are both important household food security and income generating crops. The root should be washed, cut into chips and dried properly from initial moisture content of 55-58% (w.b) to 6-7% (w.b) under sun or using mechanical dryer. In general the physiological deterioration begins 3-5 days after harvest therefore the produce should be dried at the earliest. The dried chips could be directly packed in polypropylene sacks and marketed to animal feed concentrate company or livestock producer. The dried cassava chips as a source of carbohydrate can be incorporated into the feed rations along with the traditional carbohydrate feeds like maize and sorghum etc. have much longer shelf life. After washing sweet potato and potato can be directly sold to the market or through proper processing fermented starch, modified starch can be produced that are used in wine industry. The crop residues can be used a source of plant nutrient through vermicomposting.

Conclusions

The area available for cultivation in these islands is limited and no scope for its expansion as a result judicious use of existing land and remediation of degraded coastal

land through organic farming practices are viable alternate strategy for its development. These Islands are rich in biodiversity and the agro-climatic conditions are very much congenial for the organic cultivation of crops which are in high demand in international markets.

There is a huge potential for organic farming however the success will largely depend on the capacity of the production system to meet the crop input demand. There is a greater scope for post-harvest processing and value addition of organically grown coconut, tubers and spices for which the Nicobar Islands are very much suitable. There are also many other areas of processing aspects which should be given priority. Once the processing, farmer and industry link is established many other outlets and avenues are possible which would lead to enhancing livelihood security of the tribes at large. Therefore, it is economically and ecologically feasible to practice organic farming in the Island with the reduced cost of cultivation and enhancing the value of outputs. At the same time farmers should be given access to attractive markets through value added and certified products which will enable the farmers to get premium price for their produce.

13. CLIMATE CHANGE AND VULNERABILITY OF NICOBAR ISLANDS

In contemporary era when science and technology have touched new heights, the aborigines of Nicobar Islands are at the lowest level of techno-economic existence. Such a situation is represented by the Shompens and Nicobarese particularly the plight of the former is very precarious. As a member of mainstream population and current material culture, we understand at least the meaning of climate change but do these tribes know or aware of it? As a hunter and gatherer, what way the Shompen life and food sources are going to be affected?

Interaction with both these tribes revealed that they do understand seasons, their life style and farming is in concurrence with the climate of the islands. Nicobarese used to sail from one island to another as they could read the wind and waves of that time; they go out for fishing with clear understanding of low and high tides; they practise farming and maintain livestock as they are well aware of the rainfall pattern. By seeing the heaped dark clouds (cumulonimbus) a Nicobari elder could forecast the arrival of rain. They also aware that calm humid weather followed by cool wind or halo around the moon will bring long rainy days.

But how this knowledge is passed on to the next generation? Do they realise the changes in climatic pattern? If so, all these years how they have been adjusting? The in-depth analysis of climate change and variations shows that these aborigines are the most vulnerable people in the tropical region not because of lack of knowledge but due to limited adaptive capacity. A continued dry spell of more than 25 days may affect their pig population and a severe cyclonic storm may destroy their plantations. Sea level rise with the lowest conservative value can submerge the coastal area and salinize their water resources. In this context, understanding of climate change and its variations over these islands are very important to take suitable adaptive / remedial measures.

Climate change and variability have emerged as major concerns of humankind because of the observed changes in surface temperature, rainfall, evaporation and extreme events since the beginning of the 20thcentury, though the climate of our earth had never been static. In this context, climate change has been receiving more attention of scientist, policy makers and common man with different perception. The term climate change means “any significant change in the statistical distribution of weather patterns over periods ranging from decades to millions of years”. It may be a change in average

weather conditions or the distribution of events around that average. Climate change may be limited to a specific region or may occur across the whole Earth. If the weather parameters show year-to-year variations or cyclic trend, it is known as climate variability (IPCC, 2001). It is a matter of concern for Nicobar Islands because the perceived global level changes in climatic parameters and its associated sea level rise greatly affects these islands and the tribes in various aspects.

13.1 Nature and magnitude of climate change

It is now well established that the atmospheric concentration of carbon dioxide has increased from about 280 parts per million by volume (ppm_v) to about 369 ppm_v and the global temperature of the earth has increased by about 0.6°C. The global mean sea level has risen by 10 to 20 cm. The average global surface temperature is projected to increase by 1.4 – 3°C from 1990 to 2100 for low-emission scenarios and 2.5 – 5.8°C for higher emission scenarios of greenhouse gases (under the new SRES 'Marker' scenarios) in the atmosphere. The projected temperature rise will lead to thermal expansion of the oceans and melting of glaciers and polar ice sheets resulting in the rise of mean sea level. Over the same period, the associated rise in global mean sea level is projected between 9 and 88 cm over the next century. This will have serious consequences throughout the world particularly in small islands where the magnitude of impact will be very high.

Observational evidence also suggests that much of the variability in the rainfall record of Caribbean and Pacific islands appears to be closely related to the onset of El Niño-Southern Oscillation (ENSO). El Niño events which cause drought situations in some parts of the Pacific (e.g. Papua New Guinea, Marshall Islands, Samoa, Fiji, Tonga and Kiribati), may also affect the tropical island regions (Lal *et al*. 2009). However, part of the variability in these areas may also be attributable to the influence of the Inter-Tropical Convergence Zone (ITCZ). Such effects also observed in Nicobar Islands as it is located in the equatorial belt. It is acknowledged however, that for some small islands it is difficult to establish clear trends of sea-level change because of limitations of observational data, especially geodetic-controlled tide gauge records.

In Nicobar Islands the major portion of rainfall (1133 mm) is received during the monsoon period beginning from mid of May to September followed by post monsoon and pre-monsoon periods (849 mm). Similar trend is observed for number of rainy days which is calculated as number of days in which rainfall exceeded more than 1 mm in a day (Fig. 13.1). The trend from the past 60 years of rainfall data indicated that the rainfall is decreasing with latitude in winter and post-monsoon seasons, while increases during

monsoon season. But there is no uniform trend in case of pre-monsoon rainfall. The distribution of rainfall is more important particularly for agricultural activities because long dry spell would result in crop failure and droughts. Under such conditions the food security of the tribes is at great risk. Though Nicobar Islands receive rainfall in more than 127 days in a year but the recent trend indicated that the number of rainy days during the monsoon season is decreasing. In addition, analysis of the historical climatic data indicated variation in number of rainy days and dry spell over these islands (Srivastava and Ambast, 2009). Any drastic increase in length of dry spell will reduce the fresh water availability and soil moisture, consequently the productivity of coconut, the main plantation crop of Nicobar Islands will get reduced. This will have great impact on the economic wellbeing of Nicobari tribes. In addition, this will also affect the survival of wild pig and other animals on which the Shompens are dependent to meet their food requirements.

