KFRI Research Report 177(i)

ASSESMENT OF ECONOMIC FEASIBILITY AND SOCIO- CULTURAL ACCEPTABILITY OF BAMBOO BASED ARCHITECHTURE: A STUDY IN KERALA, KARNATAKA AND ORISSA STATES

PART-I OF BAMBOO SHELTER : A DEMONSTRATION OF BEST CONSTRUCTION PRACTICE

P.K. Muraleeedharan
V. Anitha

KERALA FOREST RESEARCH INSTITUTE
PEECHI, THRISSUR

January 2000 Pages: 55

CONTENTS

LIST OF TABLES

ABSTRACT

Among the basic needs of man shelter stands next to food and clothing. Shelter is one of the important indicators of the standard of living and it plays a crucial role in the economic development of a society. In India, till the mid 1980's. housing was mainly an activity of the private sector and the role of the government was very minimal. Considering the importance of housing. the Government of India announced the National Housing Policy which gave more emphasis to cost-effective and environment friendly houses. It also emphasised construction of houses with locally available materials. In this contest. bamboo. as a construction material, assumes greater significance as it has been used traditionally by various sections of the society since time immemorial. However. over the years.. there has been a significant decline in the number of bamboo houses in many parts of the country. and at present they are mostly owned by the economically poor and socially weaker sections in the society.

This study made an attempt to assess the socio-economic and cultural factors contributing to the non-preference of bamboo for house construction in three states of India, namely. Kerala. Karnataka and Orissa. Further, the economic feasibility. viability. socio-cultural acceptability and sustainability of bamboo based houses were also analysed in detail.

Forests and homesteads are the two important sources of bamboo in the study areas. Although bamboos are available in plenty. the housing sector esperiences severe shortage of bamboos for construction as the pulp and paper industries purchase bamboos by offering higher prices. In the study areas. bamboo houses are either thatched with grass or leaves. or tiled using country tiles (clay tiles). As evident from the survey. 95 per cent of the dwellers prefer tiled houses to thatched houses because of durability and low maintenance cost of the former. It was further observed that bamboo houses, particularly tiled ones are economically sustainable and viable, as assessed in terms of availability of resources, acceptability, affinity, affordability. adaptability and cost of construction. Two main constraints faced in the promotion of bamboo tiled houses are low income of the people and non-availability of good quality bamboo.

Bamboo houses may be improved by providing more amenities and better look for aesthetic satisfaction. The state governments should promote bamboo as a construction material in their housing schemes and a few models could be demonstrated taking into consideration the local conditions and weather factors.

INTRODUCTION

Shelter is one of the basic needs of human beings besides food and clothing. A house. apart from giving protection from natural calamities and other adversities. provides people an environment for production and better performance in their day to day life. Thus. a house. in this sense. is productive andit enhances the welfare of the society. However. housing problem. characterised by shortage of proper dwellings and existence of a large number of kutcha (semi-permanent or temporay) and dilapidated structures. has been experienced in varying intensities in most of the countries in rhe world.

In India. there is a Wide gap between the demand and supply of housing stock. In addition, growth of slums. inadequate amenities and rising cost oi shelrer are some of the features of housing problem in India. However. housing sector contributes significantly to the national income of the Country. accounting for 3.5 per cent of the gross domestic products (Kathrine. 1998). Housing comes under the purview of the state governments. But in the initial Five Year Plans. both Central and state governments had very little involvement in the development of housing, as the same was exclusively assigned to the private sector. However. this sector showed a dismal performance. which enhanced the backlog of 31 million units in the Country. Considering the inadequacy and inability of the pnvate sector to fulfil the needs. the Central Government intenened the scene. Keeping in line with the UN declararion of 'Global Shelter Strategy 2001'. the Government of India formulated a National Housing Policy in 1994. This is elaborated in terms of Agenda 21 adopted in the Earth Summit. The long term goals of the National Housing Policy are to reduce houselessness. to improve the housing conditions of the inadequately housed and to provide a minimum level cf basic services and amenities to all. Following this. many state governments in the Country also announced housing policy within the broad framework of the National Policy. The main thrust of the housing policy of state governments is to solve the housing problem. particularly of the economically poor sections. by 2000 A.D. using cost effective and environment friendly technologies that would create more employment opportunities and facilitate sustainable development of the society. At the turn of the present century. this policy objective remains to be ambitious and the problem continues to be severe (Kerala Government, 1997).

In the context of high emphasis given in the housing policy on the use of cost effective and locally available materials for construction of houses. bamboo assumes great importance. Bamboo, one of the traditional and

cheap construction materials, has been used by various sections in the society for building houses since time immemorial. Because of its fast growth rate, short rotation age, ease in transportation. workability with simple tools and above all. high mechanical strength comparable to wood, bamboo is still a highly useful and preferred construction material in the housing sector. Of late. it is found that the construction of bamboo houses in many places in the Country has a declining trend. For instance in Kerala. about 90 per cent of the houses in the highland areas and 70 per cent in the mid and lowland areas were bamboo houses about 30 years back (information gathered from selected areas). But. the number has declined significantly over the years. These houses are now constructed generally by people belonging to the economically weaker sections of the society. Similar is the case in other parts of the Country also. In this context one question that arises is. why are more bamboo houses not being constructed even when bamboo resources are available in plenty in many places in the Country and there is severe shortage of housing stock and construction materials. An attempt is made in this study to idenhfy some of the probable socio-economic and cultural factors contributing to this.

The main objectives of the study are:

(i) to idenhfy major bamboo resource areas and estimate demand for housing of target communities.

(ii) to understand local knowledge of usage of bamboo as the house construction material,

(iii) to assess socio-cultural acceptability of bamboo-based architecture and

(iv) to examine sustainability. economic feasibility and viability of bamboo based architecture.

STUDY AREAS

Kerala

Kerala. situated in the south western border of India. lies between 8°18' and 12° 48' North latitudes and 74° 52' and 77° 22' East longitudes (Fig.1). With a total area of 38.863 km^2 (1.18 % of the total geographical area of India). it supports a population of 29 million which is 3.43 per cent of the total population of the Country. according to 1991 Census. The disproportion between its area and population is reflected in the density. which was 747 persons per km- in 1991. This is the second highest density among the states in the Country. The State takes pride on a high literacy rate of 94.45 per cent. The average per capita income was Rs.5.678 in 1996-97.

Kerala With its high population presents complex problems in the sphere of food. employment and housing. Owing to historical and climatic reasons the State has developed commercial agriculture rather than food crops. Consequently. the State is in short of food grains. especially rice which is the staple diet of the people.

Natural forests in the State occupy an area of 7.870 km^2 There are four major types of natural forests namely. (i) southern tropical wet evergreen and semi-evergreen (3,470 km^2), (ii) southern tropical moist deciduous (4.100 km^2), (iii) tropical dry deciduous (94 km^2) and (iv) montane subtropical (188 km^2) (Nair & Prabhu. 1998). Nearly 21 per cent of the total forest area enjoys the status of protected forest. The evergreen. semi-evergreen and moist deciduous forests are very rich in biodiversity compared to other forest types in the tropics and temperate regions.

Forest resources provide a variety of products such as timber. firewood. animal products, medicinal plants. etc. Bamboos occupy an exquisite position among the non-wood forest products. Traditionally, villagers use bamboos for making huts. thatching. and roofing. In addition. bamboos are extensively used in pulp and paper industry in the State (there are two pulp and paper mills viz. Grasim Industries and Hindustan News Prints Ltd. using bamboo as a raw material). Considering its use as a building material. bamboo can be treated as a real substitute for declining timber resources.

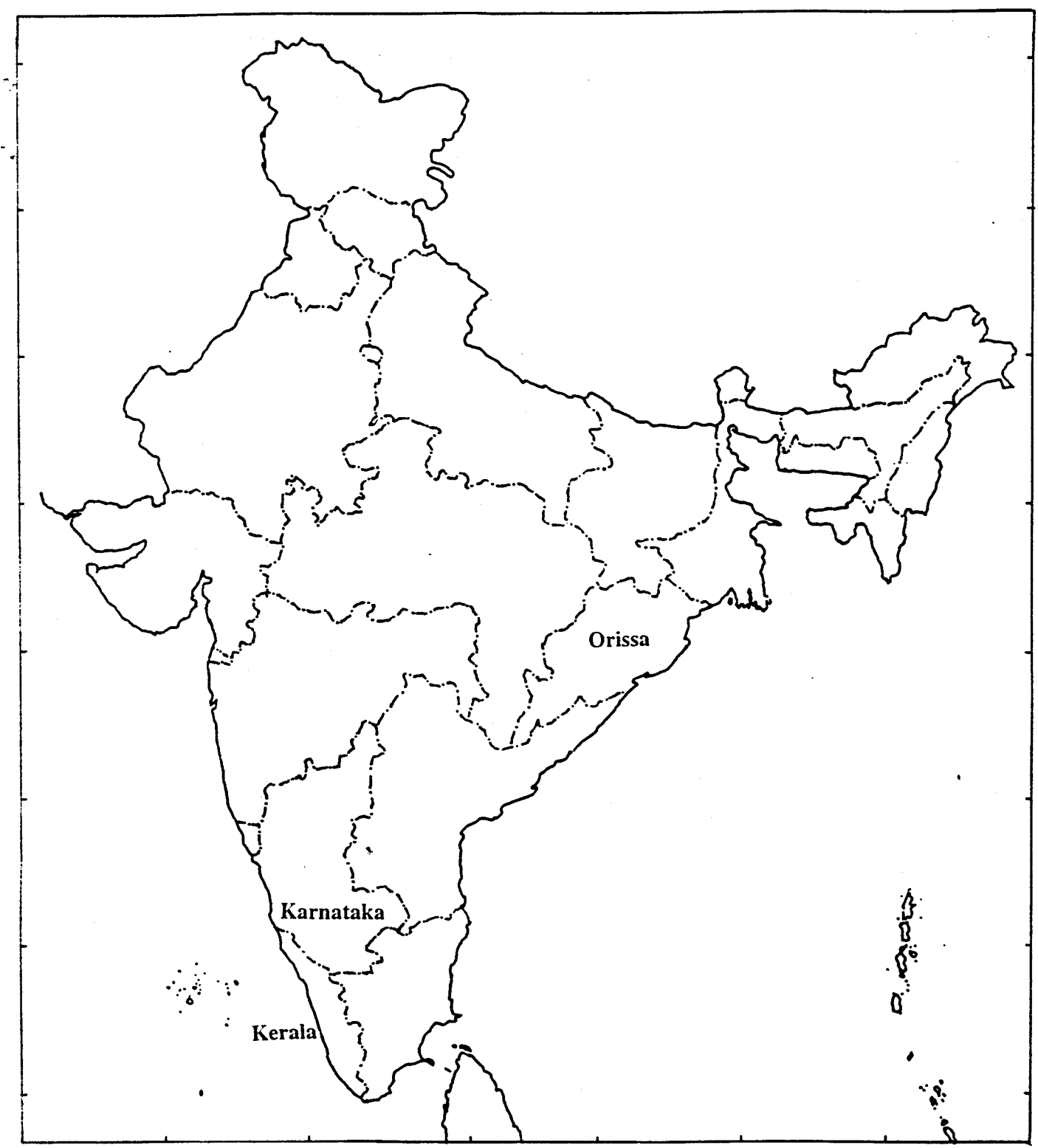


Fig.1. Map of India showing study areas

Karnataka

Karnataka, situated on the western edge of the Deccan Plateau. lies behveen 11° 45' and 18° 20 North latitudes and 74° 00' and 78° 30' East longitudes. It opens into the Arabian sea on its western side. Karnataka covers an area of 1.90.498 km^2. It is the eighth largest State in India both in terms of area and population. Total population of Karnataka was estimated as 4 5 million with a density rate of 234 persons per km^2. About 76 per cent of its population lives in rural areas and about 71 per cent of its working force is engaged in agriculture and allied activities that generate 49 per cent of the State income. The literacy rate is estimated at 55.98 per cent. The average per capita income of the State was Rs.9,384 in 1997-98. The State has a developed industrial sector (Mathew. 1999).

Forests in the State cover an area of 38.284 km^2 which is 20 per cent of the total geographical area of the State. The forest types seen here are evergreen, semi-evergreen, moist and dry deciduous. shrub and thorny forests and unwooded. forests. There are 20 National Parks and Sanctuaries in the State, covering an area of 6,360 km^2. Bamboo is one of the important non-wood forest products harvested from the forests. The main forest based industries are the M/s Mysore Paper Mills, the West Coast Paper Mills and the Karnataka State Forest Industries Corporation. The raw materials used by them are mainly bamboo and miscellaneous wood.

Orissa

Orissa, situated on the east coast of India, extends between 17° 49' and 22°34' North latitydes and 81°27 and 87°9' East longitudes. The Eastern Ghats run along the length of the State from south to north and then merge with the Chotanagpur Plateau. The State is surrounded by West Bengal in the north-east. Bihar in the north, Andhra Pradesh in the south-east, Madhya Pradesh in the west and Bay of Bengal in the east.

The Northern Plateau extends over the north region of the State and consists of high mountain ranges intercepted by extensive valleys. The altitude varies from 450 m to 1050 m and the rainfall from 1500 mm to 1750 mm per annum. The Eastern Ghats, having a highly undulating topography with mountain ranges running parallel, vary from 750 m to 1900 m altitude and temperature ranges between 12.8°C to 40°C.

Total geographical area of Orissa is 1,55,707 km^2 with a population of 31.65 million, according to 1991 census. The average density is 202 persons per km^2. Average per capita income in 1991 was Rs.3.066, indicating that this State is one of the backward areas in India. Over 76 per cent of the people are dependent on agriculture (Mathew, 1999).

Orissa is one of the forest-rich states of India. Out of 75 million ha. of land area under forest in India, 6.746 million ha. are found in Orissa (about 9 per cent of the total forest area of India). Within the State about 36 per cent of the total land area is under forest (Singh, 1997).The forests in the State are mainly grouped into semi-evergreen. moist deciduous, dry deciduous, littoral swamps and mangrove forests. Besides timber, bamboo and tendu leaves are the main forest products. Orissa produces about 15 per cent of bamboos and approximately 20 per cent of tendu leaves annually at the national level.

METHODOLOGY

The study is based on both primary and secondary data. Primary data were collected through sample survey and Participatory Rural Appraisal (PRA) technique. Preparation of sampling frame and identification of target groups are two important items in the sampling procedure. The socially and economically weaker sections in the society, who mainly construct and live in bamboo houses. constitute the target group. Multi-stage stratified random sampling method was used for the selection of sample households. Physiographically. Kerala is classified into highlands (75 m amsl). midlands (7.5 to 75 m amsl) and lowlands (less than 7.5 m amsl). This division could be, largely. extended to the panchayat levels also. Bamboos are found more abundantly in the highland areas, in the natural forests and also in plantations and homesteads. In midland areas. bamboos are grown in homesteads. Bamboo clumps are rarely seen in the lowland areas (Jayashankar. 1996).

However. bamboo houses have been found constructed in all the areas. irrespective of physiographical differences. Of the 14 districts. three districts. one each from highland. midland and lowland areas were taken for the purpose of sample selection. In each district three panchayats: that is one each from highland, midland and lowland areas were selected for data collection. Details of kutcha(temporary/semi-permanent) houses in each panchayat were collected from the respective panchayat offices and samples were taken randomly from the list.

In Karnataka. similar physiographical differences are noted in certain districts but not at the panchayat level. Bamboo brakes and bamboo houses are seen mostly in the highland districts, although they are seen in other districts also. Thus, attention was paid to follow the same criteria for selection of districts in Karnataka as done for Kerala. that is. one district each from highland, midland and lowland areas were selected. In Karnataka, although bamboo houses are found in certain areas in all the districts, no records depicting the details of kutcha houses in general and bamboo houses in particular, are maintained at the panchayat level. For the purpose of formulating the sampling frame, these areas in the selected districts were visited and a list of both types of houses was prepared. Houses were then randomly selected for data collection. The names of selected districts and panchayats/localities in each state and number of sample households from each district in Kerala and Karnataka are in Table 1.

Table 1. Selected Districts and Panchayats/localities in Kerala and Karnataka States

states	Districts	Panchayats/localities			Total selected house-holds
Kerala	Trivandrum (LL)	Vithura (HL)	Kallikkad (ML)	Vizhinjam (LL)	60
	Thrissur (ML)	Chelakkara (HL)	Vellamkallur (ML)	Vadanappilly (ML)	60
	Wayanad (HL)	Thirunelli (HL)	Nulpuzha (ML)	Muttil (LL)	60
Karnataka	Mangalore (LL)	Hoige bazaar	Baikhambal	Kulai	16
	Tumkur (Bangalore) (ML)	Panthrapalaya	Sira Taluk	Tumkur Taluk	42
	Shimoga (HL)	Kalmane	Thimpura	Talale	29

- HL - Highland. ML- Midland, LL-Lowland

A total of 180 sample households from Kerala and 87 samples from Karnataka were selected. In Orissa. the study was based mostly on secondary data. Analysis was carried out separately for the selected states as there are inherent differences in their socio-economic conditions. level of development, nature of bamboo houses, socio-cultural aspects, etc. The bamboo houses in the selected states are of two types: thatched and tiled. Analyses were carried out separately for both the types of houses.

As the data for Kerala and Kamataka are mostly primary, they are compared and presented. On the other hand. the study in Orissa is only an exploratory one based on limited secondary data. Therefore. it has not been used for comparison with other two states.

Socio-economic conditions of the selected households

Kerala

In Kerala, total population of the selected households with an average family size of 4.6, is 840 persons, of which 48 per cent are males and the rest constitute females (Table 2). About 90 per cent of the people belong to Scheduled Caste/Tribe and Other Backward Communities. who constitute the socially and economically weaker sections of the society. The adults

Table 2. Distribution of respondents according to socio-economic indicators - Kerala

Indicators	Types	Thrissur		Trivandrum		Wayanad		Total	
Samples		60		60		60		180	
Population		298		272		270		840	
	General	15	(5)	28	(10)	42	(16)	85	(10)
Caste	OBC	140	(47)	187	(69)	155	(57)	482	(57)
	SC	143	(48)	17	(6)	17	(6)	177	(21)
	ST	0	(0)	40	(15)	56	(21)	96	(124)
	Male	138	(46)	134	(49)	132	(49)	404	(48)
Sex	Female	160	(54)	138	(51)	138	(51)	436	(52)
	NA	16	(5)	15	(6)	15	(6)	46	(5)
	Illiterate	24	(8)	71	(26)	49	(18)	144	(17)
	Nursery	4	(1)	2	(1)	2	(1)	8	(1)
Education	1 – 4	85	(29)	56	(20)	56	(20)	197	(24)
	5 – 7	80	(27)	55	(20)	66	(25)	201	(24)
	8 – 10	77	(26)	60	(22)	63	(23)	200	(24)
	SSLC passed	4	(1)	5	(2)	7	(3)	16	(2)
	Above SSLC	8	(3)	8	(3)	12	(4)	28	(3)
	Below 10	53	(18)	35	(13)	45	(17)	133	(16)
	10-20	69	(23)	54	(20)	65	(24)	188	(22)
	20-30	56	(19)	63	(23)	64	(24)	183	(22)
Age	30-40	47	(16)	42	(15)	37	(13)	126	(15)
	40-50	34	(11)	37	(14)	30	(11)	101	(12)
	Above 50	39	(13)	41	(15)	29	(11)	109	(13)
	Farming	0	(0)	0	(0)	19	(12)	19	(3)
	Fishing	8	(5)	27	(15)	0	(0)	35	(6)
	Labour work	58	(35)	61	(33)	75	(48)	194	(38)
	Sales	5	(3)	7	(4)	1	(1)	13	(3)
Occupation	Business	8	(4)	2	(1)	2	(1)	12	(2)
	HH. industry	5	(3)	3	(2)	0	(0)	8	(2)
	Government employee	0	(0)	1	(1)	0	(0)	1	(1)
	Others	15	(9)	11	(5)	9	(5)	35	(6)
	Unemployed	69	(41)	74	(39)	52	(33)	195	(39)
	Total	168	(100)	186	(100)	158	(100)	512	(100)

- Figures in parentheses indicate their respective percentages to the sub-total.
- The occupied class is between the age of 18 and 60
- OBC - Other Backward Community ; SC - Scheduled Case; ST - Scheduled Tribe

and children constitute 67 and 33 per cent respectively. While 23 per cent have primary education and 46 per cent have secondary/high school levels of education, 17 per cent of the total are illiterate. Literacy rate is very low in the two selected districts of Trivandrum and Wayanad, probably because the sample population represent the fishermen and tribal communities who are the less developed communities in the State.

Casual labour is the major source of income of the selected households, followed by fishing and farming. Of the total adults (age group 18-60) in the sample. unemployed constitute 38 per cent. Among the sample households. 52 per cent receive an annual income less than Rs.20.000, 30 per cent between Rs.20,000-30,000 and the remaining above Rs.30.000. The average annual income per household in Kerala amounted to Rs.24.067 and the per capita income worked out to be Rs.4.800, indicating that the selected households fall under the low income group.

Karnataka

Distribution of respondents in Karnataka. according to the selected socio-economic variables is presented in Table 3. A total of 87 households. 29 from Shimoga. 16 from Mangalore and 42 from Thumkur/Bangalore. with a population of 331 persons (53 per cent males and 47 per cent females) were selected for the detailed study. Of the total members of the selected households, 70 per cent are adults and the rest children. About 92 per cent of the selected households are Scheduled Caste/Tribe and Backward Communi-ties and 8 per cent are other communities. Among the selected sample a little over of 51per cent are illiterate and only 16 per cent have primary level of education. Those who received secondary level of education, namely, S.S.L.C (high school) and above accounted for 17 per cent.

Casual labour is the main occupation of 23 per cent of the selected sample. Fishing (10%). making of incense sticks (10%) and coconut thatches (6%). farming (5%) and business (5%) are the other sources of income of the selected population. About 40 per cent of the selected households receive an income less than Rs.20,000. 35 per cent between Rs.20.000-30,000 and 25 per cent above Rs.30.000. The annual household income was estimated as Rs.32.000 and the per capita income was Rs.5.650.

Table 3. Distribution of respondents according to socio-economic indicators - Karnataka

Indicators	Types	Shimoga		Mangalore		Bangalore		Total	
Samples		29		16		42		87	
Population		99		45		187		331	
Sex	Male	55	(56)	20	(44)	99	(53)	174	(53)
	Female	44	(44)	25	(56)	88	(47)	157	(47)
	Adults	67	(68)	38	(85)	127	(68)	232	(70)
	Children	32	(32)	7	(15)	60	(32)	99	(30)
Education	Illiterate	56	(57)	15	(33)	101	(54)	172	(52)
	Nursery	0	(0)	0	(0)	5	(3)	5	(1)
	1 - 4	17	(17)	3	(7)	27	(15)	47	(14)
	5 - 7	11	(11)	4	(9)	10	(5)	25	(8)
	8 - 10	3	(3)	6	(13)	17	(9)	26	(8)
	SSLC passed	6	(6)	5	(11)	19	(10)	30	(9)
	Above SSLC	6	(6)	12	(2)	8	(4)	26	(8)
Occupation	Casual labour	10	(17)	0	(0)	39	(31)	49	(23)
	Business	1	(2)	0	(0)	9	(7)	10	(4)
	Farming	6	(10)	0	(0)	5	(4)	11	(5)
	Company	0	(0)	0	(0)	5	(4)	5	(2)
	Coconut thatches	0	(0)	0	(0)	12	(9)	12	(6)
	Incense stick	21	(35)	0	(0)	0	(0)	21	(10)
	Fishing	0	(0)	22	(7)	0	(0)	22	(10)
	Others	1	(1)	0	(0)	19	(15)	20	(10)
	Unemployed	21	(35)	7	(24)	37	(30)	65	(30)
	Total	60	(100)	29	(100)	126	(100)	250	(100)

- Figures in parentheses indicate their respective percentages to the sub-total.
- The occupied class is between the age of 18 and,60.

The socio-economic analysis of the selected households in Kerala and Karnataka indicates that the dwellers of bamboo houses constitute the economically poor and socially weaker sections in the society. Further, a good percentage of them are illiterate, unemployed and earn income from casual labour.

Bamboo houses in the study areas

Bamboo houses in the study area depict a more or less identical pattern and structure. Generally, these houses can be grouped into thatched and tiled houses. In both the types. bamboos are invariably used for making roof structure. In certain houses, especially thatched houses, in addition to roof, bamboos are used for wall, window, door and even partitioning. Of the total sample in Karnataka. about 54 houses, accounting for 62 per cent constitute thatched houses and the rest are tiled houses. In Kerala. these percentages are 92 and 8 respectively.

Thatched bamboo house

The thatched bamboo houses are small in size. In Kerala. the average plinth area of thatched house and the average plinth area per person are 39 m^2 and 8 m^2 respectively (Table 4). The corresponding figures for Karnataka are 31 m^2 and 7 m^2 (Table 5). The average plinth area of thatched houses was found to be higher in highland areas than in mid and lowland areas of both states, as bamboos are available at a low price in the highland areas. The basement of bamboo houses in Kerala and Karnataka is predominantly made of low quality materials like mud and sand and onIy in a few houses, brick and rubble are used. This. is attributed partly to the poor economic conditions and partly to its small size.

For instance, in Kerala, the basement of 94 per cent of thatched bamboo houses are made up of mud and only 6 per cent are made up of brick. In Karnataka, basement of 71 per cent houses is made with mud, 4 per cent of houses with rubble, 14 per cent with brick and 11 per cent with sand.