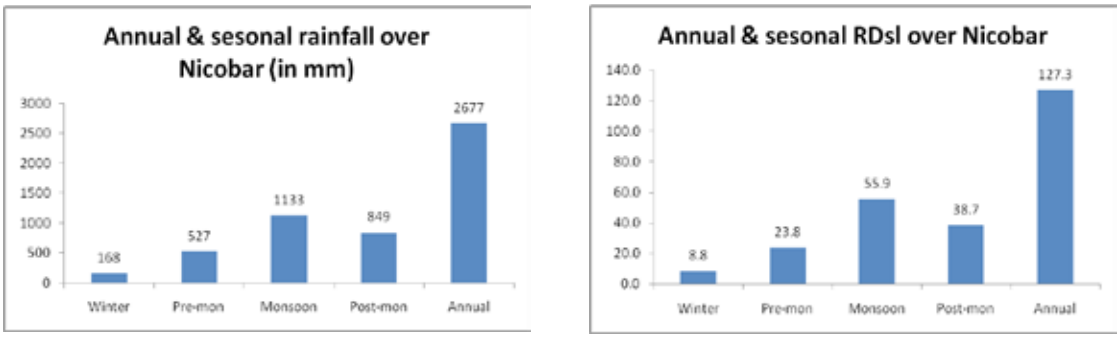


Fig. 13.1 Annual and seasonal rainfall and rainy days of Nicobar Islands (Source: IMD)

13.2 Effect of climate change on islands

Small islands are among the most vulnerable to sea level rise and climate change (Mimura, 1999) which are very much pertinent to Nicobar Islands. Due to global warming and sea level rise, many coastal systems can experience increased levels of inundation and storm flooding, accelerated coastal erosion, seawater intrusion into groundwater and encroachment of tidal waters into estuaries and river systems (IPCC, 2007). The predicted changes in climatic parameters for the future are given in Fig. 13.2 and 13.3. With warmer temperatures, evapo-transpiration rates would raise, which would call for much greater efficiency of water use. Besides, land cover changes effected by human activities in the coastal areas will make agriculture more vulnerable due to salinization and erosion.

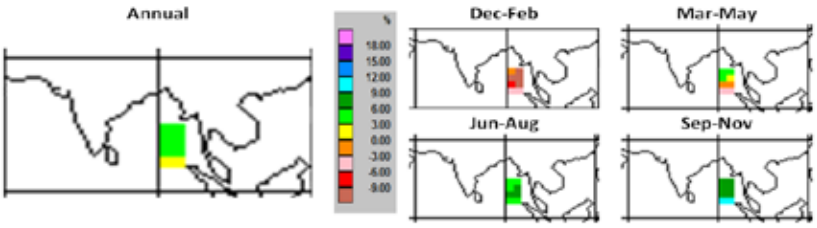


Fig. 13.2. Projected change in rainfall (%) in Andaman and Nicobar in 2025 (MAGICC/SCENGEN model)

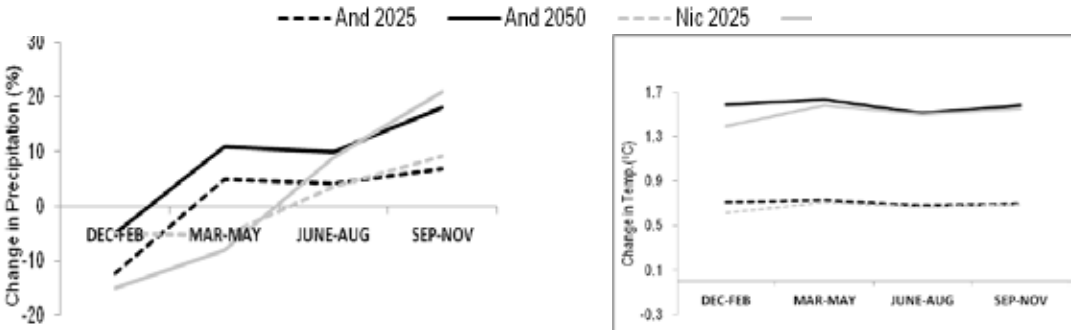


Fig. 13.3 Change in precipitation (%) and temperature (°C) in Andaman and Nicobar during 2025 and 2050 as projected by MAGICC/SCENGEN software

By mid-century, climate change is expected to reduce water resources in many small islands to the point where they become insufficient to meet the demand during low-rainfall periods (IPCC, 2007). These changes in climate would also affect the soil moisture, groundwater recharge, frequency of flood or drought episodes, crop, animal and human beings in India and so in Andaman and Nicobar Islands. The effect of climate change on crop, livestock, soil, water resources and the way in which different crops are grown are most critical aspects of agro-ecosystem vulnerable to such perceived changes. Sea level rise may lead to submergence of low lying coastal areas in addition to changes in coastal and marine biodiversity.

The direct impact of sea level rise is that it threatens the area available for farming which would be more pronounced for Nicobar group of islands (Fig. 13.4) because of its smaller size and predominantly flat topography. It was seen from the Indian Ocean Tsunami of 2004 that nearly 5600 ha of cultivated land in this group of islands was damaged critically affecting the livelihood of the tribes.

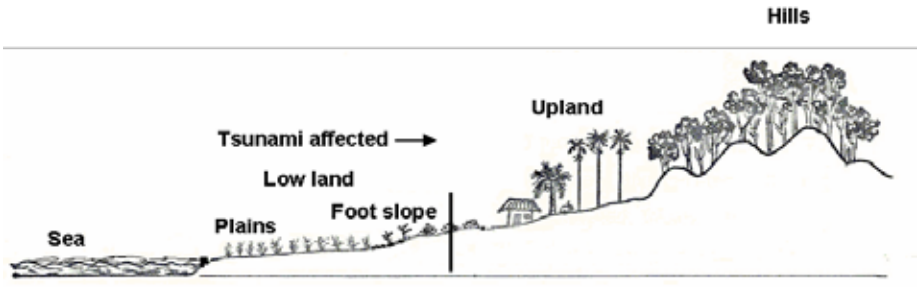
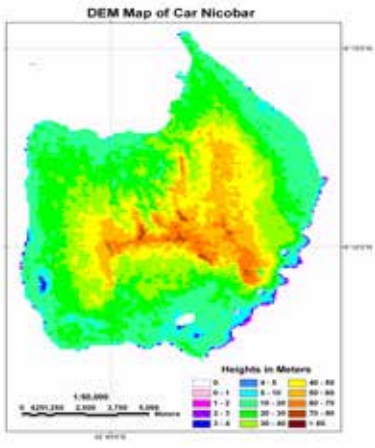


Fig. 13.4 Cross sectional view of a typical Island

Climate change and global warming also affect the abundance, spawning and availability of commercially important marine fisheries (Krishnakumar *et al.* 2007). Increase in sea surface temperature also adversely affects coral and coral associated flora (sea grass and seaweed) and fauna. In addition, sea level rise associated with global climate change produces greater wave attack and flooding leading to greater erosion and amplified impact of storm (Patwardhan, 2006). Collectively these changes are posing a serious threat to the livelihood of coastal communities.

13.3 Vulnerability of Nicobar Islands



The inundation of coastal land area by the surging of sea water by different natural phenomena is favoured by its elevation from the mean sea level. Most of the coconut plantations in Nicobar Islands are located within 40 m of MSL. The Digital Elevation Model (DEM) of Nicobar Islands (Fig. 13.5) indicates that about 70% and 93% of the total land area in Car Nicobar and Great Nicobar respectively have an elevation more than 20 m above MSL. In contrast, Trinket and Chowra Islands have 15% of the total land area with an elevation ranging from 0 to 10 m of MSL (Fig. 13.6). In general, only the central portions of the different islands have more than 20 m elevation surrounded by flat land. Mountain range of considerable length and height is present only in Great Nicobar Island. Locations with more than 40 m are not directly affected by sea level rise particularly by the physical action of the waves. Consequently variations in vulnerability of these islands to sea level rise are observed. Because of smaller size and flat topography most of the islands in central group are subjected to sea water inundation even during high tide occurring daily.

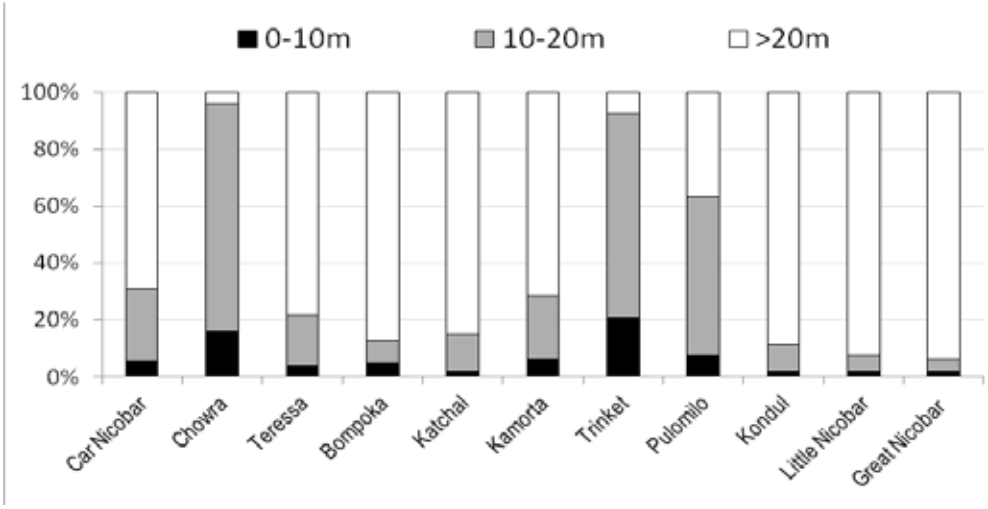


Fig. 13.6. Area (%) under different elevation in Nicobar

Fig. 13.7 Ring well in the coastal areas of Car Nicobar

In Nicobar Islands surface water is naturally replenished by precipitation and lost through discharge to the oceans, evaporation, evapo-transpiration and sub-surface seepage. Although the only natural input to surface water system is precipitation, the total quantity of water in that system at any given time is dependent on storage capacity in lakes, wet lands and artificial reservoirs, permeability of the soil beneath these storage bodies, runoff characteristics of the land, timing of the precipitation and local evaporation rates. All of these factors also affect the proportion of water lost. In these Islands only a fraction of the total annual precipitation is stored in surface structures and shallow aquifers which are tapped in the shallow ring wells (Fig. 13.7). Only a very few bore wells / open wells are under use which are dependent on rainfall and its distribution pattern and they are the only source of fresh water for many purposes including life saving irrigation during dry season

As discussed earlier, only rainfed agriculture is practised in Nicobar Islands. Irrigation through canals and river is not possible due to climatic and physiographical limitations. Hence, utilization of stream water by constructing small check dam or direct flow into the field has been practiced to a limited extend. Though there is limited scope for construction of check dams / minor dams in the narrow river valleys of Great Nicobar but the Shompens are not practicing any crop cultivation. Aquaculture is a small but

growing activity; freshwater commercial fisheries may also be considered as agricultural uses of water, but have generally been assigned a lower priority than irrigation. All of the livestock either in a semi feral system or free ranching depends on rainwater for drinking. Household uses (8% of water use) include drinking water, bathing, cooking, sanitation, and gardening. Drinking water is water that is of sufficiently high quality so that it can be consumed or used without risk of immediate or long term harm. Such water is commonly called potable water. The presently existing small hydrological reservoirs are mostly catering to the needs of drinking water, which depends on the monsoon.

13.4 Effect of climate change on natural resources of Nicobar Islands

Precipitation and temperature pattern

The analysis of the historical rainfall data of Andaman and Nicobar Islands indicated no significant change in the average decadal rainfall but the rainfall pattern has changed with increase in number of extreme rainfall events. The projected changes in mean temperature and precipitation for Nicobar region assessed based on the recent GCMs using the MAGICC/SCENGEN software indicated that the rainfall pattern is all set to change significantly during different seasons and the pattern of change in Nicobar would be different from Andaman. However, the mean temperature is expected to follow a similar pattern in both the group of islands.

The average monthly sea surface temperature (SST) derived from different locations around the Nicobar Islands for 2010 was higher than the corresponding monthly average SST for each of the three different decadal averages, during January to July. During April to July, the increase was higher (0.75-1.25^{o}C) than the rest of the months. This anomalous increase in SST in Andaman during 2010 had resulted in mass bleaching of corals (Krishnan *et al.* 2010). Similar anomalous SST events and subsequent coral bleaching were recorded in 1998 (Arthur, 2000), 2002 and 2005 (Krishnan *et al.* 2010). As the SST has direct correlation with the intensity of cyclones, there is greater likelihood of frequent and more intense cyclones in the region in the near future. There is an evidence of a 5-10% increase in intensity (wind speed) which would contribute to enhanced storm surges and coastal flooding (IPCC 2001).

Inundation by sea water

The elevation (DEM) taken together with the population density in different islands (Fig. 13.8**)** of Nicobar group indicated that Chowra is the most densely populated island which has a vast expanse of its land area with low elevation. As a result it is more

vulnerable to sea level rise associated with climate change. Nicobar group of islands have suffered extensive loss of infrastructure and human life during the devastating Indian Ocean *Tsunami* in 2004, which demonstrated the vulnerability of these islands to sea level rise. The effect of storm surge can be presumed from the effect of tsunami with lesser magnitude on the coastal areas. The maximum storm surge disaster for the islands under the worst hypothetical scenario involving the super cyclone with maximum wind speed of 80m s^{-1} has been determined as 3.7 m (Kumar *et al.* 2008) with distance of penetration ranging from 50 to 1000 m under neap tide conditions (Ramamurthy *et al.* 2005).

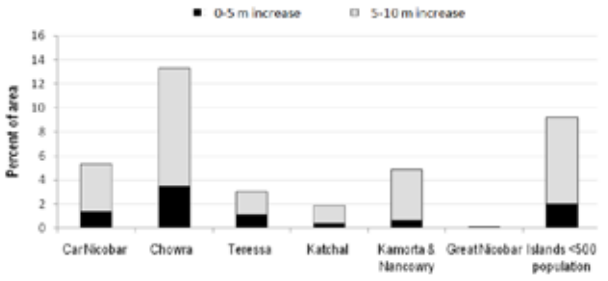


Fig.7. Percent area affected by 0-5 and 5-10m increase in sea level of Nicobar group of islands

Fig. 13.8. Estimated low lying area affected by sea inundation

The factor that contribute to the extent of vertical run-up of sea water during sea surges depend on earthquake, geographical location, velocity of waves and frequency, near shore bathymetry, beach profile, land topography, subsidence due to earthquake and path of coastal settlement. As per the tsunami run-up sub-sector database for Indian Ocean during 1750-2007, seven tsunamis have been reported in Indian region and the extent of run-up recorded was 0.76 m in Car Nicobar during 1881 (Rai and Murty, 2005). Further, massive earthquakes also result in alteration of island topography leading to subduction of the islands. The extent of area that will be affected with 0-5 and 5-10 m increase in sea level rise was estimated and it was observed maximum (13.34%) loss of land will be in Chowra due to 5-10 m rise, where as 5% of island will be inundated with 0-10 m increase in sea level.