Table 4. Distribution of selected thatched houses - Kerala

Particulars	Kerala		Thrissur		Trivandrum		Wayanad	
No. of houses	166		54		59		53	
Age of houses (in yrs.)	15		13		20		13	
Average family nos.	5		5		5		5	
Plinth area (m^2)	39		31		40		45	
Plinth area/person (m^2)	8		6		9		10	
Structure of the houses								
Basement								
Mud	157	(95)	52	(96)	52	(88)	53	(100)
Brick	9	(5)	2	(4)	7	(12)	0	(0)
Floor								
Dung	109	(66)	23	(42)	49	(83)	37	(70)
Cemented	36	(22)	22	(41)	6	(10)	8	(15)
Clay	21	(12)	9	(17)	4	(7)	8	(15)
Wall								
Bamboo frame	5	(3)	0	(0)	5	(9)	0	(0)
Wood	8	(5)	3	(5)	3	(5)	2	(4)
Brick	101	(61)	22	(41)	44	(75)	35	(66)
Leaves	38	(23)	29	(54)	6	(10)	3	(5)
Bamboo mat	2	(1)	0	(0)	1	(1)	1	(2)
Bamboo frame+mud	12	(7)	0	(0)	0	(0)	12	(23)
Door								
Bamboo frame	51	(31)	8	(15)	14	(23)	29	(55)
Wood	86	(52)	22	(41	40	(68)	24	(45)
Others	4	(2)	4	(7)	0	(0)	0	(0)
Leaves	25	(15)	20	(37)	5	(9)	0	(0)
Window								
Bamboo	14	(9)	6	(11)	6	(10)	2	(4)
Wood	52	(31)	9	(17)	30	(51)	13	(24)
Nil	70	(42)	9	(17)	23	(39)	38	(72)
Leaves	30	(18)	30	(55)	0	(0)	0	(0)
Roof								
Grass	43	(26)	2	(4)	11	(19)	30	(57)
Leaves	90	(54)	50	(93)	40	(68)	0	(0)
Palmleaf	11	(7)	2	(4)	3	(5)	6	(11)
Reedleaf	5	(3)		(0)	5	(8)	0	(0)
Sheet	17	(10)		(0)	0	(0)	17	(32)
Roof frame								
Bamboo	166	(100)	54	(100)	59	(100)	53	(100)
Sources of bamboo								
House compounds	54	(33)	25	(46)	13	(22)	16	(30)
Depots	55	(33)	29	(54)	26	(44)	0	(0)
Forest	57	(34)	0	(0)	20	(34)	37	(70)

- Figures in parentheses indicate their respective percentages to the sub-total.

Table 5. Distribution of selected thatched houses Karnataka

Particulars	Karnataka		Shimoga		Mangalore		Bangalore	
No.of houses	56		8		11		37	
Age of houses (in yrs.)	4		7		3		4	
Average family nos.	4		4		5		4	
Plinth area (m^2)	31		45		21		27	
Plinth area/person (m^2)	7		11		4		7	
Structure of the houses								
Basement								
Mud	40	(71)	8	(100)	0	(0)	32	(87)
Rubble	2	(4)	0	(0)	0	(0)	2	(5)
Brick	8	(14)	0	(0)	5	(45)	3	(8)
Sand	6	(11)	0	(0)	6	(55)	0	(0)
Floor								
Sand	6	(11)	0	(0)	6	(55)	*0*	(0)
Cemented	4	(7)	0	(0)	2	(18)	2	(5)
Clay	46	(82)	8	(100)	3	(27)	35	(95)
Wall								
Bamboo	3	(5)	3	(38)	*0*	(0)	0	(0)
Brick	39	(70)	2	(25)	0	(0)	37	(100)
Thatches	13	(23)	2	(25)	11	(100)	0	(0)
Mud	1	*(2)*	1	(12)	*0*	(0)	0	(0)
Wood	53	(95)	7	(88)	11	(100)	35	(95)
No door	3	(5)	1	(12)	0	(0)	2	(5)
Wood	23	(41)	5	(63)	2	(18)	16	(43)
Nil	33	(59)	3	(37)	9	(82)	21	(57)
Grass	22	(40)	4	(50)	4	(36)	14	(38)
Leaves	34	(60)	4	(50)	7	(64)	23	(62)
Roof frame								
Bamboo	56	(100)	8	(100)	11	(100)	37	(100)
Source of bamboo								
House compounds	1	(2)	*0*	(0)	1	(9)	*0*	(0)
Depots	48	(85)	1	(13)	10	(91)	37	(100)
Forest	7	(13)	7	(87)	*0*	(0)	*0*	

- Figures in parentheses indicate their respective percentages to the sub-total.

Tiled houses

In Kerala. the average plinth area of the tiled house is 58 m^2 and plinth area per person is 14 m2. Of the total sample in the State, tiled bamboo houses constitute only 8 per cent (Table 6). Around 35 per cent of the totai sample in Karnataka are tiied houses with an average plinth area of 72 m^2 (Table 7). The average plinth area of the tiled houses in Karnataka varies between 82 m^2 in highland areas and 51 m^2 in lowland areas. Plinth area per person is 18 m^2 . The plinth area of a tiled house in the highland area in Kerala. is slightly less than that in the lowland area and this is probably because sample in the highland area consists of a number of tribal households, whose houses are generally small.

Table 6. Distribution of selected tiled houses - Kerala

Particulars	Kerala		Thrissur		Trivandrum		Wayanad	
No. of houses	14		6		1		7	
Age of houses (in yrs.)	15		10		27		9	
Average family nos.	4		5		4		4	
Plinth area (m^2)	58		44		70		60	
Plinth area/person (m^2)	14		10		17		16	
Structure of the houses								
Basement								
Brick	12	(86)	4	(67)	1	(100)	7	(100)
Mud	2	(14)	2	(33)	0	(0)	0	(0)
Floor								
Dung	9	(64)	2	(33)	0	(0)	7	(100)
Cemented	4	(29)	3	(50)	1	(100)	0	(0)
Clay	1	(7)	1	(17)	0	(0)	0	(0)
Wall								
Wood	2	(14)	2	(33)	0	(0)	0	(0)
Brick	12	(86)	4	(67)	1	(100)	7	(100)
Door								
Wood	14	(100)	6	(100)	1	(100)	7	(100)
Window								
Wood	12	(86)	5	(83)	1	(100)	6	(86)
Nil	1	(7)	0	(0)	0	(0)	1	(14)
Leaves	1	(7)	1	(17)	0	(0)	0	(0)
Roof								
Tiles	14	(100)	6	(100)	1	(100)	7	(100)
Roof frame								
Bamboo	14	(100)	6	(100)	1	(100)	7	(100)
Source of bamboo								
House compounds	8	(57)	6	(100)	1	(100)	1	(14)
Forest	6	(43)	0	(0)	0	(0)	6	(86)

- Figures in parentheses indicate their respective percentages to the sub-total.

Table 7. Distribution of selected tiled houses Karnataka

Particulars	Karnataka		Shimoga		Mangalore		Bangalore	
No.of houses	31		21		5		5	
Age of houses (in yrs.)	9		8		12		8	
Average family nos.	4		4		5		5	
Plinth area (m^2)	62		82		51		52	
Plinth area/person (m^2)	16		21		10		10	
Structure of the houses								
Basement								
Mud	1	(3)	1	(5)	0	(0)	0	(0)
Rubble	5	(16)	2	(9)	0	(0)	3	(60)
Brick	25	(81)	18	(86)	5	(100)	2	(40)
Floor								
Cemented	17	(55)	9	(43)	4	(80)	4	(80)
Clay	14	(45)	12	(57)	1	(20)	1	(20)
Wall								
Bamboo	4	(13)	4	(19)	0	(0)	0	(0)
Brick	25	(81)	17	(81)	3	(60)	5	(100)
Thatches	2	(6)	0	(0)	2	(40)	0	(0)
Door								
Wood	31	(100)	21	(100)	5	(100)	5	(100)
Window								
Wood	27	(87)	19	(90)	3	(60)	5	(100)
Nil	4	(13)	2	(10)	2	(40)	0	(0)
Roof								
Tiles	31	(100)	21	(100)	5	(100)	5	(100)
Roof frame								
Bamboo	31	(100)	21	(100)	5	(100)	5	(100)
Sources of bamboo								
Depots	10	(32)	0	(0)	5	(100)	5	(100)
Forest	21	(68)	21	(100)	0	(0)	0	(0)

- Figures in parentheses indicate their respective percentages to the sub-total.

In Karnataka and Kerala, 80 to 85 per cent of tiled houses have their basement made of brick. Brick is also used for the construction of walls in both the states. primarily because it is felt that these type of walls are stronger and have an aesthetic beauty. On the other hand. bamboo reinforced mud walls which deteriorate slowly, need periodic plastering. Further. a strong basement and walls made up of at least brick are needed for tiled houses because of obvious reasons. Wood is widely used for windows and doors in both the states. Bamboo is used as roof frame in all the sample houses. In highland areas, where very thick bamboos

available, they are used even as the main and lateral supporting beams. But in other areas. some houses have used wood or Casuarina poles as main or supporting poles.

Local knowledge of usage and preservation of bamboo

a. Usage of bamboo

For many centuries. bamboo has been a potentially renewable resource and an inexhaustible raw material to the economically weaker sections of the society who have used bamboo for the production of a variety of products. Traditionally. people have perfected and used most of the technology by which bamboo can be transformed into different products. Further, this technology has been passed on from one generation to another. In the past, although timber was available in plenty. bamboo had been preferred to timber by majority of the people as they were familiar with the technology of construction of bamboo houses. This technology is very simple but labour intensive which makes them self reliant in the matter of housing. Further. bamboo houses are environment friendly and suitable for the local weather conditions. Over a period of time. there has been significant modifications in the bamboo houses in the study areas. Thatched houses were the earliest version of bamboo houses. Construction of tiled bamboo houses was one of the important developments in the history of bamboo houses in the study areas. It necessitated several modifications in the roof structure (spacing of bamboo, strong lateral beams. etc.) and demanded a stronger basement and walls. Reinforced bamboo mud wall is another important modification in the construction of bamboo houses, which increased the longevity of the wall from 5 to 15 years (based on PRA).

b. Preservation of bamboo

Availability of thick bamboo, free from pest attack, is one of the pre-requisites for the construction of good quality bamboo houses. Traditionally. people have given emphasis to this aspect and developed a variety of natural preservative treatments for this purpose.

Soaking in water

Soaking in water for 10 to 15 days followed by air drying is one of the methods used in Kerala and Karnataka for protecting bamboos from borers and beetles. In Kerala, there are plenty of ponds. even in homesteads, in which bamboos are soaked. Some ponds, especially in the lowland areas, contain saline water. Soaking in such water is considered by the local people to be one of the best preservation methods.

Diesel, waste oil and pesticides application

In order to protect bamboos from borers and beetles, diesel or waste oil (waste engine oil from automobiles) is applied on bamboo, followed by air drying for a coupIe of days. Some people apply pesticides before using bamboo in the construction of the house.

Smoking

Round bamboo is often smoked over gentle fire for primary protection against fungal decay and insect attack. It not only helps in drying, but also provides some protection against bio-degradation.

Of the total sample in Kerala, about 30 per cent adopt treatment of bamboo before construction of the house while 70 per cent do not adopt any type of preservative treatment. In Karnataka, only 13 per cent households adopted preservative treatment before construction (Table 8).

Table 8. Distribution of households adopting preservation methods in Kerala and Karnataka

Methods	Kerala		Kamataka	
Soaking	24	(44)	13	(100)
Diesel painting	4	(7)	-	-
Insecticide	10	(18)		-
Waste oil painting	12	(2)	-	-
Smoking	1	(2)	-	-
Kerosene	3	(5)	-	
Keep in mud	1	(2)	-	
Total	55	(100)	13	(100)

figures in the parentheses are percentages to total

Soaking in water is the most common preservative method used by the respondents, in both the states. In addition. application of diesel. waste oil or pesticide is another method of preservation adopted in Kerala. In Karnataka. some of the people follow a method of seasoning of bamboo in highland areas, that is. uprooting of bamboo clumps for drying. It is generally believed that bamboo dried like this is less prone to surface cracking as compared to those harvested individually under similar conditions.

Bamboo houses in Kerala : growth and decline

An attempt is made here to examine the growth and decline of bamboo houses in the study areas. Since. no information on this aspect is available for Karnataka, this is confined to Kerala alone.

In olden days bamboo houses were predominant in the housing sector in Kerala. Based on the information gathered from old people and PRA conducted in several places, around 30 years back, 90 per cent of houses in the highland area and about 70 per cent in midland and lowland areas were made of bamboo. But now their number has declined remarkably owing to a variety of reasons of which the following are the most important.

Kerala had about 1.67.000 ha. of private forests which were taken over and vested with the Forest Department during 1971 (Zachariah. 1980). As soon as the landlords knew about nationalisation of private forests, they undertook massive deforestation in these areas and sold the timber at throw-away prices. Coupled with this. large scale clear felling carried out in the Reserve Forest areas by the Forest Department for plantation activities, resulted in flooding of timber in the market. Consequently, the price of timber slumped down (for instance. the price of timber of Irul *(Xylia xylocarpa)* was only Rs.250/m^3 during 1970). This inspired the people to replace bamboo with timber. in the construction sector.