Water resources

Nicobar Islands receive an average annual rainfall of more than 3000 mm of which maximum rainfall is received during southwest monsoon season. The relative humidity (RH) varies from 68 to 86% and the annual average maximum and minimum temperature is 32 and 22°C respectively. In spite of its location in the high rainfall zone the Island

suffers from moisture stress and poor crop harvest due to the erratic nature of rainfall and the intermittent dry spells during the monsoon. A surplus of about 1530 mm rainwater from mid-May to mid-December and a deficit of about 610 mm are experienced during January-April. Nearly 75 % of the rainfall received in the islands is lost due to undulated terrains, steep slopes, porous soil stratum and its proximity to the sea. Therefore, the water resources and its use in the present and future would be strongly influenced by the pattern of rainfall and other climatic variables.

Based on rainfall and population growth pattern it is reported that the per capita water availability in Nicobar Islands is very high (57,970 m^3/year) for the present (2010-11) and it is projected to decrease to 22,380 m^3/year in 2051, which is very high considering the national average per capita water availability only 1700 m^3 (less than 1700 m^3 and 1000 m^3 are termed as water stress and water scarce conditions). But, the amount of water available for harvesting is far below the available potential due to topography, forest land cover, high intensity of rainfall and other social reasons.

Variation in seasonal rainfall and its distribution are considered as an indicator to examine climate variability/change in the context of global warming. The study of climatic pattern highlighted decreasing trend in rainfall and rainy days over the Islands in winter and post-monsoon seasons (Fig. 13.9).

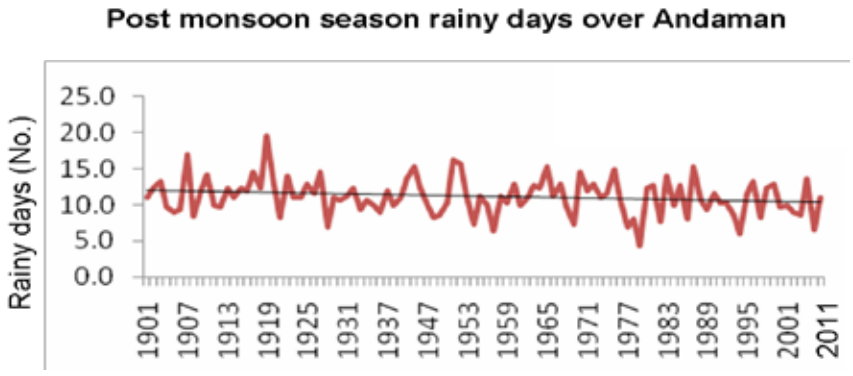


Fig. 13.9 Trend in rainy days over Andaman and Nicobar Islands

It also decreases with latitude, for example Kondul Island, which is at southern latitude, gets the highest rainfall and on the other side, Maya Bandar, which is at northern latitude gets the lowest rainfall during these seasons. In 124 years, probability of occurrence of drought was found to be maximum in west Rajasthan (25%) followed by Saurashtra and Kutch (23%), however, surprisingly even for A&N Islands it is estimated to be 13% (Sinha Ray and She Wale, 2001).

13.5 Vulnerability of tribal farming

In the previous section it has been discussed that the Nicobarese derive their livelihood from agriculture and allied sectors though they practice at subsistence level. Agriculture is one of the most vulnerable sectors of the economy to the projected global climate change. It is also argued that locally adapted, climate resilient crop varieties with diverse crop combination is ideal for such conditions. In this context, it is essential to document and evaluate the land races / local cultivar / wild relatives scientifically so as to work out a proper combinations or crop rotations. In Shompen areas the wild relatives / land races should be conserved in its natural state for present use and future benefits. Although an increase in carbon dioxide levels could moderately increase the temperature which may result in an increase in crop yields, through carbon fertilization, the increased frequency of crop losses due to extreme events may overcome any such benefits of moderate temperature increases (Easterling *et al.* 2007).

Crop production

Plantations (coconut and arecanut) are the major crops of the Nicobar group of Islands followed by root crops and fruits. Though Nicobar Islands accounts for over 60% of the total area of the union territory under plantation crops, its contribution to total production of plantation crops is just 32%, which reveals the wide gap between the production and potential. A critical look at the genetic potential, distribution and management of coconut in the tribal areas will provide some explanation for this. In the Nicobar Islands, coconut is naturally distributed, with a lot of genetic variation but not necessarily it is cultivated or scientifically managed. All the inhabitants of these islands entirely depend on external sources for their daily ration of cereals, pulses and oilseeds. In the absence of significant local production of these commodities, this dependency makes them more vulnerable. The warming trend and length of dry spell in recent years could reduce the yields of major food staples and consequently this will require shifts to new varieties that are more heat tolerant and have a higher temperature optimum for photosynthesis. Due to the absence of assured water supply and irrigation facilities in Nicobar Islands, it would not be possible to grow all kind of summer vegetable or fruit crops. Therefore, any new varieties indented for Nicobar Islands should fit into the socio-economic aspects of the local population. In addition sea water inundation and water logging of coastal areas may be detrimental to coconut and other food crops which form part of the daily dietary requirements of tribes.

Soils and fertility

The soils of Nicobar group of islands are fine to medium in texture, slightly acidic in nature (pH 5.87±0.7) due to the leaching of soluble cations and have low soluble salts (EC 0.3±0.2 dS/m). The soil fertility of these islands shows that these soils are generally low to medium in available N (291.4±44.9 kg/ha), high in organic carbon (1.8±0.7%) and low in available K (118.9±19.3 kg/ha) which implies that climate change-induced increase in rain fall or seawater ingression would lead to erosion, leaching of salts and salinization of coastal lands thus rendering the soil unproductive for agriculture. As per the standard evaluation criteria it was found that only about 2% of the area was highly suitable for coconut cultivation while 56% was moderately suitable and 35% marginally suitable. Hence, any natural calamity or anthropogenic activity which destroys the coastal vegetation protecting the coastline and acting as a biofence will lead to degradation. In long run, due to disturbance and modification of coastal land surface, the coastal plantation may be wiped out and areas close to the coast become unproductive which will seriously undermine the livelihood of the tribes residing in these Islands. It was estimated that the predicted climate change events affect about 20% of the geographical area of Car Nicobar is high to very high vulnerability to climate change (Fig. 13.10). For example, the pandanus and some fodder grasses thrive in the littoral and adjoining areas may also get affected. Consequently the food resources of the tribals will start diminishing.