Kerala witnessed the Gulf boom since mid 1970s. characterised by large migration of labour to West Asia and inflow of foreign exchange to the State. The total stock of Indian migrants in the West Asia is estimated as 2.8 million of which the migrants from Kerala account for 50 per cent (Prakash. 1998). Currently, Kerala is getting about Rs.55.000 million per year from the Gulf. as workers' remittance. According to one survey carried out by the Department of Economics and Statistics in 1987, of the total utilisation of the remittance (excluding current consumption). 21 per cent was'spent for purchasing or improving land and 36 per cent for construction. improvement or purchasing buildings. This brought about significant change in the construction sector in the State, the most spectacular being the replacement of a large number of old bamboo and wood based houses with RCC houses. Although the RCC houses are energy using, capital intensive and unsuitable for the weather conditions in the State, people of Kerala have shown a preference to this type of house. simply because of social esteem. beauty and less maintenance cost.

In the past, bamboos had been used only for limited purposes like house construction, agricultural purposes and traditional industry. Now its uses have diversified and apart from the traditional uses. bamboos are being used by pulp and paper mills and construction sector as support for the RCC work. Partly because of high demand from pulp and paper industry

and partly due to low supply especially from the homesteads, the price of bamboo has shot up recently. For instance, one tonne of bamboo which had cost Rs.36 in 1967, has increased to Rs.2.145 in 1994 (Krishnankutty, 1998).This has forced the poor people to find a substitute for bamboo as a construction material.

Bamboo resource areas in Kerala and Karnataka

Forests and homesteads are two important sources of bamboos in Kerala. Bamboos are more abundant in northern forest areas than in southern parts of the State. Specifically. Nilambur and Wayanad Forest Divisions in Northern Circle and Achencoil Forest Division in the Southern Circle supply about 80 per cent of the thick bamboo (Fig. 2). In addition. bamboos are also available in homesteads. especially in the high and midland areas in Kerala. but they are more concentrated in Palakkad and Malappuram districts in the State (Jayashanker. 1996).

Major bamboo resource areas in Kamataka are shown in Fig. 3. Bamboos occur almost all over the State but are more concentrated in the moist deciduous tracts of three zones, *viz.,* the northern zone (North Kanara and Belgaum districts). central zone (Shimoga and Chickmangalore districts) and southern zone (Mysore, Coorg. South Kanara and Hassan districts). Northern zone contributes 65 per cent of the total bamboo production in the State, followed by central zone. accounting for 24 per cent (Bennet. 1993).

Bamboo demand for housing of target communities

Details on average consumption of bamboo per house and total number of bamboo houses are required for estimating the total demand for housing in a particular area. For Karnataka. no data are available on total number of bamboo houses, probably because majority of the construction activities are undertaken by private sector. In the absence of this information, demand for bamboo for housing was estimated for the State of Kerala alone.

According to 1991 census there were 5.45 million houses and 5.51 million households in Kerala. Thus, the numerical shortage of houses during 1991 was 54,000 as against the shortage of 1.56.000 houses in 1981 (Kerala Government, 1997). It has been estimated that 20 per cent of 5.45 million houses in Kerala are thatched huts of semi-permanent nature. Of this, nearly 5.50.000 units are sub-standard huts which are not fit for safe human living. Moreover 5 per cent of the existing houses required to be demolished and reconstructed. Thus, housing demand as existed during 1991 is given below.

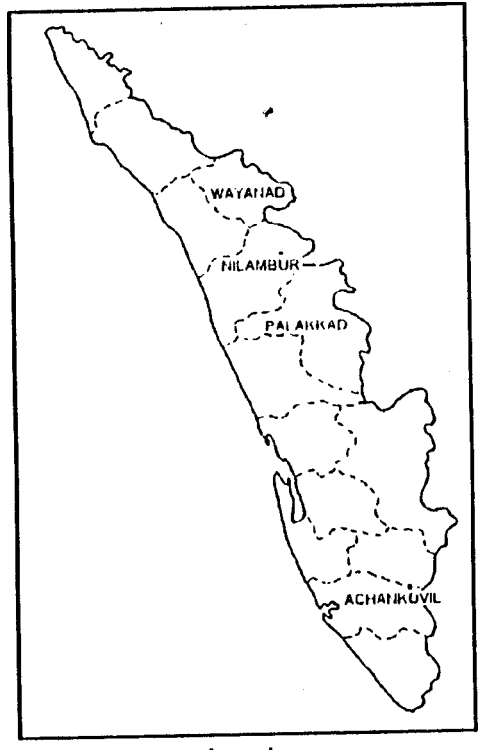


Fig. 2. Major bamboo resource areas in Kerala

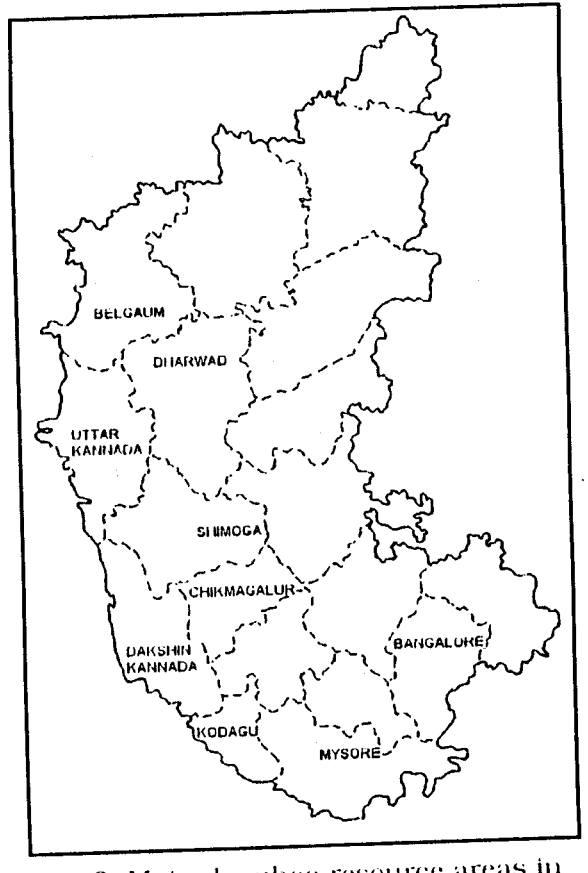


Fig. 3. Major bamboo resource areas in Karnataka

Numerical shortage during 1991	54 000
No. of sub standard huts which need to be reconstructed	550 000
No. of houses which required major repair/reconstruction	270 000
Total	874 000

It is projected that the population in the State would increase from 29 million in 1991 to 32.8 million in 2000 A.D. with an increase of about 3.8 million. Assuming an average household size of 5.3, the number of houses required for accommodating this increase in population would be 7.20,000. Thus, the total demand for construction of houses during the period 1991-2000 is approximately 1.6 million (Kerala Government, 1997).

Now, let us examine the demand for bamboo in the construction sector in Kerala. During the period from 1991-92 to 1994-95, a total of 5.13.000 houses have been constructed of which 4.31.000. accounting for 84 per cent, were constructed in panchayat areas and the remaining 16 per cent were constructed in Municipalities and Corporations (Appendixces 1a, 1b and 1c). On an average, about 1.20.000 to 1.60.000 houses have been constructed every year in Kerala of which 20 per cent, that is 24,000 to 32,000 are kutcha houses. It was found in the sample survey that. about 40 per cent of the kutcha houses in the State are bamboo houses (9,600 to 12,800 nos) of which 92 per cent are thatched and the rest are tiled bamboo houses. The average number of bamboos used per house by thatched and tiled houses in Kerala are estimated to be 22 and 29 respectively. Thus, of the total bamboo houses. thatched and tiled houses are 9.277 and 807 and their total demand for bamboos is 2,04,094 and 23,403 numbers respectively. constituting a total of 2.27.497 numbers. The average weight of a bamboo (5.5 m length) is about 20 kg and thus totally, construction of new bamboo houses in the State requires 4.550 tonnes of bamboos every year. It is assumed that annually half of the bamboo houses in the State are repaired. which requires an equal quantity of bamboo that would be required for a new construction. Thus. total demand for bamboo, both for new construction and maintenance. is estimated as 5.100 tonnes.

Economic feasibility of bamboo houses

Cost of construction

Details regarding the different items of cost involved in the construction of thatched and tiled bamboo houses in Kerala and Karnataka are given in Tables 9 and 10. Major items of expenditure are costs on basement. walls. doors, windows and roof.

Table 9. Details of cost of construction of thatched bamboo houses -Kerala and Karnataka (in Rs.)

Particulars of Houses	Kerala								Karnataka							
	State Total		Thrissur		Trivandrum		Wayanad		State Total		Shimoga		Mangalore		Bangalore	
No. of bamboo used	22		20		14		31		21		32		14		18	
Basement	410	(6)	585	(10)	296	(4)	350	(5)	324	(5)	296	(5)	267	(4)	410	(6)
Bamboo	1386	(22)	1874	(33)	1186	(18)	1098	(16)	1151	(18)	288	(5)	1330	(21)	1836	(27)
Wall	2926	(46)	1870	(33)	3737	(555)	3170	(48)	2220	(36)	2078	(37)	1848	(28)	2735	(41)
Roof	904	(14)	775	(14)	883	(13)	1054	(16)	1921	(31)	2462	(44)	22	(35)	1042	(16)
Wages	749	(12)	591	(10)	669	(10)	988	(15)	639	(10)	495	(9)	790	(12)	633	(10)
Total cost	6377	(100)	5695	(100)	6773	(100)	6662	(100)	6257	(100)	5620	(100)	6496	(100)	6656	(100)
Cost/m²	167		185		170		147		222		124		313		251	

- **Figures in the parentheses are percentages *to* total**

Table 10. Details of the cost of construction of tiled bamboo houses - Kerala and Karnataka (in Rs.)

Particulars of houses	Kerala								Karnataka							
	State Total		Thrissur		Trivandrum		Wayanad		State Total		Shimoga		Mangalore		Bangalore	
No.of bamboo	28		24		20		41		29		42		22		24	
Basement	5000	(26)	4000	(24)	5000	(25)	6000	(31)	4734	(22)	5780	(25)	3772	(21)	4650	(21)
Bamboo	1843	(10)	2294	(14)	1740	(9)	1496	(7)	1638	(7)	378	(1)	2090	(12)	2448	(11)
Wall	5077	(27)	4333	(26)	5500	(27)	6400	(28)	4972	(24)	6330	(26)	3936	(22)	4650	(20)
Roof	4150	(22)	3146	(18)	4987	(24)	4316	(22)	8980	(42)	10440	(43)	7200	(40)	9300	(41)
Wages	2786	(15)	3025	(18)	3000	(15)	2333	(12)	1241	(5)	1227	(5)	900	(5)	1596	(7)
Total cost	18857	(100)	16798	(100)	20227	(100)	19547	(100)	21566	(100)	24156	(100)	17898	(100)	22644	(100)
Cost/m^2	331		380		288		324		360		294		350		437	

- Figures in the parentheses are percentages to total

Majority of the thatched houses have been built with no proper basement: the latter is mostly made up of either mud or sand. On the other hand.80 to 85 per cent of the tiled houses have proper basement either of brick or rubble. Regarding flooring, majority of the thatched houses have used clay/mud flooring smeared with dung. About 64 per cent of the tiled houses in Kerala, have mud floor smeared with dung. The cost of basement including flooring in the case of thatched house amounted to Rs.410 in Kerala, while it was Rs.325 in Karnataka. In the case of tiled houses, this amount worked out to be Rs.5.000 in Kerala as against Rs.4.734 in Karnataka.

Wall is one of the most expensive items in a house construction and hence reducing the cost without compromising on its strength is more important. Many houses in the highland areas have bamboo reinforced walls. In most of the tiled houses, the walls are built with brick.

Doors and windows are also an important item of cost. Only very few thatched houses have doors and windows and they are made up of either bamboo or small timber. The tiled houses, on the contrary, have doors and windows made up of wood. In the highland areas in Kamataka. where availability of bamboo is high, about 38 per cent of the houses have used bamboo for the construction of windows and doors.

The average cost of wall including doors and windows in the thatched houses amounted to Rs.2.926 in Kerala and Rs.2.220 in Kamataka. accounting for 46 and 36 percent of the total cost respectively. The cost of this item in tiled houses is significantly higher than that in thatched houses, amounting to Rs.5.077 in Kerala and Rs.4,972 in Karnataka because of obvious reasons.

Roof is made up of bamboo in almost all the sample houses in the study areas. In highland areas. bamboo is used even as the main and lateral supporting beams. In certain houses in the midland and lowland areas. the main and lateral beams are made up of Casuarina poles. because it is cheaper than bamboo. As bamboos are found extensively in the highland. many people here quite often take this material illegally from the forests for house construction. This indicates that about 75 per cent of the respondents in the highland areas in Karnataka cut bamboo from the forests illegally and use it for various purposes. Thus, they incur only the cutting, transporting and other handling charges. which work out to be Rs.9 per culm. In addition, these bamboos are mature and thicker. But the other selected areas in Kamataka depend on the market supply. These bamboos are more expensive (Rs.32.84per culm in midland and Rs.44.55 per culm in lowland) and more often immature. The condition is slightly different in Kerala where only very few people cut bamboos from the

forests. Majority of the people. especially those in mid and lowland areas depend on the homesteads to meet their requirement. Probably due to this, bamboo price is found to be slightly lower in Kerala than that in low and midland areas of Karnataka.

The number of bamboos used, differ from house to house varying between 14 in lowland and 31 in highland areas in Kerala (thatched houses). On an average, numbers of bamboos used per thatched and tiled houses were estimated as 22 and 29 respectively. Similar was the case with regard to Karnataka also. The average cost of roof (including cost of bamboo and thatches), of thatched house in Kerala was Rs.904 as against Rs. 1921 in Kamataka. The high difference in cost on this item arises due to the fact that thatches are less expensive in Kerala. The average cost of roof of tiled houses in Kerala amounted to Rs.4.150 while it was Rs.8.980 in Karnataka. One possible reason for this difference may be high cost of tiles and bamboos in Karnataka.

Another important resource involved in house construction is the availability of workers. Unskilled workers are largely used for construction of thatched houses in both the states. For the construction of tiled houses, two types of labourers, that is, carpenters and unskilled workers are used. The carpenter shapes and splits the bamboo and assembles the roof structure. He usually gets wages. ranging from Rs. 130 to Rs. 150 per day depending upon the place. On the other hand. other workers involved in the construction activities such as placing grass or thatches on the roof, preparing cementing mixtures. building wall and flooring, get compara-tively lower wages. ie. Rs.50 in Shimoga. Rs.100 in Bangalore and Rs. 125 in Kerala.

The average cost of a thatched bamboo house was estimated as Rs.6.377 in Kerala. while it was Rs.6.257 in Karnataka. In the case of tiled houses, the costs were about Rs.18.857 in Kerala and Rs.21.566 in Karnataka. The average cost of construction per m2 of thatched houses amounted to Rs.167 and Rs.229 in Kerala and Kamataka respectively, while it was Rs.331 in Kerala and Rs.360 in Karnataka for tiled houses. Per unit cost of construction was found to be low in highland areas (except tiled houses in Kerala), mainly due to low price of bamboo and wage rate. Because of the moderate cost of construction. it is economically feasible for the low income groups to construct bamboo houses in the study areas. particularly in highland areas.

Viability of bamboo houses

The longevity of a house is very difficult to calculate especially in the case of thatched house. as each component of the house has its own life time.

For instance, brick wall lasts for more than 50 years, bamboo reinforced mud wall lasts for 10 to 15 years, bamboo used as roof frames lasts for two to fifteen years, depending upon the quality, coconut thatches last for one or two years, straw roofs lasts for 3 years, tiles are replaced as and when they get broken, etc. The investment in tiled houses is three times higher than that of thatched houses. This is one of the reasons why people are compelled to live in thatched houses.

As regards the frequency of repairing of thatched houses. 60 per cent and 21 per cent of the selected houses in the study areas are repaired at the end of first and second years respectively just before the onset of monsoon. On the other hand, about 88 per cent of the selected tiled houses are repaired during the fifth or later years. Hence the repairing cost is very less for tiled house (Rs.42.93/m2/year), compared to thatched houses (Rs.267.17/m2/year). From the house owners point of view. the initial investment in thatched house is less than that of tiled house. An attempt is made here to compare cost of construction and cumulative repair charges of thatche-d and tiled houses for five years, assuming that the life of a tiled house is 25 years (mortised to five years). The methods used for estimation of cumulative repair cost are given in Appendix 2. The result of the analysis is given in Table 11.

Table 11. Details of construction and cumulative repair cost (in Rs.) of thatched and tiled houses of Kerala and Karnataka

Particulars	Thatched houses		Tiled houses	
	Kerala	Karnataka	Kerala	Karnataka
Construction cost	6377	6257	8857	21566
Cost of bamboo for 5 yrs.	714	575	587	645
Cost of thatches for 5 yrs.	3015	4177	-	-
Cost of other materials for 5 yrs.	2736	2168	3402	3985
Cumulative cost for 5 yrs.	6465	6921	3989	4630
Amortised value	12842	13179	7761	8944

Cumulative cost of bamboo and other repair cost for five years for thatched houses are less than that of tiled houses for five years. To assess the benefits of the two types of houses in the long run, mortised values of both thatched and tiled houses, considering the cost of construction and repair cost for five years, were taken and analysed. The results showed that, for tiled houses the mortised value was Rs.7.761. while it was Rs.12.843 for thatched houses, which was 65 per cent higher than that for tiled houses. This result supports the fact that tiled houses are economically beneficial in the long run.

A significant number of dwellers of thatched houses prefer to live in tiled houses. Economically also tiled houses are better than thatched ones especially in the long run. Then why do people go for thatched houses which require frequent repair? Two major'constraints in the construction of tiled bamboo houses are. low income of the people and non-availability of cheap and good quality bamboo.

Socio-cultural acceptability

Most of the sample houses in Kerala have permanent dwellers, while in Karnataka, except in the highland areas. the dwellers are of the floating type who have come to settle down because of their jobs. This group of people, reportedly, have no permanent interest in the places where they live and do not spend much money in maintaining their houses. Further, they are either owners of tiny plots of land or encroachers of porumboke land (waste and unoccupied public land). In the absence of proper title deeds, they are not willing to construct tiled houses which requires more investment. The selected mid and lowland areas are located near the city, where a significaiit number of dwellers of bamboo houses are very much attracted by the RCC houses. Some respondents in the midland and lowland areas opined that, given the options, they would prefer RCC houses due to low repair cost, social esteem and better looks.

In the highland areas of Karnataka. where bamboos are available in plenty, people prefer bamboo houses. They are even content with thatched bamboo houses as they felt that it was affordable and comfortable. They showed some social and cultural affinity towards bamboo houses, as they were born and brought up in this type of houses and also the technology and materials required for its construction were at their disposal.

Kerala provides a different picture regarding socio-cultural acceptability of bamboo houses. The selected households gave a variety of reasons for their preference of bamboo houses of which affordability accounted for 50 per cent. According to 44 per cent of the respondents, bamboo houses are comfortable and affordable and four per cent did not like other types of houses.

Another important question is whether the selected households are satisfied with the bamboo houses? The answer is that about 35 per cent of them are satisfied with the thatched bamboo houses, while others expressed dissatisfaction. In the case of tiled bamboo houses, about 70

per cent of the people expressed satisfaction. High maintenance cost and leakage during rainy seasons are the two important reasons for dissatisfaction regarding thatched houses. Given a choice between thatched and tiled houses. about 95 per cent prefer tiled bamboo houses. There are a number of policy implications to this which will be dealt with later.

Sustainability

Of late, the concept of sustainability has received much attention from the policy makers, environmentalists. and socio-economists and consequently, the evaluation of sustainability of a project is often called for. There are a large number of definitions of sustainability. but the basic ideas of these definitions are more or less similar to the one given by the World Commission on Environment and Development. According to them sustainable development is the development that meets the needs of present without compromising on the ability of future generations to meet their own needs (WCED. 1987).This concept envisages appropriate use of resources without obvious degradation set in. The sustainability is a multifaceted character with large number of constraints and as a result, it is quite often difficult to achieve, Further. sustainability is clearly a relative concept and has different dimensions such as economic. ecological, social and cultural. It is markedly influenced by time, space. scales and perception of different people (Kathrin and Malcolm. 1991). As the bamboo houses are owned by the socially and economically weaker sections in the society, economic sustainability is more important than other types of sustainability. Keeping this in view, an attempt is made here to exarnine the economic sustainability of bamboo houses in Kerala and Karnataka.

Indicators of economic sustainability

Indicator is a measure to value a particular aspect and may be a quantitative or qualitative variable which can be a measured or described or a demonstrated trend. Some indicators may not be quantifiable. In cases where there are no reasonable quantitative measures as indicators. qualitative or descriptive indicators are important. Some of the indicators of sustainability. with which we indicate the economic sustainability of bamboo houses are: availability of resources, acceptability and affinity, affordability and adaptability.

Availability of resources

Kerala and Karnataka are endowed with bamboo resources. The most common species found in Kerala are Bambusa *bambos* and *Dendrocalamus* strictus. Species like *Bambusa vulgaris* and *Thyrsostachys oliveri* are also distributed sporadically in the State (Jayashankar. 1996). Only scanty information is available on the increment of bamboos in forests or the extent of distribution in the State. According to one estimate. the growing stock of bamboos in Kerala was about 1.8 million tonnes of air dry bamboos (Chandrasekharan. 1973). Estimate by Tewari (1981) shows about 63.000 ha. of bamboo forests of which *B.bambos* occupied 22,000 ha. Krishnankutty (1998) has estimated demand and supply of bamboo in Kerala. According to him, forests and homesteads are the two major sources of supply of bamboos in Kerala, accounting for 37 and 63 percentages respectively (Appendix 3).

In the State. there are two pulp and paper mills *viz.,* Grasim Industries, Hindustan Newsprints Limited, and Punalur Paper Mills, using bamboo as a raw material. Though Forest Department has the contractual obligations to supply raw material to these industries, often they are unable to meet even 50 per cent of the requirements. This acute shortage in raw material availability from forests has forced many of these industries to purchase bamboos from open market. The presence of an established market in Kerala has prompted even Mysore Paper Mills in Karnataka to import bamboos from Kerala. Large quantities of bamboos are also imported by the bamboo traders and agriculturists of Tamil Nadu from Kerala (Jayashankar, 1996).

The bamboo market in Kerala is mainly concentrated in the northern region. especially in Palakkad and Malappuram districts. Of this, about 80-90 per cent of the bamboo depots are functioning in Palakkad. There are about 94 registered depots. of which 37 are functioning. About 90 per cent of supply of bamboo from the homesteads is traded through the private depots and their major buyers are bamboo traders of Tamil Nadu and pulp and paper mills.

In Karnataka. forest is the major source of supply of bamboos. Total bamboo area of the State was estimated as 5.00.000 ha. (Bennet. 19931. Total production of bamboo in Kamataka was estimated as 67,834 tonnes during 1996-97 and it declined to 52.318 tonnes in the following year

(Table 12). Bamboos occur almost all over the State but is concentrated in the moist deciduous tracts of northern. central and southern zones. *Bambusa bambos* and *Dendrocalamus* strictus are the two main species which occupy 50 and 40 per cent respectively of the total bamboo areas. No information is available on the supply of bamboo from homesteads in Karnataka (Bennet, 1993). Details of bamboo consumption by major groups are presented in the Table 13. Medars. who belong to the economically weaker sections in Karnataka are traditional users of bamboo, making mats, baskets and incense sticks. The pulp and paper industry is another consumer of bamboo in Karnataka.

Table 12. Region-wise production of bamboo in Karnataka (in tonnes)

Regions	1996-97	1997-98
Dakshin Kannada	43.166	15.966
Kodagu	4573.587	1133.427
Belgaum	1810.747	2486.600
Dharwad	100.000	0.000
Mysore	3245.801	1993.150
Uttar Kannada	44519.399	24218.164
Shimoga	7645.636	8700.423
Chikmangalur	5682.629	13770.763
Bangalore rural	213.333	0.000
Karnataka	67834.298	52318.493

- Source: Collected from ICFRE, Bangalore

From the above discussion, it may be concluded that both the States are endowed with plenty of bamboo resources and a major quantity of bamboos produced in the States are consumed by the industrial sector.

Table 13. Major consumers of bamboo supplied by Karnataka Forest Department

	1995-96				1996-97			
	Medar (nos)	Inst. (nos)	others (nos)	MPM (tonnes)	medar (nos)	Inst. (nos)	others (nos)	MPM (tonnes)
1. Bhadravati	854960	1350	22100	5324.3	376325	4500	14700	998.127
Big bamboo	145860	1100	20200	-	90100	3000	13400	-
Small bamboo	709100	250	1900	-	286225	1500	1300	
2. Chickmagalore	141306	0	0	2259.3	78000	0	0	1864.78
Big bamboo	141306	0	0	-	78000	0	0	
Small bamboo	0	0	0		0	0	0	
3. Koppa	8723	16792	28753	1267.6	125683	8700	3500	194.15
Big bamboo	8723	16792	28753	-	114800	8700	2000	
Small bamboo	0	0	0	-	10883	0	1500	
4. Sagar	5000	0	30000	0	4500	0	600	0
Big bamboo	3000	0	30000		1500	0	600	
Small bamboo	2000	0	0	-	3000	0	0	
5. Shimoga	73106	34000	28735	638	48350	65335	15780	239
Big bamboo	46816	34000	28335	-	37840	59735	15230	
Small bamboo	26290	0	400	-	10510	5600	550	
6. Shimoga circle	1083095	52142	109588	-	529538	78535	34580	
Big bamboo	345705	51892	107288	-	218920	71435	31230	
Small bamboo	737390	250	2300	-	310618	7100	3350	

* Inst. - Institutions
• MPM - Mysore Paper

The sustainability of bamboo houses, to a large extent, depends on the availability of bamboos. In both the States, there will not be any dearth of bamboo required for the housing sector. For instance, the estimated quantity of bamboo for house construction in Kerala is much lower than the total supply of bamboo. But the main constraint in this regard is that the industrial sector competes with the construction sector and takes away a significant portion of the supply, by offering a higher prize. This often results in non-availability of bamboo, at a reasonable price, to the construction sector. Thus, in order to increase the supply to the construction sector. changes in the present policy are essential. This includes reservation of bamboo from forests to housing construction sector, establishment of depots in different parts of the States and supply of subsidised bamboo for housing to the low income groups.