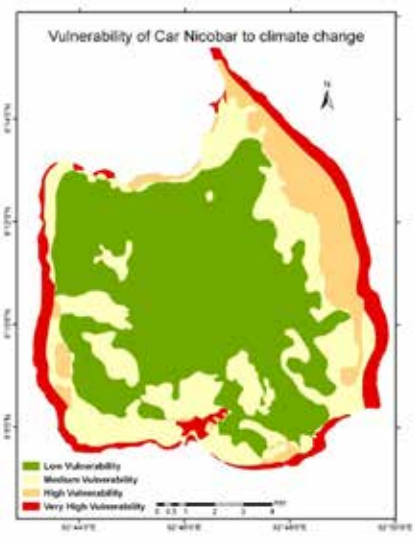


Fig. 13.10. Predicted vulnerability of Car Nicobar to climate change

Livestock

The major livestock reared by the tribes in Nicobar group of Islands are pig, goat and poultry; farming of dairy cattle is limited to Great Nicobar but by the non-tribals. The Nicobarese rear both goat and pig under free range resource driven production system, mainly depending on the coconut and locally available feed/fodder resources. Loss of land and coconut plantation during the 2004 tsunami significantly affected the existing production system. Climate change could affect the availability of feed resources by changing the land use pattern, production system, decreased productivity of crops due to biotic and abiotic stresses and limited availability of natural resources especially water (Singh *et al.* 2010). Moderate increase in temperature would also impact the health of livestock due to prevalence of more conducive environment for the pathogens thus resulting in possible outbreak of diseases and loss of germplasm. In this context it is to be noted that outbreak of foot and mouth disease (FMD) in cattle and incidence of swine fever in pigs were reported from Nicobar in the post-*tsunami* period (Jaisunder *et al.,* 2008).

Fishery

The southeast coast of the Great Nicobar Island is particularly more vulnerable to sea level rise and associated sea surges, which would affect the marine life in general and giant leatherback turtle in particular. The fishery in Nicobar Islands is entirely capture-based. Though 14% of the active fishers and fishing crafts of the Union Territory are in the Nicobar group of Islands, they contribute just 2% of the total catch. The poor catch could be attributed to inappropriate craft and gear, dislocation from coast in the post-*tsunami* period, lack of motivation among the local tribes to expand their fishing operation and the inherent fear among them to explore new fishing grounds in deeper waters. The possible effects of climate associated changes like wind direction and velocity, tidal surges, etc would further adversely impact the fishing capabilities of the tribal fishers. This in all probability will result in low fish catch thereby it affects the livelihood of farmers until otherwise skills are imparted and proper material and technological supports are provided to them.

Conclusions

The most significant and immediate consequences of climate change on islands / small island states are likely to be related to changes in sea levels, rainfall regimes, soil moisture budgets, prevailing winds (speed and direction) and short-term variations in

regional and local patterns of wave action. The majority of socio-economic activities, infrastructure and the population of Nicobar Islands are likely to be highly vulnerable to the impacts of climate change and sea-level rise owing to their flat topography and limited space for retreat. Therefore, proper analysis and understanding of the global and regional level change in climate and weather pattern is very essential. In view of the looming detrimental effects of climate change to Nicobar Islands, the vulnerability of land, crop, animal and water resources has to be assessed and the key risks factors should be identified. This should lead to prioritization of adaptation responses in these Islands. In addition the efficacy of various adaptation strategies or coping mechanisms that may reduce vulnerability of the regional water resources should be evaluated for immediate adoption. The level of understanding of the problems and required skills to cope with the changing situations should be imparted to tribes through suitable capacity building programmes.

14. STRATEGIES FOR ENHANCING LIVELIHOOD SECURITY OF TRIBES

In Nicobar Islands coconut followed by arecanut, oil palm and rubber are the major plantation crops occupying major area under agriculture in Nicobar Islands. The tribals also grow tubers, fruits and vegetables either as intercrops in the interspaces of coconut garden or in the backyard conditions without proper spacing. Due to various constraints the soils are only moderately suitable for plantation crops with low nutrient supplying capacity. The Nicobarese not yet learned manuring the crops but they leave the crop residues on the soil for natural decomposition. On the other hand the Shompens are gatherers and maintains only few selected crops in its natural habitat. Though these islands receive more than 300 cm rainfall annually, water deficit during dry season is a major problem due to high evapo-transpiration, seepage, gravitational flow and poor ground water storage requiring supplemental irrigation for successful crop production. This results in low crop productivity as compared to the national average. With increasing population, changing needs of the people, climate change events and remoteness of the Islands with poor transportation facilities increases the dependency of people on limited resources. For these reasons, a tribal centric developmental strategies should aimed at inclusive of enhancing agricultural productivity which is resilient to climate change events without affecting the fragile island ecosystem.

14.1 Constraints

In general the agricultural production and productivity including the livestock sector in Nicobar group of Islands are low due to the following constraints.

- Mono cropping of coconut which are mostly old and senile under rainfed condition with very less diversification
- Lack of knowledge on scientific crop production practices and no infrastructural facility for irrigation together responsible for the poor yield of fruits and vegetables
- Destruction of crops (fruits and vegetables) by animals like pig, goat and insect pests
- Timely harvesting / collection of nuts are not commonly practiced and many of the nuts start sprouting in the field itself which drastically reduces the quality of copra
- Lack of knowledge on improved cultivation practices, post-harvest processing and value addition of coconut makes the farming less remunerative

- Limited market for agricultural products especially for perishable items together with poor connectivity discourages the farmers from going for large scale production
- Lack of land records makes it difficult to avail loans from the banks. Besides community holdings makes the individuals to restrain from taking up vegetable cultivation and other new agricultural enterprises
- Remoteness, poor infra structural facilities and lack of market access for inputs and farm produces particularly for Shompens as there is neither any organization which promotes farming nor organized marketing for their minor produce

Although the tribes of these islands practice mixed farming, the animals are less cared resulting in low productivity due to the following reasons.

- Despite having several locally adapted native breeds adapted to harsh conditions of these islands the total production is very low due to poor multiplication rate and distribution.
- Scarcity of fodder due to shortage of suitable land and village / community grazing land, expansion of coconut plantation in Nicobar and use of tuber crops for human consumption have decreased the availability of food resources for pigs and other livestock.
- Lack of proper housing facilities and animal shelters for livestock leading to health problems and low productivity
- Lack of knowledge on scientific interventions like reproductive management, piglet care, hygiene and disease control etc. among the tribal farmers

14.2 Scope for improving agricultural production in Nicobar Islands

Though the agricultural production and productivity are very low, these Islands have certain inherent advantages favouring plantation crops. The agro climatic condition is very congenial for coconut cultivation and these tribes have never used any chemical inputs. At present day concept, it is nothing but organic production. In Car Nicobar about 70% of the total geographical area is covered under coconut plantation which can be transformed to specialized crop cultivation and coconut based products can be developed. Though these Islands are remotely located and water scarcity is a major problem during dry season, there is ample scope for improving production through rainwater harvesting. This will help to diversify the coconut based farming system and enhance the farm income. Tribes can be motivated by involving individuals and their institutions in all the stages of decision making and implementation of any developmental program.