Acceptability and affinity

These aspects have been discussed in the preceding pages. under the heading socio-cultural acceptability. As mentioned earlier, people especially the low income groups have an affinity towards bamboo houses and are willing to accept the same. This is especially true in the case of construction of tiled bamboo houses.

Affordability

Affordability is also an important factor for the construction of bamboo houses, which depends upon the income of the people and the cost of material especially that of bamboo.

In Kerala. about 55 per cent of the families dwelling in thatched houses have an annual income of less than Rs.20.000. while others receive a higher income (Table 14). On the other hand. only 21 per cent dwellers of the tiled house, fall in the category of less than Rs.20.000 and the rest in the above Rs.20.000 category. The trend is more or less same in Karnataka also. The income of the owners of tiled houses is higher than those dwelling in thatched houses, indicating that the level of income is one of the determinants in deciding the type of bamboo houses to be constructed. In other words. with an increase in income. the households may opt for tiled bamboo houses.

In Kerala. bamboos required for construction are obtained mostly from homesteads. The house owners purchase bamboos either from homesteads or from depots. which are located in different places. Thus. bamboo price in the midland and lowland areas of Kerala is less when

compared to that in mid and lowlands of Karnataka, but higher than that in the highland areas. One obvious reason for this is the saving on the transportation costs when purchased from homestead directly, unlike in Karnataka.

Table 14. Distribution of thatched and tiled houses according to annual income - Kerala and Karnataka

Particulars	Thatched houses-				Tiled houses			
Income in Rs.	Kerala		Karnataka		Kerala		Kamataka	
Below 10000	14	(9)	6	(11)	0	(0)	0	(0)
10000 – 20000	77	(46)	25	(45)	3	(22)	6	(19)
20000-30000	47	(28)	17	(30)	8	(57)	17	(55)
Above 30000	28	(17)	8	(14)	3	(21)	8	(26)
Total	166	(100)	56	(100)	14	(100)	31	(100)

Figures in parenthesis represent percentages

It is generally said that about 10 per cent of the total production of bamboo in Karnataka has been set apart for the construction sector at a reduced rate, which is Rs. 10 for one culm. But, the problem is that people who are in need of bamboo for construction have to come to bamboo depots which are located far away in the production centres. High transportation cost and other handling charges make it less attractive for them and they finally depend on the private depots for meeting their requirement.

In Kerala, the problem is slightly different. The thick bamboos collected from the forest are supplied to the organised industry. Except some people living nearby the forest areas who cut bamboos illegally and use for house construction, others depend on homesteads and other private depots for meeting their requirement. During the last two decades, there has been a significant increase in the demand for homestead grown bamboos resulting in high prices. The price of bamboo per tonne increased from Rs.36 in 1967-86 to Rs.2.145 in 1993-94 (Appendix 4). resultant of the increase in demand from pulp and paper industry and export to neighbouring states. The agents of the pulp and paper industry purchase bamboo from the homesteads by offering higher prices. Since the farm price of bamboo accounts for only 42 per cent of the price they receive from the industry. bamboo sale is a profitable business for them. Export of bamboo from Palakkad to the neighbouring Coimbatore district in

Nadu provides a profit of 22 per cent to the agents (Jayashankar and Muraleedharan, 1995).This indicates two major problems prevailing in the construction of bamboo houses: good quality bamboos are not available to the construction sector and financial stringency poses a constraint to the weaker sections to purchase bamboo for their construction purposes.

Adaptability

Technology for the construction of bamboo houses is very simple and adaptable to any situation. Small bamboo houses used by low income groups can be constructed by both skilled and unskilled workers. Even dwellers can make bamboo houses without much assistance from the hired labour. Also. bamboo houses can be used by any sections of the society, whether rich or poor (The rich can go for modem bamboo houses with materials like bamboo boards). Bamboo can be used for the construction of small and. individual houses and also community halls like auditorium, and school buildings. Tiled bamboo houses with good quality bamboo are durable and last for at least 25 to 30 years.

The above discussion on sustainability, based on some indicators, points out that bamboo houses are economically sustainable in the study areas, provided some constraints are removed. This requires some changes in the present policy of the government and attitudes of the people. The state governments should give more preference to bamboo based architecture, especially in their housing programmes, like construction of school buildings, low cost housing for poor, etc. Similar to the low cost housing schemes implemented by some government and non-governmental organisations like Nirmithi Kendra and Centre of Science and Technology For Rural Development (COSTFORD)in Kerala, the bamboo based houses may also be popularised. As a pre-requisite, construction of some model houses, with different range of costs may be initiated for demonstration/ popularisation in the study areas.

Bamboo houses in Orissa:An Overview

Housing scenario in Orissa

According to 1991 Census, there were about 5.99 million households in Orissa of which 5.1 million were located in the rural areas and 0.89 million in urban areas. Total residential houses were estimated as 5.63 million with a break up of 4.8 million and 0.8 million in rural and urban areas respectively. As many as 74 per cent of the houses in rural Orissa have thatched roof and 71 per cent are mud walled (SUDA, 1992).

The rural housing shortage as per 1991 Census stood at 0.68 million. Orissa stands sixth in rural housing shortage in the Country. The shortage in Orissa is at 64.37 per cent which exceeds the national average (38.37 per cent). As compared to the national average, Orissa accounts for a shortage of 30.65 per cent in kutcha (semi-permanent) houses and 23. 87 per cent shortage in pucca (permanent) houses. The proportion of pucca houses is very low in Orissa and falls short by 23.87 per cent of national average (30.59 per cent).

Bamboo resources

In Orissa, bamboo occupies about 1.05 million ha. According to the Forest Survey of India. the annual yield potential of bamboo is 0.8 million tonnes. But the actual production (Table 15). is only less than 0.25 million tonnes annually. *Dendrocalamus strictus* is the dominant bamboo species, covering 80 per cent of the total bamboo areas in the State. The next important species is *Bambusa bambos.* accounting for 15 per cent of the bamboo area. Remaining 5 per cent of the bamboo areas is occupied by miscellaneous bamboo species. out of which *Gigantochola rostrata* and *Schizostachyum pergracile* are worth mentioning. Dendrocalamus *strictus* occurs almost all over the State in considerable quantity except in areas such Mayurbhanj. Keonjhar. Sundergarh divisions (Fig. 4). *Bambusa bambos* occurs mainly in valley regions of Angul. Dhenkanal, Athgrah and Berhampur divisions (Bennet, 1993).

Table 15. Details regarding bamboo production in Orissa during 1990-91 to 1997-98

Year	Quantity (in tonnes)
1990-91	2,14,000
1991-92	2.33,000
1992-93	2,41.000
1993-94	2.39.000
1994-95	2.38.000
1995-96	2,15.000
1996-97	2.46.000
1997-98	2.05.000

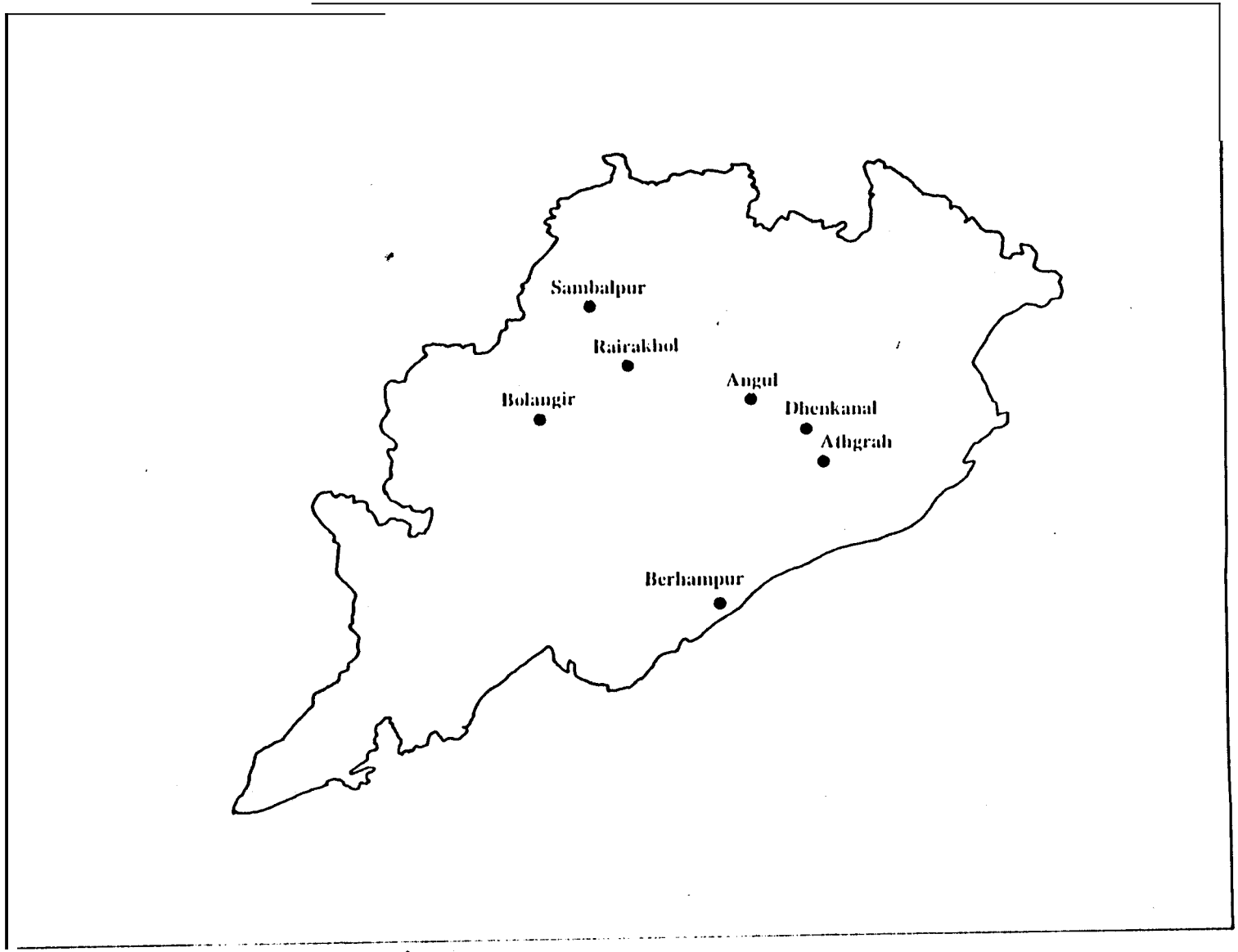


Fig.4. Major resource areas in Orissa

Although. Orissa is one of the important bamboo growing areas in the Country. it is estimated that there is a wide gap between the demand and supply of bamboo resources in the State. Total requirement of bamboo in the State was estimated to be 0.46 million tonnes in 1991 and 0.48 million tonnes in 1996 as against the supply of 0.24 million tonnes (Orissa Forest Department. 1993). About 98 per cent of the total production of bamboo has been sold to industrial sector which consists of traditional industry in the State and pulp and paper industries within and outside the State and 2 per cent to the farmers and other local people for various uses. The Forest Department charges an amount of Rs.1.497 per sale unit of bamboo (1 sale unit = 2,400 running metres) from industrial consumers. while it is cost price from the farmers and other users.

Sustainability, viability and economic feasibility of bamboo houses in Orissa

As mentioned earlier. about 74 per cent of rural houses in Orissa have thatched roof and 71 per cent mud walled. Low affordability, unawareness about sources of funding and unorganised collective efforts have resulted in the predominance of houses made of thatched roof and temporary walls in the villages of Orissa. Of the total thatched roof houses, about 60 to 70 per cent have used bamboo for roofing in rural areas. Bamboos are also being extensively used in some houses in urban areas in Orissa.

We visited about 20 bamboo houses and gathered information regarding various aspects of socio-cultural acceptability. sustainability. viability and economic feasibility. A few PRA meetings mere also organised to collect information regarding the same. The following are some of the important informations gathered from the pilot survey.

1. The dwellers of bamboo houses are poor. belonging to socially and economically weaker sections in the society. They receive income mainly from agriculture and other manual work. The average wage rare of a male worker is Rs.100 and that of a female worker is Rs.60 per day. On an average they get employment for about 10 to 15 man days per month.

2. Most of the dwellers in the bamboo houses were born and brought up in bamboo thatched houses and about 40 per cent were reported to be satisfied with the same. while others expressed dissatisfaction. because of poor amenities. lack of adequate space and frequent repair charges. Most of the people in this group preferred bamboo tiled houses which are considered to be more comfortable and more prestigious.

3. Lack of adequate fund is the major constraint for construction of bamboo tiled houses in Orissa. The State has a number of housing programmes such as Indira Awas Yojana, Kaling Kutir Yojana. Low Income Group Housing Scheme. Middle Income Group Housing Scheme, Millennium Housing Scheme. etc. As the housing problem in Orissa is so vast and acute. they touch only tip of the iceberg.

4. Majority of the bamboo house owners purchased bamboo from either homesteads or from local depots. The latter procure bamboo either from homesteads or from forest depots. There exist price differences between forest and private bamboo depots. As thatches are available in plenty and quite often obtained free of cost. they generally prefer thatched houses.

5. Bamboo tiled houses are found to be less in Orissa than Karnataka and Kerala, probably because the people are poor and tiles aremore expensive in Orissa. Thus. sustainability, viability and economic feasibility of bamboo based houses in Orissa. like the other two states. depend -upon affordability. which in turn depends upon increase in income and availability of cheap bamboo and tiles.

6. The State of Orissa. quite often takes the brunt of natural calamities like flood. drought. tornado or cyclone. People feel that bamboo houses are more suitable for their environment. Thus. there is much scope for construction and popularisation of bamboo houses in Onssa.

Can we promote bamboo houses?

It was found that a good percentage of people in the study areas are satisfied with bamboo houses. particularly. tiled houses. In this context one question is. can we promote bamboo houses in the study areas? Before answering the question. major constraints for the construction of bamboo houses are to be identified. Low economic condition of the people is the main constraint for the construction of bamboo tiled houses. In addition to this, lack of availability of good quality bamboo. especially in low and midland areas. also figured. Thus. removal of these constraints is one of the essential conditions for promoting bamboo houses in the study areas.

The poor economic conditions of the people in the study areas are contributed by two factors: (i) most of the people are casual labourers who are not getting regular employment, and (ii) unemployment level among the dwellers is very high. Data show that about 80 per cent of the sample

households with tiled houses are higher income groups. In other words higher income earners prefer tiled houses to thatched ones. Thus, in order to improve housing situation in the study areas, the income of the households should be enhanced by providing employment opportunities to the people.

Out of the thatched and tiled bamboo houses, the latter is better and more acceptable to the people. The government can implement housing schemes either to replace thatched bamboo houses with tiled ones or to construct new tiled houses. In this context, one scheme *'Ashraya'* being implemented by the Karnataka Government is to be specially mentioned. The aim of this scheme is to construct tiled bamboo houses and supply to economically weaker section in the society at free of cost. Some of the respondents in Shimoga region are the beneficiaries. However, this scheme could benefit only a negligible percentage of the population which needs financial help for house construction.

Bamboo, is available in plenty in the study areas. Due to reasons such as subdivision and fragmentation of land. and low holding size, bamboos are being removed from the homesteads. Further, due to commercial exploitation of bamboos in homesteads carried out by the agents of pulp and paper mills, supply of bamboo has declined and the price has gone up significantly in Kerala. In Karnataka, bamboo production is concentrated in certain regions and bamboos are supplied to other areas by the traders. who, quite often. supply immature and unprocessed bamboos at exorbitant price.

Thus, the state governments can study the ways and means for rationing the bamboo for the sake of poor people who are living at a far off place from the source. Further. the government can sell bamboo at a reasonable price and also through better processing, preservation techniques, etc., to ensure optimal utilisation of bamboo in the housing sector.

The Kerala and Karnataka Governments are implementing a number of housing schemes for different income groups and various schemes implemented in Kerala are presented in Appendix 5. They also construct a large number of houses for community uses like schools. Most of the houses are tiled wooden houses with semi-permanent or permanent structure. In some construction, Casuarina is used for roof, because it is cheaper than bamboos, the price difference being 20 to 30 per cent. Quality-wise. Casuarina is far inferior to bamboos in the case of strength and its longevity is only about 5 to 7 years as against at least 25 years in the case of good bamboos (based on survey). It appears that the

government is not aware of the quality and superiority of bamboo as a construction material. Bamboo is the most versatile building material because of its ready availability, low cost (compared to wood), high strength/weight ratio and capacity to absorb more energy. The tensile strength of bamboo is nearly equal to that of mild steel, varying from 1.400 to 2,800 kg/cm^2 (Punhani, 1998). For popularising bamboo houses, more awareness regarding its quality and superiority should be created among the people and as part of this some model bamboo houses with different types of structures should be built in different parts of the study areas.

A model house

One of the drawbacks of bamboo houses in the study areas is that it is only a semi-permanent structure with less amenities and poor looks. Thus, for popularising bamboo houses, the present construction should be modernised with more amenities and better appearance at a reasonable cost which will enhance the social esteem of the dwellers. In collaboration with COSTFORD, an attempt was made to develop a plan and estimate of a model bamboo house. This is for those people who are interested in possessing a small house with various amenities (more ventilation, cupboard, doors, windows, toilet facilities. etc. that are non-existent in the existing structures) and having a longer life span. This model is also designed to satisfy one's aesthetic tastes.

COSTFORD is ,a registered non-profit making voluntry organisation of scientists, technologists, educationists. professionals. architects, and social workers. One of the objectives of this organisation is to deal with problems of poor, especially the rural poor. Among various activities. the COSTFORD has made commendable achievement in the matter of transfer of technology especially the design and construction of low cost houses for tribals and other weaker sections. Further, COSTFORD has been assigned the task of providing technical advice and guidance for the construction of houses using locally available materials and cost/energy-effective technologies. To their credit, they have constructed thousands of low cost houses in different parts of the State.

Plan and estimate of a low cost bamboo house, with plinth area of about 25.52 m^2. is given in Appendixces 6a and 6b. The house contains one bed room, living room, kitchen and toilet. Other features of the model house are: bamboo with mud mortar for foundation, bamboo windows, bamboo

ply shutters for doors and windows, mud plastering for walls inside and outside. flooring with brick bats and bamboo roof with tiles. The cost of a house is estimated as Rs.35.000. The estimated cost of a bamboo tiled house in the study was Rs.21.566 in Karnataka and Rs. 18.857 in Kerala. This was worked out at the price level of the year of construction. At the current price level. this would be about Rs.32.000 per house and average cost per sq. m. amounts to Rs.551 in Kerala and Rs.444 in Karnataka. However, the cost per sq. m. for the model house worked out to be Rs.1,371 per sq. m. It is true that the cost per unit of the model house is significantly higher than that of the existing one. but its longevity, durability. appearance, compactness and other amenities make it far superior.

CONCLUSIONS

1. Most of the dwellers of bamboo houses belong to the socially and economically weaker sections in the society. Probably due to their poor economic condition. they opt for low cost bamboo houses.

2. Bamboo plays an important role in the housing sector in the study areas. In Kerala, demand for bamboo for the construction sector is estimated to be 9,100 tonnes per year. which is less than the total supply of bamboo in the State. A good proportion of the selected respondents are aware of the construction technology and traditional bamboo preservation techniques.

3. Recently the price of bamboo has gone up because of high demand from pulp and paper industry, which forcespeople to go for cheaper materials like Casuarina poles. Forests and homesteads, two important sources of supply of bamboos in the study areas, divert the resources to those sectors which offer better price. Thus. availability of bamboo for the construction sector at a lower price has declined in the study areas.

4. There is strong evidence to show that dwellers of bamboo houses prefer tiled bamboo houses because of its superiority to thatched houses. The economic feasibility and viability tests also show that the cost of maintenance of this type of house is less and the benefits accrued are more, compared to thatched bamboo house. People living under thatched roof have strong preference to construct tiled houses. if financial help is provided.

5. Low income of the dwellers is one of the reasons for not modifying thatched houses into tiled houses. Thus. economic conditions of the dwellers must be improved to construct more tiled bamboo houses. People prefer to construct tiled bamboo houses if they get bamboo at a cheaper rate. Quality bamboos, at low cost. must be made available to people who wish to construct bamboo houses.

Suggestions

1. Bamboo. a woody plant with short maturity cycle and suitable for house construction. may be grown in wastelands and mid and lowland areas in Karnataka to increase the supply. Cultivation of bamboo in homesteads of Kerala may be encouraged and this can also be included in the plantation programmes of the Forest Departments in the study areas.

2. Bamboo houses are not preferred in many places owing to the non-availability of good quality bamboo. Thus, good quality bamboos from forest may be made available to the housing sectors. Rationing of bamboos in areas where its supply is less or price is more, can be thought of. More bamboo depots may be established by the Forest Departments at different parts of the States so that the dwellers can buy bamboo easily.

3. The state governments should include bamboo as a construction material in their housing scheme and more houses should be constructed with good quality bamboos. Cheap technology for preservative treatment of bamboo should be popularised for construction. Some model bamboo houses suitable for local conditions and weather can be constructed to popularise the same among the people.

REFERENCES

Bennet. S.S.R. 1993. Status of bamboos in India. *In*: National Seminar on Forest Produce, 15-16. October. IFGTB. Coinibatore, 27p.

Chandrasekharan. C. 1973. Forest Resources of Kerala: A Quantitative Assessment. Kerala Forest Department. Trivandrum. 245p.

Jayashankar. B. and Muraleedharan. P. K. 1995. Marketing of Agro-forestry Products: A study of Marketing of Bamboos in Kerala. Journal *of* Tropical Forestry, 1 1 : 149- 158.

Jayashankar. B. 1996. Economic Analysis of Forest Resource Management: A Study of Bamboos in Kerala, Ph.D Thesis. FRl Deemed University. Dehra Dun.

Kathrine Fox. 1998. Rural Housing in Kerala. A case study of Chavakkad Taluk Rural Housing Co-operative Society. M.A.Dissertation, University of Calicut. Calicut.

Kathrin. S. and Malcolm. H.(Eds.) 1991. Economic and Ecological Sustainability of Tropical Rain Forest Managemenc UNESCO. France.

Kerala Government. 1997. Ninth Five Year Plan 1997-2002. Report on the task force on housing. State Planning Board. Trivandrum.

Krishnankutty, C. N. 1998. Socio-economic and Ecological Aspects of Developing Bamboo Resource in Homesteads of Kerala: Part II Economic and Management Aspects. KFRI Research Report No. 125. Kerala Forest Research Institute. Peechi. 62p.

Mathew. K.M. (Ed.) 1999. Manorama Year Book. Manorama Publishing House, Kottayam. P 125.

Orissa Forest Department. 1993. Orissa Forests, Bhubaneswar.

Prakash. B.A. 1998. Gulf Migration and its Economic Impact: The Kerala Experience. Economic and Political Weekly, 34 : 3209-3213.

Punhani, R.K. 1998. Engineered Use of Bamboo for House Construction - A Review in International Workshop on Engineered Bamboo Housing in Earthquake-Prone Areas. Forest Research Institute, Dehra Dun, 23-26 November.

Singh, J.P. 1997. Forestry Development in Orissa. ORI-FOREST 4 : 1- 13.

State Urban Development Agency (SUDA). 1992. Kalinga Kutira, Orissa: p25.

Tewari. D.N. 1992. A Monograph on Bamboos. International Book Distributors. Dehra Dun. 498p.

WCED World Commission on Environment and Development). 1987. Our Common Future. Oxford University Press. Oxford.

Zachariah. P.K. 1980. The First Working Plan for the Nilambur Special Forest Division 1980-81 to 1989-90. Kerala Forest Department, Trivandrum.