Another most important feature of tribal farming is that the coconut plantations are in the state of default organic farming as fertilizers and pesticides were never been used in crop production in tribal areas of the Nicobar Islands. There are wide diversity of crops found both in managed and natural conditions forms the basic tribal diet. Therefore, ample scope exists for organic production which can fetch premium price in the market. Besides, there is an opportunity for export of value added organic products of coconut and promotion of traditional handicrafts as the tribes are known for their inherent craftsmanship.

The strength of tribal society exists in its democratic set up and homogeneity. Democratically elected village headmen and tribal council are the key tribal institutions to assist in technology transfer and bring the tribes together to improve the farm production and value addition.

14.3 Strategies for improving tribal farming

Planning of agricultural activities

The success of rainfed agriculture in Nicobar islands is largely depends on weather parameters. Some of the critical farming decisions like crop selection, harvesting and processing got evolved in the tribal society which constitute the tribal traditional knowledge are based on the climate of these islands. Farmers are aware of the fact that all the agricultural activities cannot be carried out throughout the year.

Similarly any agricultural and developmental activities by the change agents or government machineries should be planned and carried out in accordance with the prevailing weather conditions. As for as the tribes are concerned certain period in a year is preferable for certain activities owing to climatic and social reasons as shown in Fig. 14.1. A comprehensive assessment of tribal culture and farming reveals that coconut and livestock rearing is practiced throughout the year. On the other hand, vegetable cultivation, oil extraction and manuring are carried out only during certain

period of the year. Tubers are mostly grown during the rainy seasons, and any land improvement work is carried out during the dry season. Therefore, understanding the weather-crop relations and cultural calendar of tribes will be immensely helpful to carry out technological interventions in the tribal areas. Such approach will definitely get rid of the feeling by the tribes that something is imposed on them while the tribal centric approach will greatly increase the chances of its acceptance and its impact.

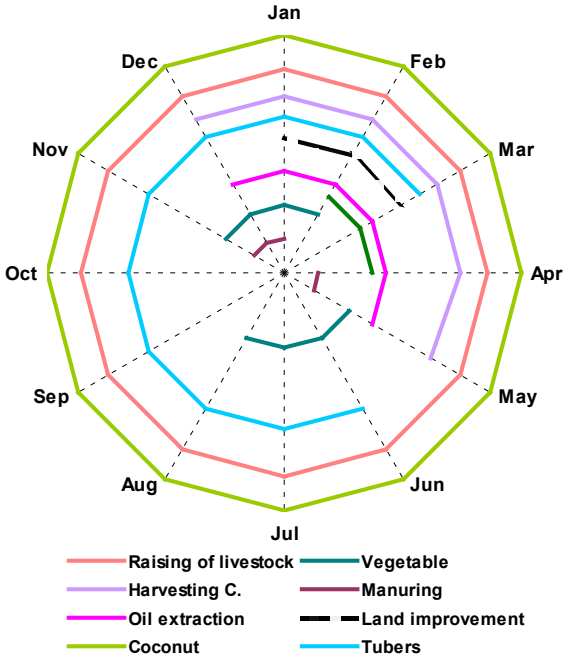


Fig. 14.1 Planning chart for various agricultural activity

Crop production

- As scarcity of water is the major problem for crop cultivation during dry period, rain water harvesting through lined ponds and from roof top should be widely adopted followed by efficient utilization of harvested water in crop production. Efforts should be made to collect and utilize the organic wastes particularly from plantation areas which are available in plenty. The organic wastes should be recycled through suitable composting methods (Fig. 14.2) to meet the crop nutrient requirements and to improve soil health.

Fig. 14.2 Organic waste recycling model for nutrient security

- Introduction of suitable varieties with package of practices to achieve crop diversity and higher production. The crops should be cultivated during suitable season (Table 14.1).

Table 14.1 Suitable crops and their season

Sl.No	Season	Suitable vegetables
1	June to September	Okra, cowpea, sweet corn, ground nut
2	October to December	Radish, beans, spinach, amaranth, chilies, gourds
3	January to March	Okra, brinjal, chilies, gourds, leafy vegetables
4	April to May/June	Okra, cucumber, leafy vegetables

- Optimum integration of different farm enterprises for efficient resource utilization and increasing farm production
- Adoption of system approach and integrated plant protection strategy suitable for Island conditions. Pest and disease surveillance and timely management measures should form part of the crop production strategy. Biocontrol agents can be introduced by the stakeholders with the involvement of tribal institutions
- Capacity building and input support at adequate amount and time is very vital to begin and to stabilize the sustainability of introduced technologies
- Implementation of all the suggested measures and accomplishment of the desired results will take several years before the tribes of Nicobar Islands reap the benefits.

Livestock production

- The use of locally available material for constructing suitable livestock sheds will lead to large scale adoption and encourage the farmers to provide animal shelters with locally available materials
- Proper health care management of animal will pave the way not only for higher productivity but for stabilization of production
- Introduction of alternate low cast feed for animals along with proper utilization of available land for fodder production
- Intercropping of fodder crops like fodder cow pea, sorghum, maize in coconut plantations
- Use of *Sesbania grandiflora* and other locally available fodder trees as a biofence in home gardens which can be used as a fodder as well as organic manure
- Conducting suitable capacity building programs on organic livestock rearing and management of bio-waste for families rearing livestock

Tuber crops

Tuber crops are very important in the context of food and nutrition security of tribes of Nicobar Islands. Wider diversity, adaptability, great flexibility in planting and harvesting of these crops makes them suitable to include in tribal farming systems. Partial shade tolerance of yams and aroids are highly suitable to intercrop in grown up plantation crops. High dry matter production potential/ unit area/ unit time coupled with cheap source of energy should encourage tribal farmers to use tuber crops in livestock feeding. Tuber crops products can be used in fresh or dried form sometimes in ensiled form in animal feeding. In small holder farming systems growing tuber crops along with plantation crops, feeding green tops and excess/culled tubers either fresh or processed form decreases the purchased inputs and increase the farm net income. In the changing climate, cassava, yam and elephant foot yam intercropping in plantation crops are indispensable for tribal farming systems along with livestock and fisheries.

14.4 Natural resource management for enhancing farm production

Vermicomposting of coconut wastes

- Vermicompost can be produced in any place with shade, high humidity and cool weather. If it is to be produced in an open area, shady place is selected. A thatched roof may be provided to protect the process from direct sunlight and rain.

- The composting can be done in vermibags, plastic tubs or in any concrete structures of suitable size 1m (b) x 75 cm (h) with any length. The bottom of the container should be sloping to drain the excess water from the composting unit. This is very much feasible in Nicobar Islands. Our interaction with the Nicobarese during demonstration of vermicomposting technology showed that they are very eager to learn the things which suit them.
- For composting vermibed is prepared by placing saw dust, coir waste or husk at the bottom of the tank. A layer of fine sand is spread over the culture bed followed by a layer of garden soil to a thickness of 3cm. Animal wastes, farm wastes, crop residues, kitchen waste and all other bio degradable waste are suitable for vermicompost production. The animal waste should be slightly dried before used for vermicompost production. The details are depicted in the Fig. 14.3.
- The residues are cut into pieces before filling the tank. The composting of coconut husk was done by cutting the husks into pieces of 1-2 cm and mixing with poultry manure or pig slurry at 20% weight basis. In this method coconut husk and poultry manure were thoroughly mixed and filled in composting tanks up to the brim.
- The residues are allowed for 20 to 25 days for pre-composting and the moisture is maintained at 60%. After a period of 25 to 30 days the selected earthworms are placed uniformly. For a tank of 1x1x0.5m size, 300-500 g of earth worm is required. The surface dwelling earthworms collected from Nicobar Islands like African earthworm (*Eudrillus eugenia) and* Red worms (*Eisenia foetida)* can be used.
- During composting process moisture should be maintained at 60% by periodic watering and it should be stopped before harvest of the compost.

Fig. 14.3 Different composting methods

- The castings formed on the top layer are collected periodically put in a shady place as heap like structure. This periodical harvesting is necessary for free flow and retaining the compost quality. The harvested vermicompost is spread in a dark, cool place until it is used for crops or it can be applied to the crops immediately.

Application of vermicompost to different crops

The vermicompost can be applied to all crops: agricultural, horticultural, ornamental and vegetables at any stage of the crop. The application rates for different crops are as follows.

- For vegetable crops approximately 10 kg m^{-2} is applied in the bed for raising healthy and vigorous seedlings. In the main field 200-250 g of vermicompost is applied per plant at the time of transplanting and also after 30-45 days after transplanting at the time of first weeding and earthing up.
- For fruit trees like papaya and banana, 5 to 10 kg of vermicompost per tree depending on the age is applied. A small basin formed around the trunk of the tree in which the compost is applied and incorporated well. It may be applied twice in a year i.e during September - October after rainfall season and April – May before onset of the monsoon.
- For Pineapple about 400-500g of vermicompost is applied at the time of planting and after periodically at 5 month interval.
- Coconut can be manured twice in a year one before on set of monsoon (12 kg/tree) another at the end of monsoon period (12 kg/tree) to have higher production.

In situ composting

As the coconut occupies the major area under agriculture in Nicobar Islands, *in-situ* composting methods can also be used by cultivation of green manure crops *in-situ* and incorporating them in soil. Leguminous green manure crops improve the soil structure and nitrogen status of the soil. In addition, they aid in releasing plant nutrients, reducing leaching, regulating soil temperature, and enhancing the activity of soil micro flora. The green manure crops viz., hedge lucerne *(Desmanthus virgatus),* green leaf desmodium *(Desmodium tortuosum), c*owpea *(Vigna unguiculata), t*ephrosia *(Tephrosia purpurea),* daincha *(Sesbania aculeata),* and sunnhemp *(Crotolaria juncea)* can be grown in coconut basins of 1.8 m radius and are incorporated *in situ* at their flowering stage.

At the introduction stage of this technology the Nicobarese are very skeptical and did not pay any interest still some of the progressive minded ladies came forward with the

persuasion by the village captain. Once the crops grown up well, large gathering was noticed in the second phase of our demonstration, eager to see what we are going to do with the waste collected and heaped up in the e*l-panam* (common place*)*. Probably first time they are seeing green manuring crop grown around the coconut trees which can really support the palm.

In the case of cowpea, tephrosia, daincha and sunhemp incorporation is done at about 50 - 55 days after sowing while *Desmodium* and *Desmanthus are* incorporated 75 days after sowing. The green manure crops can be sown during June – July and can be incorporated into the soil during October – November. Or they can be grown during January- February and incorporated into the soil during April – May before onset of the monsoon. The interest shown by the Nicobarese is very high, however, the change agents should understand the interest of the tribes and devise ways to sustain it for large scale upscaling of the technology.

Water harvesting and efficient utilization

In situ water harvesting technologies helps to address the water shortage issue due to changes in rainfall pattern and to cope up with climatic variations. In order to adapt to dry conditions especially during the post monsoon season rainwater harvesting, storage and utilization should be the core strategy around which crop and animal production can be improved. It can be accomplished by (a) Lined tank for hill top (b) rooftop rainwater harvesting (c) Broad bed furrow system for low-lying areas (d) Check dam for mid hill areas and (b) Ring well downstream of check dam. The recharge structure cum well system in mid hills can be both dugout or impounded type or combination of both depending up on the topography of a location. The technology is well defined but then the problem lays in its implementation and its maintenance. At present capital formation in agriculture addressing the tribal issues are negligible. Thus it is imperative that the establishment of these structures in tribal areas should come from public funding. This will instill confidence among the tribes and create a strong desire for moving forward to enhance the farm production.

14.5 Strategies for development of organic farming

The strategies to promote organic farming in the Island should essentially encompass organic farming technologies, adequate infrastructure, appropriate policy framework and capacity building of tribes. The strategies are given below;

- Proper assessment of status of present farming system along with the total agricultural assets and consumption of inputs in each farm holdings to identify the potential crops and areas.
- Compact area group approach should be employed by encouraging the formation of organic farmers groups, clubs, SHG's and cooperatives for the purpose of cultivation, input production, seed / seedlings / planting materials production, certification and marketing.
- Implementation of a simple certification process for all the organic farmers and promotion of specific brand name for the tribal products.
- The seed sovereignty of the farmers must be ensured by establishing seed villages, seed banks and seed cooperatives to produce, store, share and supply good quality seeds.
- Ensure availability of quality and enriched organic manure to the farmers by technology transfer and capacity building. The policy should also encourage tribal youth and women entrepreneurs to produce and sale quality manures.
- Document agro-biodiversity and related traditional knowledge and practices, both cultivated and un-cultivated in each islands.
- Make crop-livestock integrated farming as part of organic farming, with women centered ownership and management in the farmer households and groups.
- Improve soil quality, ensure water conservation measures and establishment of laboratory testing facilities in these Islands.
- Create organic production and marketing network by establishing separate and decentralized storage facilities and markets for organic farm produce to ensure its organic integrity.
- Promotion of farm level processing, value addition and encouragement of the use of organic farm produce in food industry.
- Other promotional services like financial assistance and specific crop and livestock insurance for organic farmers is expected to instill confidence among the farmers.
- Task force should be formed involving scientist, developmental agency and policy makers to develop seed to seed package and market network to promote organic cultivation.

These strategies will promote innovations and technological adoption which will play an important role in pushing tribal farming towards sustainability, quality and low risk. Additionally, the soil act as a sink for atmospheric CO_2 supporting the mitigation efforts of global warming (Lal, 2004).

14.6 Revamping research focus and extension strategies

The tribal farming should not be seen as inferior to the mainstream agriculture. In this context, the required steps to improve the research on tribal farming are as follows,

- **Natural resource survey and mapping:** It is very essential to begin with the natural resource survey so as to identify the constraints and potential in a detailed manner. This will help to channelise the efforts and resources.
- **Selection of villagers and farmers**: Select villages in each farming situation comprising marginal/small and medium/large farmers. Selection of village and farmers should be at random so as to represent all farming community of the target island. The sequence of steps and its next higher constituents are depicted in fig. 14.4 for greater success.

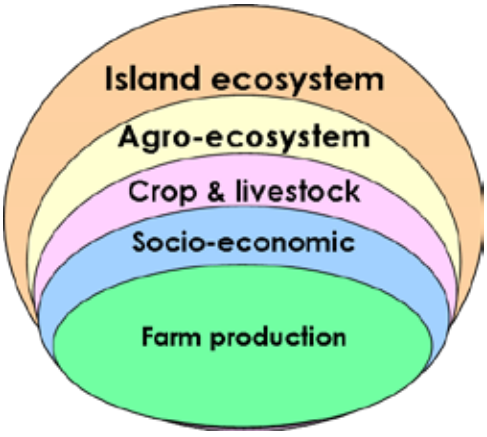


Fig. 14.4 Sequence of steps and considerations to identify the problems

- **Farm and farmers selection**: Stratify the islands based on the natural features that decide the yield and crop distribution, identify specific micro farming situations before starting any demonstrations.
- **Diagnosis of constraints:** In order to increase the farm productivity, carry out survey through personal contact using well prepared questionnaire to identify the production constrains.
- **Research design:** Suitable design or technology should be developed, validated for Nicobar conditions before adoption. Sometime refinement of existing method and practises is necessary to improve the benefits / production, identification of existing technologies and evaluation for the local conditions before its adoption.
- **Technology transfer and diffusion:** Efforts should be made to transfer the technologies of improved farming systems within the recommended domain

- **Impact of Technological interventions:** It can be assessed through productivity, economic return, energy input-output, employment, equity (gender issue) and environmental aspects. This should in up scaling of technologies among the tribal farmers of Nicobar Islands.

Redesigning extension services to reach out to the tribal farmers

Much emphasis needs to be laid on diagnosis of the problems, developing their skills in sustainable technologies to mitigate the identified problems, developing insight into the farming system and harness the natural resources effectively leading to self-sustainable agriculture in these islands (Fig. 13.5).

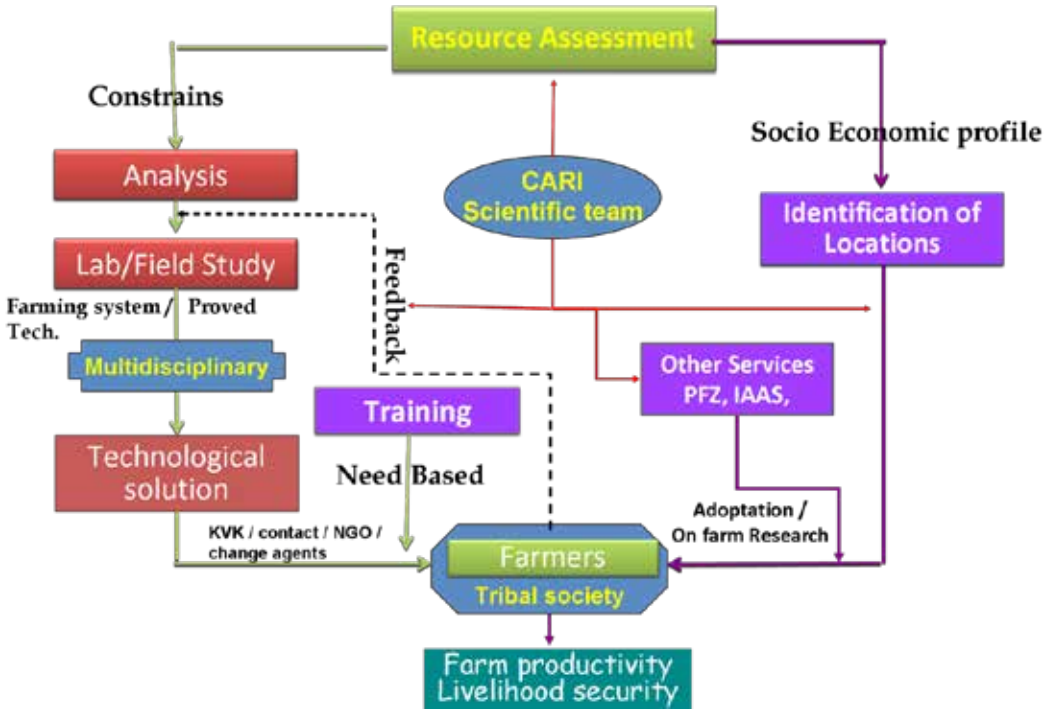


Fig. 13.5 Extension developmental model for Tribes of Nicobar Islands

However, large gap exists between the production potential and the actual yield. This can be narrowed down through proper transfer of technology to the tribal farmers. To accomplish the task the social and cultural aspects of the tribal community has to be considered.

This scenario can be achieved by,

- Continuous refinement of existing technologies and development of new technologies suitable for Nicobar Islands.
- The transition from traditional mixed farming to modern integrated farming system should be very smooth for which strenuous efforts are required to convince the tribal hierarchy and the individual farmers.
- Researchers and developmental agencies should establish direct contact with the tribal captains and farm families for effective transfer of technology and to get proper feedback.

Traditional method of processing coconut

Modern coconut processing unit at Hut Bay

Traditional method of drying excess catch of

Solar dryer can be used to get quality product fish

Fig.14.6 Efficient methods suitable for tribal areas holds the key to enhance the farm income

Focus should also be paid to the role of women in the tribal farming though it is dominated by men. The results of this approach resulted in reasonable success rate and some of them are shown in Fig. 14.6 & 14.7. In the light of our experience in dealing with the tribes it is proposed that the extension services should be redesigned to focus on,

(i) Appropriate training/sensitisation of extension personnel towards the role and contribution of women in the total agricultural system
(ii) Increasing the proportion of trained female extension workers and sensitising male extension workers to the needs, approaches and perspectives of women
(iii) Improving communication between women, researchers and extension / developmental agencies for the effective implementation of any technologies especially on post-harvest processing, animal rearing and home gardening
(iv) Establishing head of the farming family as the target group for extension services and assuming that the information will automatically trickle down to women farmers.

Capacity building and constant encouragement

Adoption of drought tolerant sweet potato

Health care and night shelter for poultry

Efficient, drudgery reduction tools

Fig. 14.7 Introduction of suitable technology for island conditions

Conclusions

Agricultural production in Nicobar Islands is largely limited by the monocroppping and senile plantations of coconut, low input use and maintenance, low productivity of soils, lack of technology adoption, poor transport facilities and organised marketing among other things. In addition, the climate change and variation is posing a serious threat to the livelihood of tribal inhabiting these islands. Reorienting agricultural research and extension system specific to the tribal farming is very essential to address these challenges. Further, there are no valid reasons for not encouraging the Shompens to start a settled life somewhere in their territory. This will enable greater technology transfer and adoption resulting in enhanced farm production and livelihood security. Organic waste recycling, rainwater harvesting, health care for farm animals along with need based skill development have the potential to enhance and sustain the agricultural production. Strengthening the crop husbandry with biotic stress tolerant and high yielding varieties, identification and conservation of genetic resources of food crop from these islands form part of the strategy to address the constraints in tribal farming system. As majority of the tribes are having coconut plantations and maintain pig or other livestock in their backyard, the integrated farming system seems to be the possible solution to the continuous increase of demand for food and nutritional security, stability of income and conservation of limited resources of Nicobar Islands.

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