APPENDICES

Appendix la. Different types of houses constructed in panchayats in Kerala during 1991-95

sl. No	District	Thatched 1991-95	Sheeted 1991-95	Tiied 1991-'95	Terraced 1991-95	Total houses
1	Trivandrum	13332	1532	10126	20732	44722
2	Kollam	9288	2044	8632	12664	32228
3	Pathanamthitta	4744	1265	4977	7834	18820
4	Alappuzha	13468	2121	9903	8380	33872
5	Kottayam	8710	2841	9544	8272	29367
6	ldukki	5254	2257	3141	2076	12728
7	Ernakulam	6352	2798	11484	20046	40680
8	Thrissur	12108	911	8512	22077	43608
9	Malappuram	9731	742	16430	17972	44875
10	Palakkad	5128	1598	10406	9558	26690
11	Wayanad	2803	1104	3408	2553	9868
12	Kozhikode	8244	525	12211	21763	42743
13	Kannur	3327	637	11463	17072	32499
14	Kasaragode	2308	180	8812	7836	19136
Total		103797	20555	129049	178435	431836

Source: State Planning Board, Kerala

Appendix 1b. Different types of houses constructed in Municipalities in Kerala during 1991-95

Sl. No	District	Thatched 1991-'95	Sheeted 1991-'95	Tiled 1991-'95	Terraced 1991-'95	Total
1	Trivandrum	514	82	654	2056	3306
2	Kollam	236	167	408	1301	2112
3	Pathanamthitta	123	55	599	1502	2279
4	Alappuzha	639	192	4392	2455	7678
5	Kottayam	90	243	432	1071	1836
6	Idukki	38	-	306	336	680
7	Ernakulam	302	271	1151	5843	7567
8	Thrissur	183	112	483	5138	5916
9	Palakkad	56	25	349	1750	2180
10	Malappuram	102	24	2198	3207	5531
11	Kozhikode	262	1	389	2434	3086
12	Wayanad	10	20	38	66	134
13	Kannur	20	-	859	3107	3986
14	Kasargode	56	12	684	1010	1762
Total		2631	1204	12942	31276	48053
%		(5.5)	(2.5)	(27.0)	(65.0)	(100.0)

Source: State Planning Board, Kerala

Appendix 1c. Different types of houses constructed in corporations in Kerala during 1991-95

Sl.No	Corporation	Thatched	Sheeted	Tiled	Terraced	Total
1	Trivandrum	400	121	823	7480	8324
2	Kochi	112	1254	4394	12637	18397
3	Kozhikode	327	81	1629	3894	5931
Total		839	1456	6846	24011	33152

Source: Planning Board. Kerala

Appendix 2. Estimation procedure of cumulative repair cost of thatched and tiled bamboo houses

THATCHED HOUSE

Database

1. Cost of bamboo used in construction (investment) = AD
2. Expected life of bamboo = AF
3. Cost of roof (in the 0th year) = AH
4. Frequency of repairing thatches = AI
5. Construction cost (or initial investment per house) = AG

Steps

1. Cost of bamboo used for 5 yrs = (AD/AF)*5= AP
2. Thatches cost* (roof cost* *- bamboo cost**) = AH-AD =AQ
3. Thatches cost
   (replacing cost) for 5 yrs = (thatches cost / frequency of repair) *5
   = (AQ / AI) *5 = AR
4. House cost - roof cost. i.e..
   cost of wall. floor. window. door
   and its life is assumed to be 10 yrs = AG - AH = AS
5. Above variables (AS) cost for 5 yrs = AS *5 / 10 = AT
6. cumulative cost of all the matenals used in
   house construction for 5 yrs = cost of bamboo for 5 yrs +
   cost of thatches for 5 yrs + cost of other matenals for 5 yrs
   = AP + AR+ AT = AU = required answer.

Note : * all initial investments only
** for a penod (frequency of repairing)

TILED HOUSES

Database:

1. Cost of bamboo In the cost of zero th year = AD
2. expected life of bamboo = AF
3. Construction cost or investment = AG

Steps

1. Cost of bamboo lor 5 yrs = (AD/AF)*5= AR
2. Cost of other materials used in house construction
   excluding bamboo i.e.. tiles, walls, floor. etc. = AG-AD = AS
3. Cost of other materials' for 5 yrs = (AS/25) *5 = AT
   (* the life of other materials is assumed to be 25 yrs)
4. Cumulative cost for 5 yrs = cost of other materials for 5 yrs +
   cost of bamboo for 5 yrs = AT + AR = AU = req. answer.

For estimation of amortised value

In the case of thatched house. the longevity of thatches is assumed to be five years and the cumulative cost is worked out for five years. Since the period of estimation is only 5 years. which is very shrt. no discounting is carried out for thatched houses. In the case of tiled house. the life was assumed to be 25 years. The mortised value of construction cost for five years was then estimated. The cost of construction of thatched houses and its cumulative construction cost were then added. In the case of tiled houses. mortised value of cost of construction for five years and cumulative cost of repair are added.

Consuming sectors	Demand Quantity		Supply Quantity		
	(Tonnes)	%	Sources of supply to consuming sectors	(Tonnes)	%
Pulp-based industry	64902	38.34	Forests	62463	36.90
			Home-gardens	2439	1.44
Export	374883	22.15	Home-gardens	37488	22.15
Household and their uses	66887	39.51	Home-gardens	66887	39.51
Total	169277	100.00	Forests	62463	36.90
			Home-gardens	106814	63.10

Appendix 4. Price trends of bamboo poles sold through hole sale depots

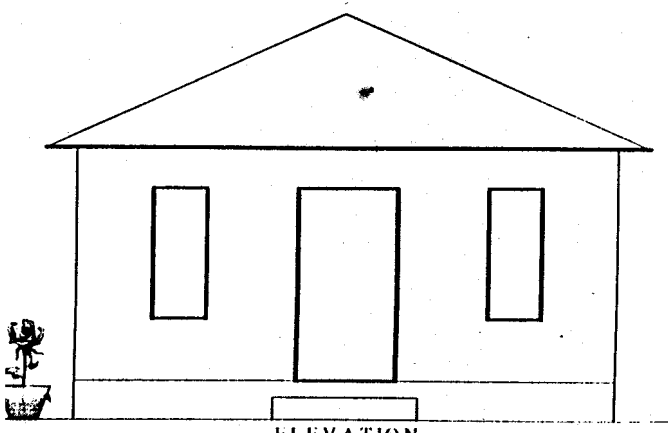
Year	Price Rs.per tonne	
	Current price	1981-82 constant price
1967-68	36	110
1969-70	70	208
1974-75	250	402
1979-80	400	517
1984-85	800	665
1989-90	1200	724
1993-94	2145	865

Appendix 5. Achievements in housing schemes in Kerala

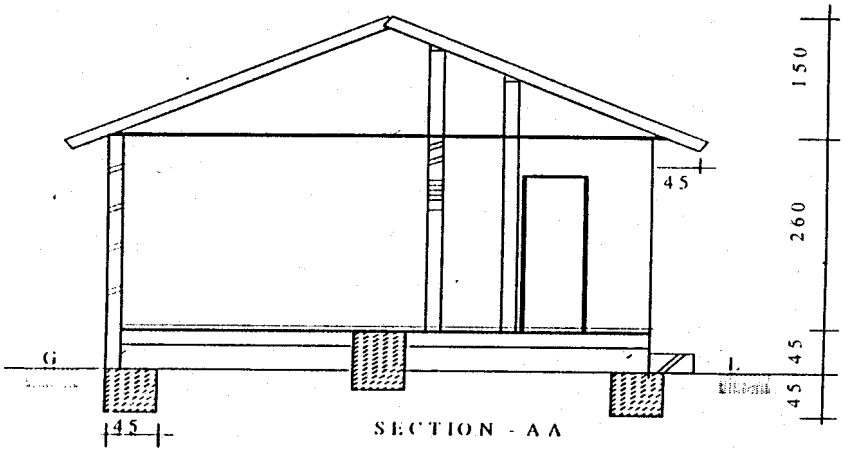
No.	Scheme	1986-87	87-88	88-89	89-90	90-91	91-92	92-93	93-94	94-95	95-96
1	Provisions of house site to rural landless workers	5517	1869	2903	2179	2634	2585	2214	2402	3364	2322
2	Hut/Houses for rural workers	974	366	852	335	396	335	-	-	-	-
3	Village Housing Project	-	-	-	29	52	72	-	-	-	-
4	Low Income Group Housing	-	-	-	28	66	2240	1131	3767	5169	6184
5	Middle Income Group Housing	59	22	27	53	68	1119	603	1621	714	1018
6	Co-operative Housing Scheme for Economically Weaker Section	2625	-	-	-	-	-	-	-	-	-
7	Subsidised Aided Self Help Housing Scheme with co-operation of Voluntary Agency	2090	-	-	-	-	-	-	-	-	-
8	Rental Housing Scheme	-	-	11	78	258	84	-	16	-	-
9	Public Housing Scheme	613	544	488	278	276	878	822	188	2878	68
10	Kudikidappukar Housing	212	-	-	-	-	-	-	-	-	-
11	Scheduled cast/Scheduled Tribe Development Corporation	2215	1916	675	1283	1249	739	1060	1683	2805	2515
12	Tribal Welfare Department	90	350	377	286	404	583	626	880	871	628
13	Scheduled caste Department	159	1166	957	1131	818	985	1135	2030	1844	419
14	Fisherman Housing	2290	3870	6143	869	2211	63	2423	1547	1023	2287
15	Kerala State Co-operative Housing Federation	8387	8658	8716	3502	4577	5313	5563	6231	9386	2236
16	Rehabilitation Housing Scheme	86837	9840	22062	6497	29611	5239	5621	32	-	-
17	National Rural Employment Programme (NREP)	9544	7560	9451	-	-	-	-	-	-	-
18	Rural Landless Employment Guarantee Programme (RLEGP)	14388	11040	8544	-	-	-	-	-	-	-
19	Jawahar Rozgar Yojana	-	-	-	22932	14225	22182	16533	16999	16283	29368
20	Other schemes implemented by Kerala State Housing Board	-	-	-	-	-	4755	6045	2256	11123	1967
21	ROMHS Housing complex	-	-	-	-	-	-	-	996	1486	903
	Total	136000	47201	59816	39374	56785	46772	43776	40648	56946	49915

Source: Katherine **Fox (1998)**

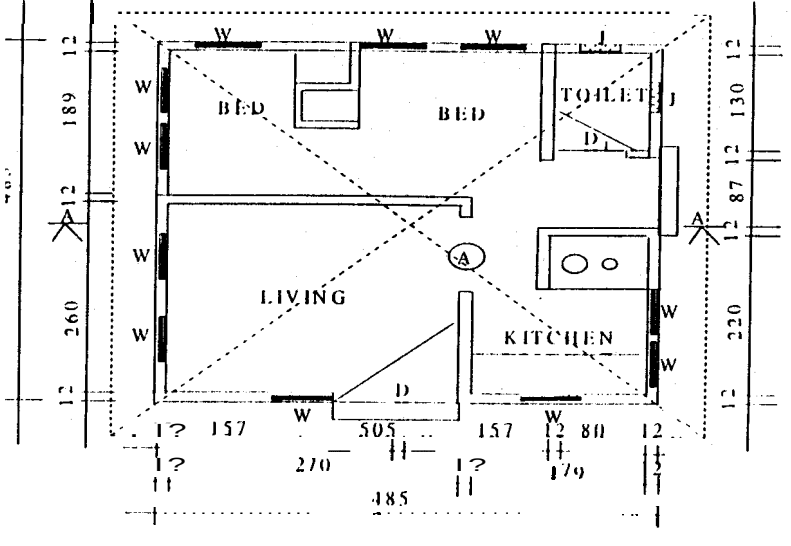
APPENDIX 6a. - PLAN FOR A MODEL HOUSE



ELEVATION



SECTION - A A



SCALE 1 SO ALL DIMENSIONS IN CMS

JOINERY DETAILS			
DOOR	D	90 x 210	J-JALLY WORK
	D_1	70 x 210	A-ARCH
WINDOW	W	60 x 135	

SPECIFICATIONS	
FOUNDATION & BASEMENT:	R.R MASORY IN CM 1:6
SUPER STRUCTURE :	COUNTRY BURNT BRICK WORK IN CM 1:6
ROOFING	BAMBOO & TILES
FLOORING	WITH CM 1:6 OVER PACKED BRICK BATS AND FINISHING WITH OXIDE
DESIGN BY	COSTFORD

PLINTH AREA - 25.52 M^2
253 sq ft

Appendix 6b. Abstract of Estimate Low income group houses with mud and bamboo

Item No.	Details of work	Quantity	Unit	Rate		Amount	
				Rs.	Ps.	Rs.	Ps.
1	Earth work excavation in hard soil and depositing on bank with initial lead 50 m. and lift upto 1.5m including breaking clods. watering. ramming. & sectioning or spoil bank etc. complete	0.65 m3	10m³	571	00	37	00
2	Bamboo with mud mortar for foundation	28.20 m	m	30	00	846	00
3	Brick work in flemish bond with countrv burnt brick	0.9m³	m³	1327	00	1.194	00
4	Mud brick work in mud mortar with mud brick for super structure	7.6m3	m3	751	00	5.708	00
5	Supplying and fixing bamboo for windows including making holes. etc. complete	12m	M	55	00	660	00
6	Supplying and fixing angle hocks for fixing door shutters	4 no	1 no	14	00	56	00
7	Supplying and fixing pivots for fixing window shutter	20no	2 no	10	00	100	00
8	Supplying and fixing bamboo ply shutters for doors and windows	6.20m2	M2	517	00	3.205	00
9	Mud plastering for walls inside and outside, 12m In thick one coat	137m3	10m2	343	00	4.699	00
10	Roofing with first class tiles over bamboo reapers as specified including preservation treatment to bamboo etc. cornulete	40m2	m2	161	00	6.440	00
11	Supplying arid fixing treated bamboo purlins. ratters. collars. etc. as per design with all fixtures etc. complete	Lumpsum		7.000	00	7.000	00
12	Flooring with brick bats arid plastering with CM 1:4. 15 mm thick including neat cement flushing coat	21.03m3	10m²	1.400	00	2.944	00
13	Plastering with CM 1:5. 12mm thick trowelled smooth inside the toilet and outside the basement	9.77m2	10m2	44 1	00	431	00
14	Supplying and fixing Indian type medium level closet iricluding construction of two pit la trine arid cover slab.	Lumpaum				2.000	00
Total						35.320	00
Limited to Rs.35.000/-							

Source: