CHAPTER 1

Background

Land

Air, water and land are basic resources for biological systems. Among these, the land is the most important basic resource for several biological production systems. The land and its soil profile support the plants and other living organisms. The land provides a medium and stores nutrients and water for the growth of plants and animals. Production of food grains, vegetables, fruits, firewood, spices, fodder, timber and other crops largely depends on the land area, type of soil, availability of water, technology and several other physical and socio-economic factors. The soil, which is the uppermost layer of earth crust is important for plant growth and production of several kinds of goods, e.g., agricultural, horticultural, forestry, etc.

Of the total land area of 13,300 million ha in the world, India has only 329 million ha, i.e., approximately 2.4 per cent of the world's area. India has, however, a large human and livestock population. According to the 1991 census, the human population in India is 845 million while that of livestock (1982 census) 416 million, which constitute about 15 per cent and 16 per cent of the world's human and livestock population respectively. Looking to the large human and livestock population, India is very poorly placed as far as land resource is concerned.

Land Problems

Though the total land area of the country is 329 million ha, all of it is not productive. There are several factors which limit the productivity of the land. Some of the important factors include: water stress, physiography, soil erosion, land degradation, floods, etc.

(a) Water stress

For good growth of crops and plants, a sufficient supply of moisture is necessary. Most of the moisture is obtained from rain, dew, snow, etc. This moisture is retained by the soil as soil moisture or ground water and can be available to plants. About 70 per cent of the total land area in the

country faces a varying degree of water stress. The area subject to wind erosion is about 32.0 million ha. It includes 18.8 million ha desert and about 6.5 million ha coastal sandy lands (NCA, 1976a). The desert area is spread over the states of Rajasthan (16.68 million ha), Gujarat (0.70 million ha) and Haryana (1.4 million ha). Coastal sandy lands fall in Orissa, West Bengal, Gujarat, Kerala, Karnataka, Maharashtra and Tamil Nadu. Nearly 2/3rd of the country's cropped area is rainfed. Failure of the monsoon, therefore, adversely affects the productivity of these lands. These lands are primarily used for production of coarse foodgrains, pulses, oilseeds, etc.

A large area of the country is prone to drought. Drought is a general term which implies a deficiency of precipitation of sufficient magnitude so as to affect adversely the agricultural production and, in turn, the economy. Drought causes water stress, which adversely affects the plants and crop yields. It also depletes the surface water and leads to drying of reservoirs, streams, lakes, rivers, etc. During the last one hundred years, the ten worst drought years have been recorded in which more than 50 per cent of the area of the country was affected. Such droughts occurred during 1899, 1901, 1918, 1920, 1941, 1951, 1965, 1966, 1979 and 1987. While widespread severe droughts occur once in a period of about 10 years, the monsoon fails repeatedly in arid and semi-arid areas causing drought conditions in these areas (Table 1).

Table 1: Periodicity of drought in different parts of India (Anon, 1973)

	Area/Region	Periodicity of drought
1.	Assam	Very rare, once in 50 years
2.	West Bengal, Madhya Pradesh, Konkan, Andhra Pradesh, Karnataka, Maharashtra, Orissa, Bihar & Kerala	Once in 5 years
3.	Eastern UP, South interior Karnataka, Vidarbha	Once in 4 years
4.	Eastern Rajasthan, Gujarat, West UP, Rayalaseema, Tamil Nadu, Kashmir	Once in 3 years
5.	Western Rajasthan	Once in 2.5 years

The average productivity of rainfed arable land is low. The monsoon is not certain. There is always some problem in the annual rainfall either in its quantity or in its distribution. Drought causes reduction in agricultural production. It also reduces the availability of fodder. This brings down the national productivity level and also neutralises the efforts to improve the agriculture production per unit area (Anon., 1982; Anon., 1984).

Plate 1. Village wastelands in Uttar Pradesh

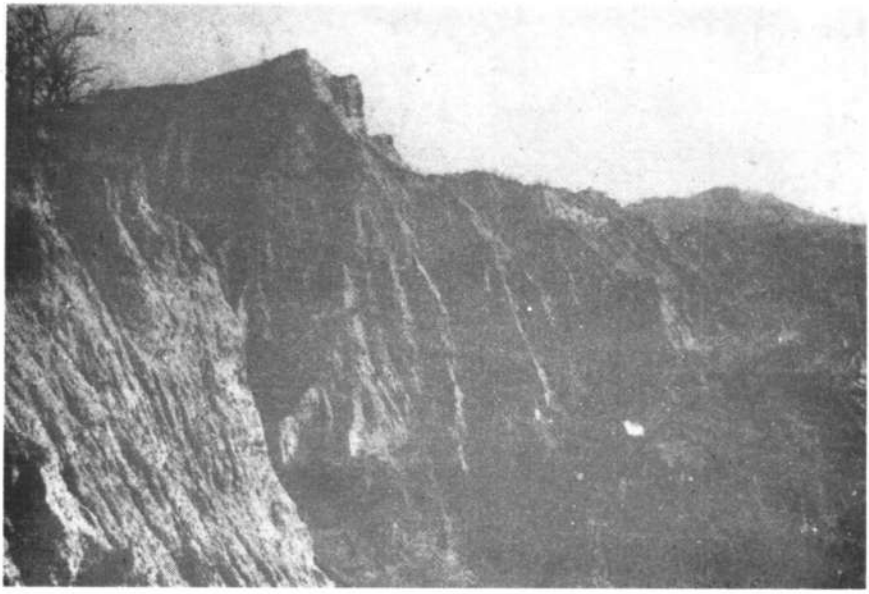

Plate 2. Eroded hill slopes

Plate 3. Floods cause severe losses

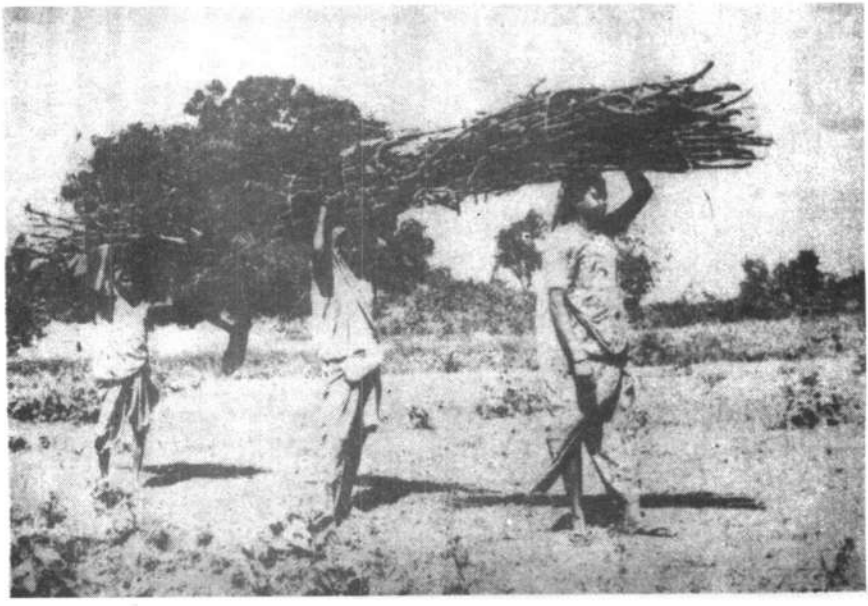

Plate 4. Firewood shortage is a serious problem in rural India

Plate 5. Cowdung made as cakes for fuel

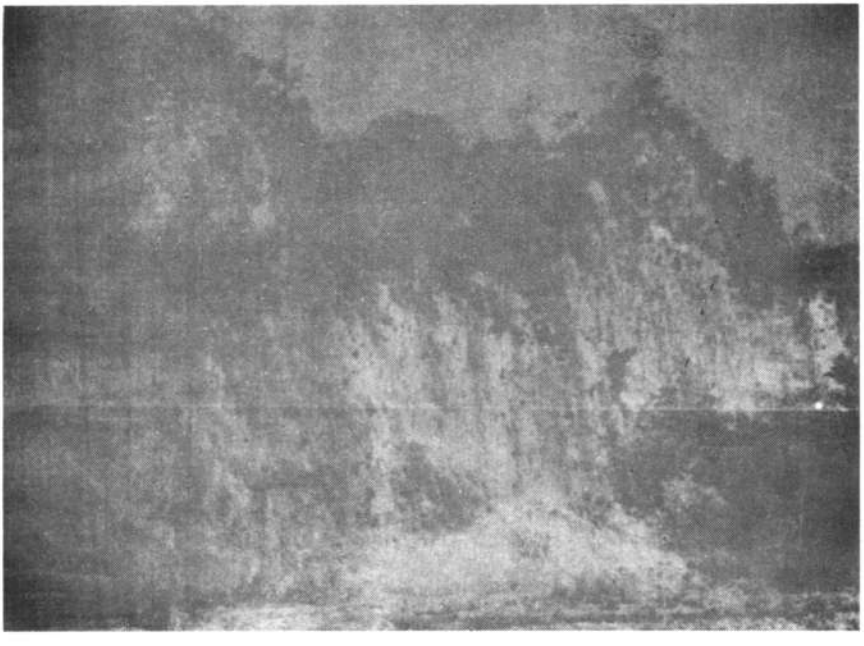

Plate 6. Degraded forest areas

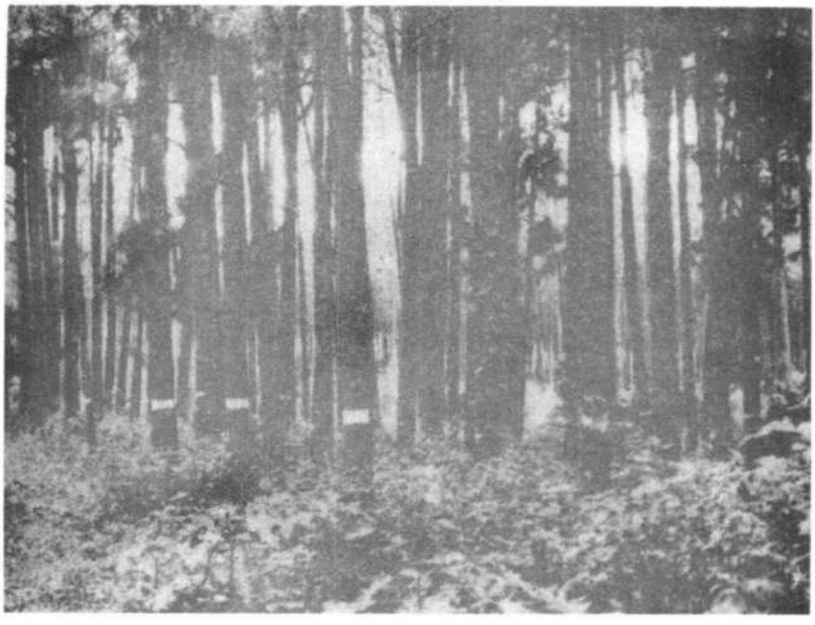

Plate 7. Good forest areas provide environmental protection and supply forest products

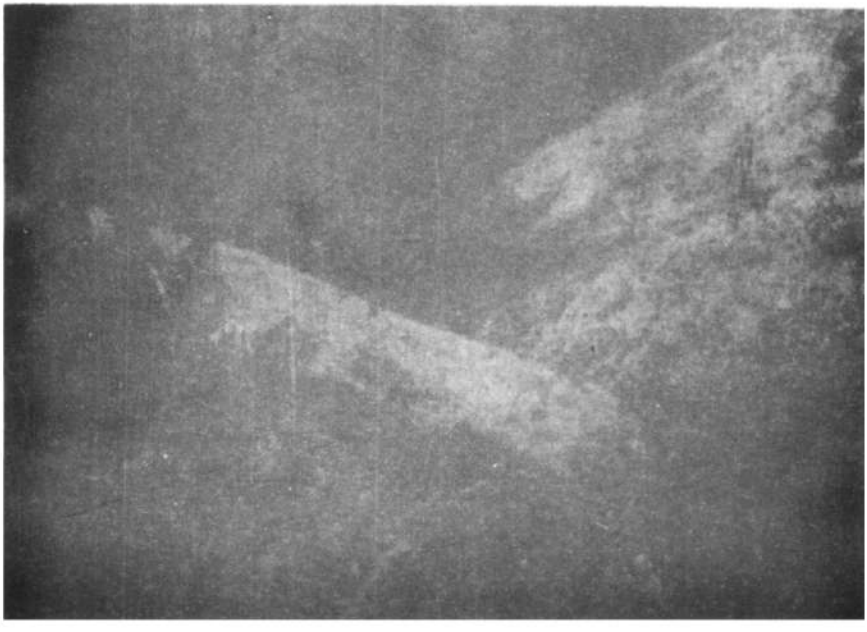

Plate 8. Shifting cultivation in Mizoram

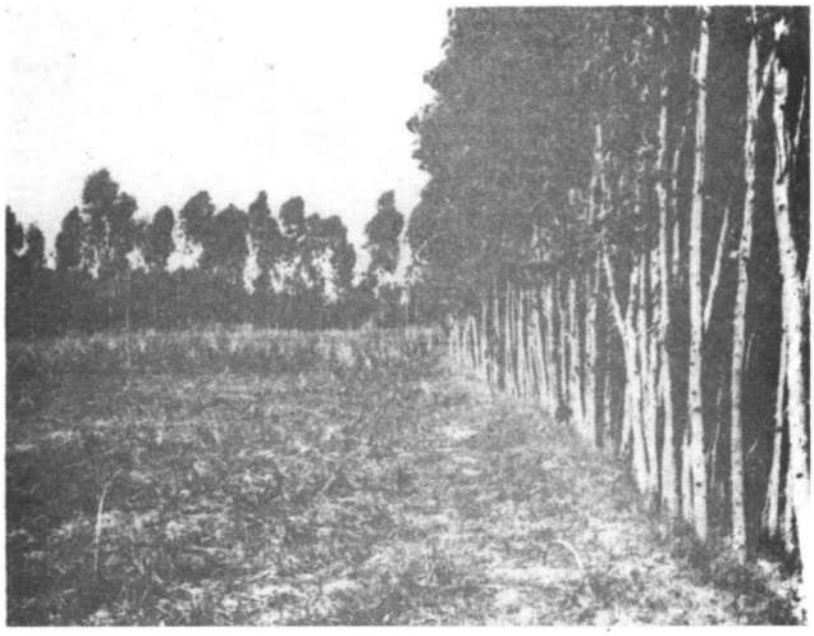

Plate 9. Eucalyptus on field bunds

Plate 10. Agrisilviculture system consisting of wheat + mango + poplar

Plate 11. Poplar ETP are being planted in crop lands

Plate 12. Bund planting of *Syzygium cumini*

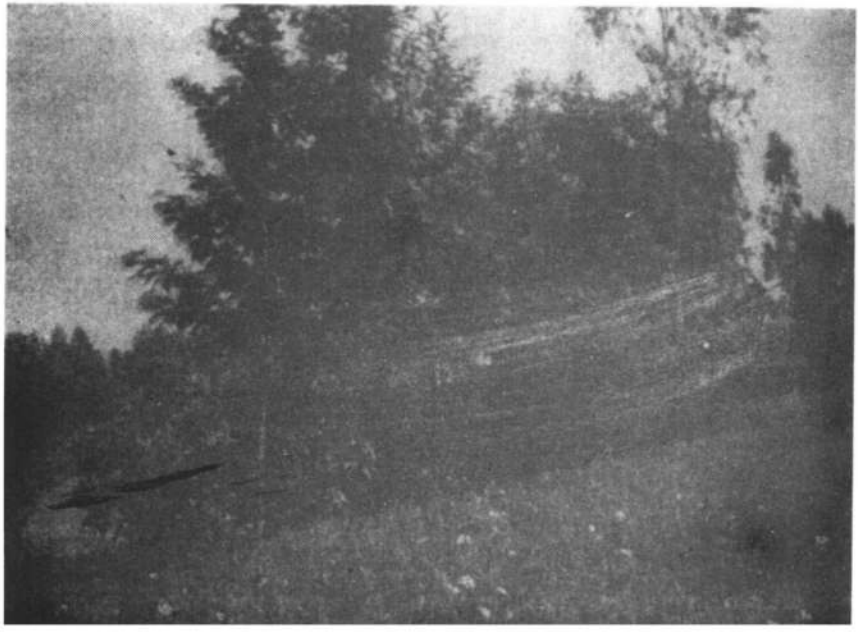

Plate 13. ***Grevillea robusta*** **on field bunds**

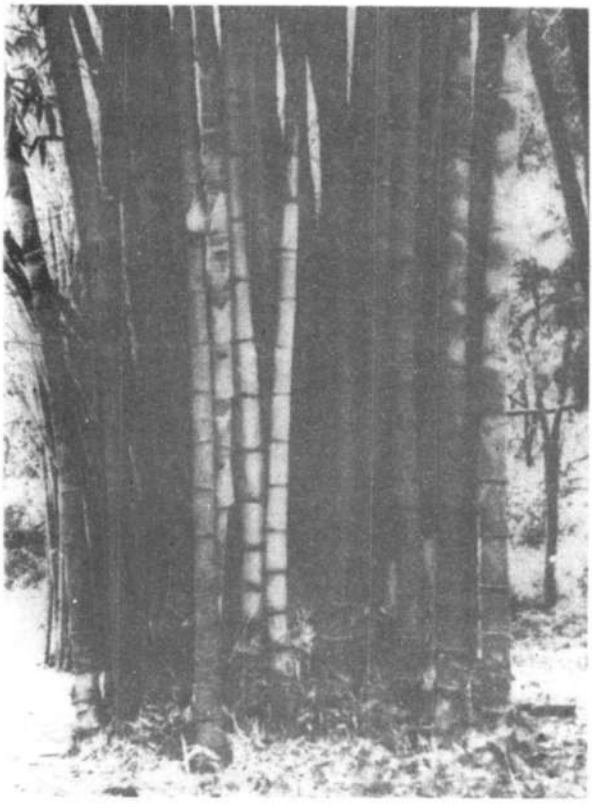

Plate 14. Bamboo, a useful tree in home gardens

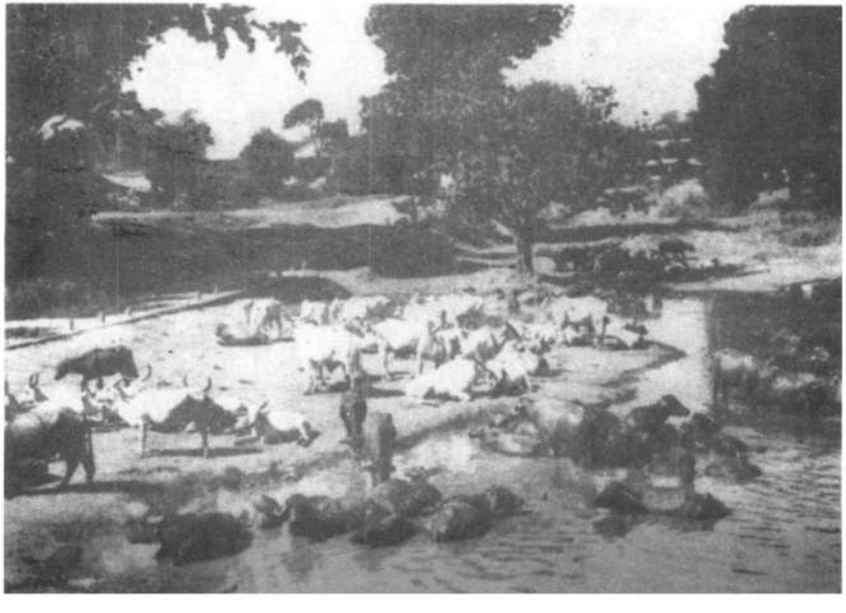

Plate 15. Heavy incidence of grazing in forests and grazing lands

Plate 16. Goat grazing is detrimental to trees and shrubs

Plate 17. Protection leads to abundant grass production for cut and carry

Plate 18. Camels are severe browsers

Plate 19. Fodder tress are severely lopped *(Grewia optiva)*

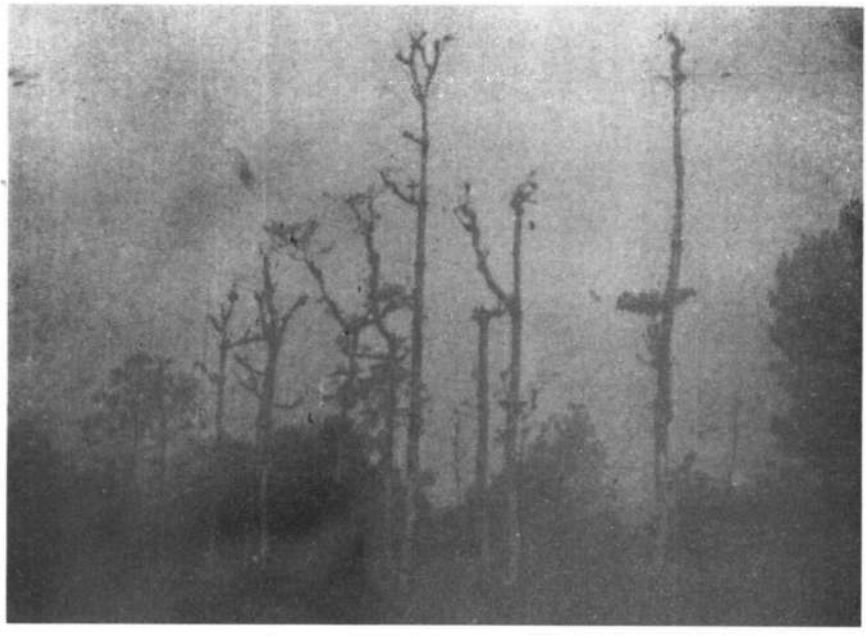

Plate 20. Heavy lopping causes damage to the forest *(Ailanthus excelsa)*

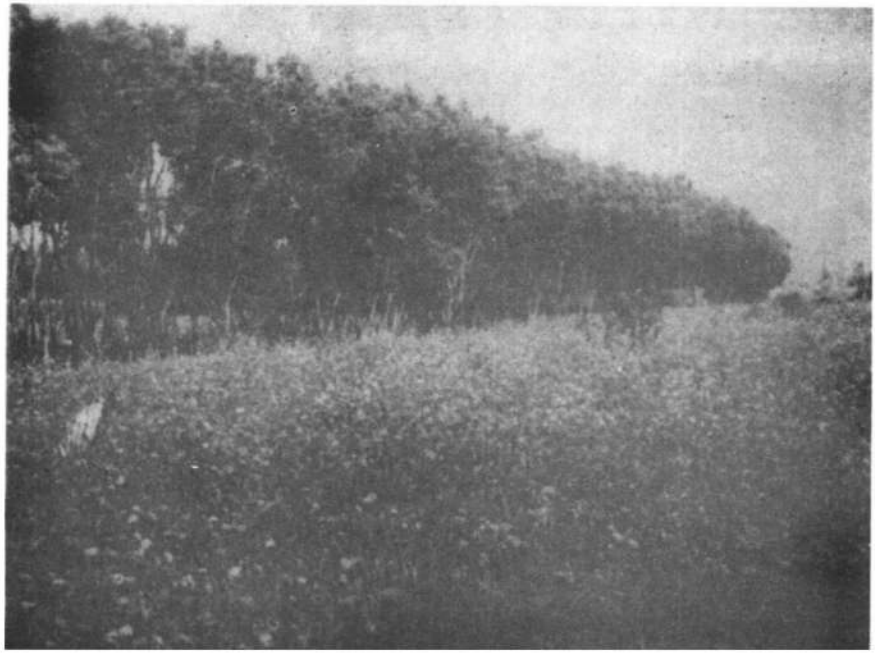

Plate 21. A medium dense windbreak provides protection to agricultural crops

Plate 22. Plantation of subabul on village roads

Plate 23. Plantation along canals

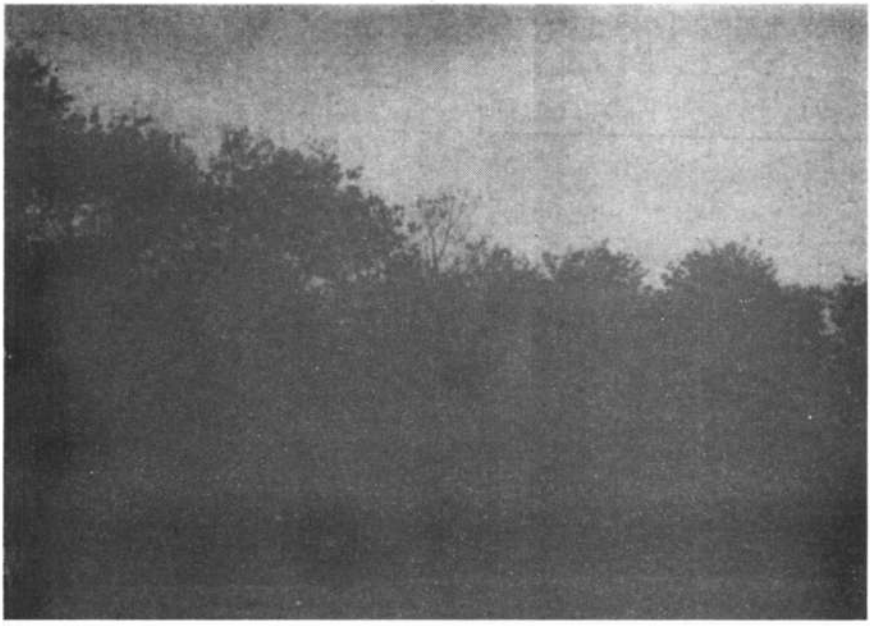

Plate 24. Village woodlots of subabul, babul, sissoo, etc.

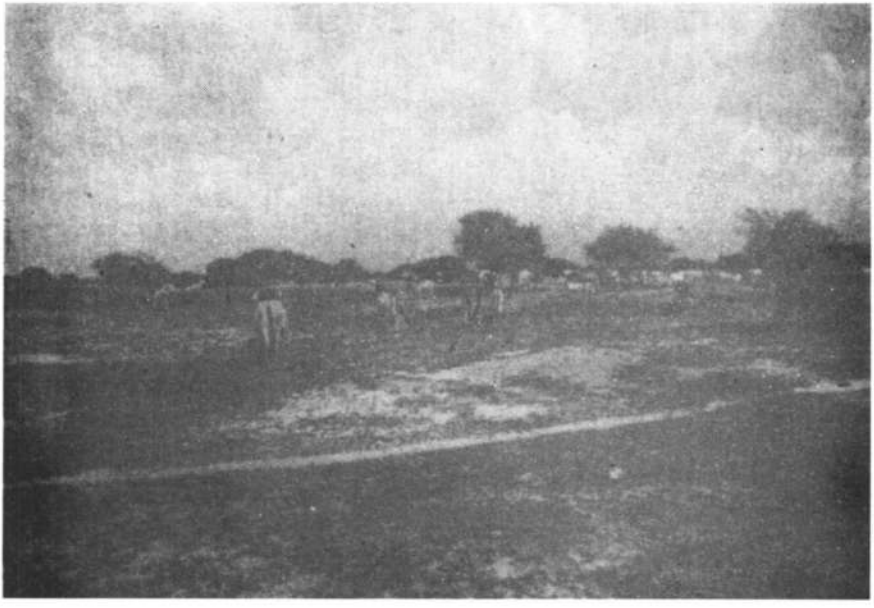

Plate 25. Saline-alkaline areas

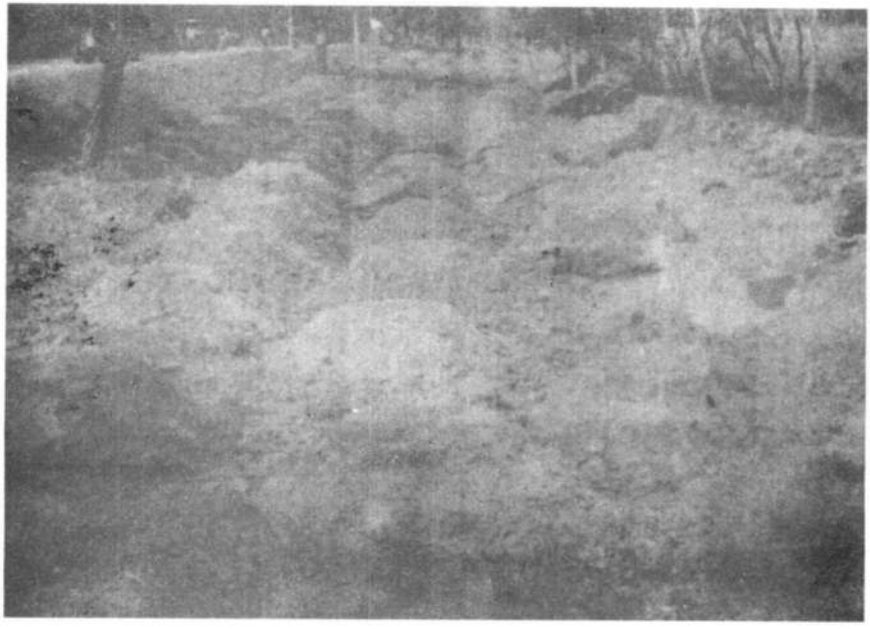

Plate 26. In waterlogged area mounds are prepared for planting

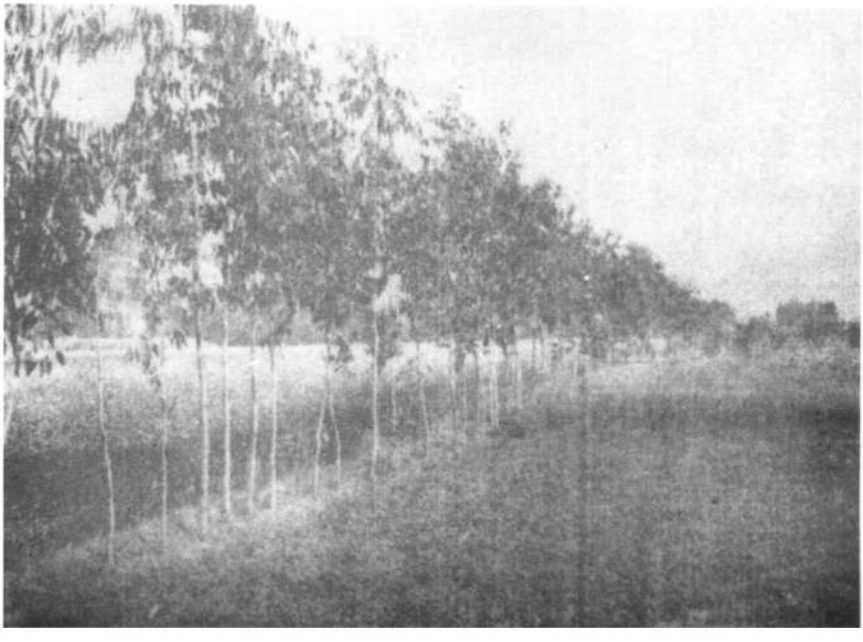

Plate 27. No adverse effect of trees on crops is visible when they are young

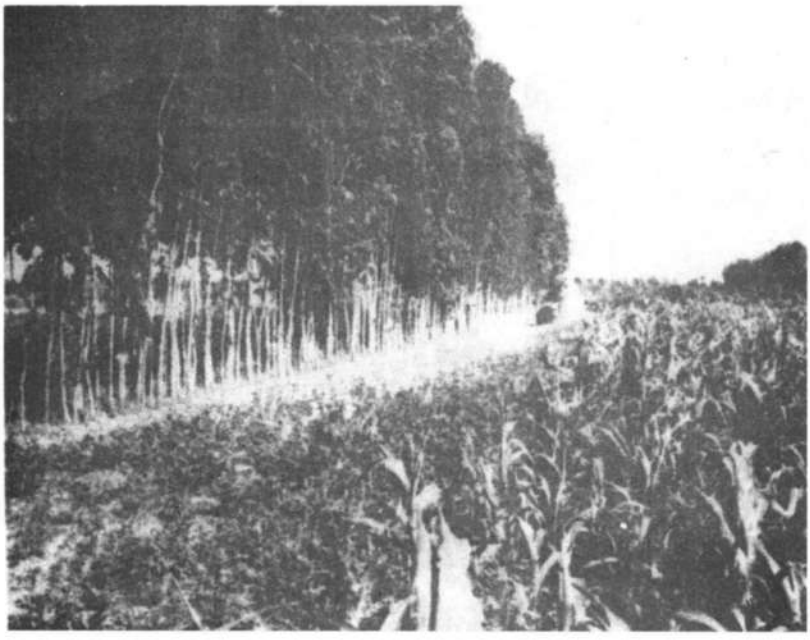

Plate 28. Eucalyptus trees cause adverse effect on agricultural crops in their vicinity.

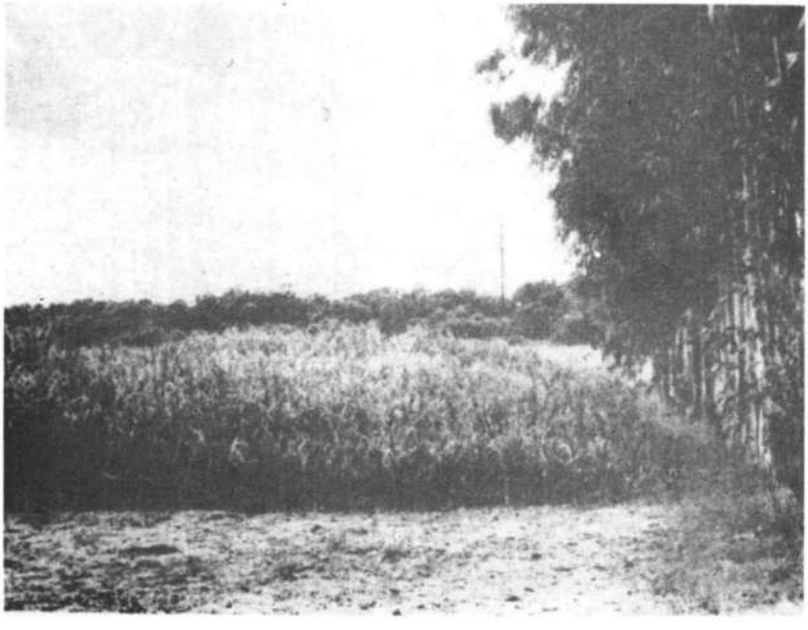

Plate 29. Adverse effect of Eucalyptus is less when sufficient water is available

(b) Physiography

Productivity of the land is also controlled by the physiography, which emerges over long periods and is manifested in the form of mountains, plateaus and plains. The physiography controls altitude, soil depth, slope, drainage and various other soil parameters which are important for influencing the productivity. The water flow in rivers originating from mountains considerably influences the land productivity in the plains. Usually, mountains with high altitudes are associated with steep slopes, low soil depth, adverse climatic factors, etc., and therefore, have low productivity. In India, about 93.06 million ha of 329 million ha of geographical area, is mountainous. The distribution of these areas is given in Table 2 (Anon., 1988).

Table 2: Distribution of montane areas in India

Sl. No.	Region	Area in million ha
1.	Himalayan region	51.43
2.	Vindhyan region	9.27
3.	Satpura ranges	6.60
4.	Western ghats	7.74
5.	Eastern ghats	18.02
	Total	93.06

The productivity in these areas is comparatively low compared to the Indo-gangetic plain. The Satpura and Vindhyan hill ranges consist of hard rocks and the soils derived from them are low in fertility. Therefore, the productivity of these areas is also low. Similarly, the Eastern and Western ghats are montane areas with poor soil conditions. The upper reaches of the Himalayas above 3500 m support no significant vegetation.

(c) Soil erosion problems

About 150 million ha land area is subject to the problem of a varying degree of soil erosion (Das, 1981; Singh *et al.*, 1981; Anon., 1982). The total loss of surface soil is estimated to be about 6000 million tonnes with major plant nutrients of NPK varying from 5.37 to 8.4 million tonnes (Singh *et al.*, 1981; Anon., 1988). Wind erosion is common in an area of 32.0 million ha lying mainly in Rajasthan, Gujarat and Haryana. Various forms of water erosion, e.g., sheet, rill and gully, are prevalent in all land classes, particularly in agricultural lands of high rainfall areas. Various types of lands which are affected by soil erosion and their extent are given in Table 3 (Singh, *et al.*, 1981).

Due to soil erosion, there is a gradual loss in soil productivity. In highly eroded soils, tillage operations become difficult as there is formation of gullies of various dimensions. Soil conservation works have been taken up but

Table 3: Area affected by soil erosion (million ha)

	Land use	Total area	Problem area
A.	*Cultivable land*		
	1. Rainfed-non-paddy	82.1	82.1
	2. Current fallows	14.3	3.5
	3. Fallows other than current fallows	9.6	4.8
	4. Permanent pastures and other grazing grounds	12.5	4.8
	5. Miscellaneous tree crops & groves	3.9	0.8
	6. Culturable wastelands	17.1	8.6
	Total of A	139.5	104.6
B.	*Forest lands*		
	1. Reserved forests	39.0	3.9
	2. Protected forests	23.2	9.3
	3. Unclassed forests	12.6	6.3
	Total of B	74.8	19.5
C.	*Area not available for cultivation*		
	1. Area under non-agricultural use	17.5	3.5
	2. Barren and unculturable wastelands	21.9	4.4
	Total of C	39.4	7.9
	Total of A + B + C	253.7	132.0

progress is slow. The state-wise area subject to soil erosion, land degradation and the area so far treated are given in Table 4.

(d) Wastelands or degraded lands

Wastelands refer to degraded lands which can be brought under vegetative cover with reasonable effort and which are currently underutilised and land which is deteriorating for lack of appropriate water and soil management or because of natural causes (NWDB, 1987). These lands can result from inherent/imposed disabilities such as location, environment, chemical and physical properties of the soil or financial and management constraints. These lands usually suffer from one or more problems such as: (i) low nutrient status, (ii) top soil completely removed due to soil erosion, (iii) difficult land surface due to formation of ravines, gullies, slides, etc., (iv) lack of moisture due to aridity, (v) development of toxicity in the soil, particularly in the root zone, (vi) poor physical conditions and (vii) waterlogging due to impeded drainage conditions.

NCA (1976) took a diagnostic view of wastelands and estimated that the area of such lands in the country is 175 million ha. While making the estimates, NCA included all such lands which were in need of attention and treatment. More recently, attempts were made to identify different kinds of wastelands. Various types of wastelands have been listed which include: (i) gullied and ravined land, (ii) upland with or without scrub, (iii) waterlogged or marshy areas, (iv) lands affected by salinity/alkalinity, both inland

Table 4: State-wise estimated area subject to soil erosion, land degradation and area so far treated (Anon., 1986)

(Area in thousand ha)

State/Union Territories	Problem area		Total	Area treated up to 1984–85
	Soil erosion	Land degradation		
Andhra Pradesh	11,502	729	12,231	772
Assam	2,217	782	2,999	158
Bihar	4,260	2,292	6,552	902
Gujarat	9,946	2,640	12,586	2,283
Haryana	1,591	2,571	4,162	436
Himachal Pradesh	1,914	–	1,914	240
Jammu & Kashmir	883	10	893	187
Karnataka	10,989	414	11,403	3,108
Kerala	1,757	178	1,935	195
Madhya Pradesh	19,610	1,107	20,717	3,825
Maharashtra	19,181	665	19,846	9,550
Manipur	374	360	734	88
Meghalaya	837	265	1,102	91
Nagaland	405	77	482	81
Orissa	4,578	3,225	7,803	619
Punjab	1,007	2,223	3,230	583
Rajasthan	19,902	17,492	37,392	1,553
Sikkim	303	–	303	69
Tamil Nadu	3,640	182	3,822	1,081
Tripura	167	112	279	92
Uttar Pradesh	7,110	6,005	13,115	2,778
West Bengal	1,033	3,270	4,303	310
Union Territories	3,414	400	3,814	–
Total	1,26,620	44,999	1,71,619	29,383
		1,465*	1,465*	
		4,64,604	1,73,084	

*Coastal sandy area not reported by state.

and coastal, (v) shifting cultivation area, (vi) desertic and coastal sands and (vii) wastelands due to mining and industries (NWDB, 1987). The area under these wastelands is not precisely known. However, some of the estimates indicate that the area under such lands may be about 58 million ha as per details given in Table 5 (Singh *et al.*, 1981; Das, 1981; Anon., 1986).

The above list of wastelands does not include the area under uplands, with or without scrub, and wastelands due to mines and industries. If we take into consideration the wastelands under agriculture, forests and pastures, the total area may be approximately 100 million ha (Singh *et al.*, 1981, Anon., 1984a). The productivity of these lands is very poor. Some of these lands could be made productive with proper inputs and adopting proper management systems.

Table 5: Area under wastelands

Category of wastelands	Area in million ha
1. Gullied and ravines	4.0
2. Alkali soils	7.9
3. Saline soils	7.9
4. Coastal sandy area	6.5
5. Shifting cultivation	4.4
6. Riverine land and torrents	2.9
7. Deserts	18.8
8. Waterlogged area	6.0
Total	58.4

(e) Floods

Several areas, particularly those located along big rivers such as the Ganga, the Yamuna, the Brahmaputra, the Godavari, the Mahanadi, the Krishna, the Narmada and their tributaries are flooded, which causes serious loss to crops, houses and other properties. Some of the river systems bring repeated floods along their banks. The total area affected by repeated floods in the country is about 34 million ha (Anon., 1978). Of this, 24 million ha lie in Uttar Pradesh, Bihar, West Bengal, Haryana and Punjab and the remaining 10 million ha lie in Assam, Orissa, Andhra Pradesh, Tamil Nadu and Madhya Pradesh. The main reasons for floods are: (i) shape of watershed, (ii) continuous high-intensity rainfall, (iii) high rate of run-off, (iv) siltation of river beds, (v) change of the course of rivers and (vi) lack of drainage facilities. The area affected and the loss due to floods in some of the past years are given in Table 6 (Anon., 1978; Anon., 1980).

Table 6: Area affected and losses due to floods

Year	Area affected (million ha)	Losses to crops and other properties (million Rs.)
1971	13.25	9,319
1973	13.72	5,619
1975	6.15	4,711
1977	16.09	12,315
1978	10.41	14,369
1980	15.45	8,350

Of a flood affected area of 34 million ha, about 12.75 ha have been provided with reasonable protection. The Rashtriya Barh Ayog (National Commission on Floods) has estimated the total flood-prone area in the country to be 40 million ha, which also includes damage to protected areas (Anon., 1980). On the basis of data for the last few years, the average annual flood affected area is 9.0 million ha (Anon., 1988). The floods are

not restricted to humid areas, but have also become frequent and devastating in arid and semi-arid areas of Rajasthan and Gujarat.

Present Land Use

Of the total geographic area of 329 million ha, land use statistics are available for 304.17 million ha. The present land use statistics and their progress over the last 30 years are indicated in Table 7 (Anon., 1988).

Table 7: Land utilisation in India

	Land utilisation classes	Area in million ha			
		1950–51	1960–61	1970–71	1980–81
1.	*Forests	40.4	60.2	63.9	67.42
2.	Land not available for cultivation (a+b)	47.6	50.7	44.6	39.62
	(a) Land put to non-agricultural uses	9.4	14.8	16.5	19.45
	(b) Barren and uncultivable land	38.2	35.9	28.1	20.17
3.	Other uncultivable lands excluding fallow land (a+b+c)	49.3	37.2	35.1	32.23
	(a) Permanent pastures	6.7	14.1	13.3	12.01
	(b) Land under miscellaneous tree crops and groves	19.7	4.5	4.3	3.49
	(c) Cultivable waste	22.9	18.6	17.5	16.73
4.	Fallow land (a+b)	28.1	21.6	19.4	24.63
	(a) Fallow other than current fallows	17.4	10.5	8.8	9.82
	(b) Current fallows	10.7	11.1	10.6	14.81
5.	Net area sown (6–7)	118.7	135.6	140.8	140.27
6.	Total cropped area	131.9	156.4	165.8	173.32
7.	Area sown more than once	13.2	20.8	25.0	33.05
8.	*Reported area for land utilisation*	*284.1*	*305.3*	*303.8*	*304.17*
	(i) Net irrigated area	20.8	24.6	31.1	38.81
	(ii) Gross irrigated area	22.6	27.9	38.2	49.58

*According to area statistics of forest departments, the area under forest lands is 74.89 million ha.

In the table given above, the reported area stands for the area for which data on land use classification are available either on the basis of land records/village papers or on the basis of *ad hoc* estimates. Area under *forests* includes all lands classed as forests under any legal enactment dealing with forest, whether state-owned or private and whether wooded or maintained as potential forest land. The area *not available for cultivation* covers all lands occupied by buildings, roads, railways or water, e.g., rivers, and other lands put to uses other than agriculture. This category of land comprises almost 40 million ha. The area under *grazing lands and pastures* includes all

such lands which are primarily used for grazing. It includes village common grazing lands but does not include forest area used for grazing. The area under *miscellaneous tree crops and groves* includes all cultivable land which is not covered in the net area sown, but is put to some agricultural use. Lands under *Casuarina*, *Eucalyptus*, Bamboo, thatching grass, other tree groves for fuel, fodder, etc., which are not included under orchards, fall under this category of land use. *Culturable wastes* mean all lands available for cultivation, whether or not taken up for cultivation, but not cultivated during the current year and the last five years in succession. The land may be fallow or covered with bushes and jungle which are not put to use. *Fallow lands other than current fallow* applies to all lands which were taken up for cultivation but have been temporarily out of cultivation for a period of not less than one year and not more than five years. The reasons for keeping such lands fallow may be: (i) poverty of cultivators, (ii) inadequate supply of water, (iii) adverse climate, (iv) silting of canal and rivers, etc. *Current fallows* comprise cropped areas which are kept fallow during the current year. *Net area sown* represents the area sown with crops and orchards, counting the area sown more than once in the same year only once.

It can be seen that over the past three decades, the net area sown has increased by 22 million ha. If the fallow lands, which are temporarily out of cultivation, are also taken into consideration, the area under agriculture is 164.90 million ha.

It would appear that almost all such areas which could be cultivated have been taken up for agriculture and perhaps no more additional land will be available for agricultural purposes. The area under tree crops and groves, though remaining unchanged for the last 20 years, is likely to increase in view of increased prices of wood and scarcity of fuel and fodder. The land put to non-agricultural purposes has been on the increase. During 1950–51, only 9.4 million ha land were under this category which rose to 19.45 million ha in 1980–81. Human settlements alone account for 17.8 million ha of land (Anon., 1988). Due to increase in population, this will continue to increase and encroach upon the land under agricultural and other uses.

Present Production

(i) Foodgrains: Agriculture is an important sector in the country's economy. It provides a livelihood for about 70 per cent of the labour force, contributes nearly 35 per cent of the net national product and accounts for a sizable share of the total value of exports. Per capita net availability of foodgrains was up to a level of 478 gms/day in 1986 as compared to 395 gms/day in the fifties. The foodgrain production has been showing an increasing trend due to use of improved seeds, fertilisers, increase in irrigation and other inputs. Table 8 shows some of the key indicators of agricultural progress

(Anon., 1988a). It would appear from this table that agricultural production has been increasing continuously. There has been a proportionate increase in the use of fertilisers, improved seeds, availability of credits, etc.

The production of foodgrain is such that the country is not only able to meet domestic requirements but is also able to export some rice and wheat to other countries. During 1986, about 250,000 tonnes of wheat were exported to Nepal, Vietnam and some other countries. However, there is a shortage of oilseeds and pulses.

(ii) Fodder: Production of sufficient fodder to meet the demand of a high livestock population is one of the goals of land use. At present, the important sources of fodder are agricultural crop residues, grass and grazing, agricultural green fodders, tree leaf fodders, etc. Among agricultural residues, the important ones are straw of cereals, such as wheat, paddy, barley, maize, millets, pulses, etc. Grass and grazing also constitute important sources of fodder in India. Several kinds of areas, e.g. forests, pasture and grazing lands, culturable wastelands, fallow lands, lands under miscellaneous tree crops, etc., which constitute about 136.99 million ha provide grazing facility. Agricultural green fodders are grown over an area of 4 per cent of the total cultivated area. Of this, 20 per cent is under irrigated fodder production. The present production of fodder in India is estimated as under (Table 9).

(iii) Firewood and timber: Firewood occupies a predominant position as an energy source in rural India. As against the estimated requirement of about 157 million tonnes of fuelwood per annum, the supply is about 40 million tonnes, of which, recorded production is only 15 million tonnes (Anon., 1988b). Because of scarcity of firewood, 73 million tonnes of cow-dung and 41 million tonnes of agricultural residues are burnt as fuel (Anon., 1979; Anon., 1981). The constructional and industrial timber which are important forest produce are also not in adequate supply. The present recorded production of timber is about 12.5 million m^3 as against the requirement of 27.5 million m^3 (Anon., 1988b). The country is already importing a large quantity of timber logs and paper pulp to meet the domestic needs.

Population

India has the second largest human population in the world, only next to China. According to the 1981 census, the total population of the country is 685.17 million which was only 361.13 million during 1950–51 (Table 10).

Of the rural population, 51 per cent represent cultivators, 30 per cent agricultural workers and 19 per cent other workers. Thus, almost 81 per cent population is engaged in agriculture.

India is primarily an agricultural country where more than 80 per cent of the population depend upon agriculture and animal husbandry for their

Table 8: Some key indicators of agricultural production

	Item/Unit	1950–51	1960–61	1970–71	1980–81	1981–82	1982–83	1983–84	1984–85	1985–86	1986–87
1)	FOODGRAINS PRODUCTION (lakh tonnes)										
	i) Rice	206	346	422	536	532	471	601	583	641	600
	ii) Wheat	65	110	238	363	375	428	455	441	469	490
	iii) Other Cereals	153	237	306	291	311	278	339	312	265	290
	iv) Total Cereals	424	693	966	1,190	1,218	1,177	1,395	1,336	1,375	1,380
	v) Total Pulses	84	127	118	106	115	118	129	119	130	130
	vi) Total Foodgrains	508	820	1,084	1,296	1,333	1,295	1,524	1,455	1,505	1,510
2)	INPUTS										
	(a) Seed										
	i) Production of Breeder seed (thousand qtls)	—	—	—	5.27	3.91	17.07	30.00	29.03	23.64 (p)	24.84
	ii) Production of Certified seed (lakh qtls)	—	—	—	21.86	24.18	36.61	41.26	49.97	64.84 (p)	56.51
	iii) Distribution of Certified/Quality seed (lakh qtls)	—	—	—	25.01	29.81	42.06	44.97	48.46	55.01	55.83
	(b) Fertiliser consumption (NPK)										
	i) Total (lakh tonnes)	0.69	2.92	21.77	55.16	60.64	63.88	77.10	82.11	87.37	92.00
	ii) Per hectare (kg)	Negligible	1.9	13.33	31.83	34.25	37.00	44.66	47.56	50.61(p)	N.A.
	(c) Area under High-yielding varieties (Lakh ha)	—	18.9	153.3	430.7	464.9	474.3	537.4	541.4	554.2	540.4
	(d) Cooperative credit disbursed (Rs. crores)	24.23	214.35	678.79 (1)	2,126.31	2,478.95 (p)	2,765.88 (p)	2,905.34 (p)	2,995.99 (p)	3,206.06 (p)	N.A.

[1] Relates to 1966–67; N.A.—Not available; p—Provisional.

Table 9: Estimated fodder production in India (Anon., 1986a)

Type of fodder	Estimated production (million tonnes)	
	Dry fodder	Green fodder
1. Agricultural crop residue	236	–
2. Grass	205	–
3. Green fodder		
(a) Cultivated green fodder	–	208
(b) Top feed including sugar-cane tops	–	4
(c) Weeds	–	14
4. Leaf fodder from trees	–	24
Total	441	250

Table 10: Population in India (in millions)

Year	Rural population	Urban population	Total
1951	298.15	62.98	361.13
1961	359.77	78.24	438.01
1971	439.10	109.10	548.20
1981	525.46	159.71	685.17

livelihood. Livestock is an important component in the rural economy. India has about 1/6 of the world livestock population. As per the census carried out in 1982, the total livestock population was 416 million. The livestock population has also been increasing steadily (Table 11).

Table 11: Livestock population in India (in millions)

Sl. No.	Category of livestock	1951	1961	1972	1982
1.	Cattle	155.3	175.6	178.3	190.8
2.	Buffaloes	43.4	51.2	57.4	69.0
3.	Sheep	38.4	40.0	40.0	48.1
4.	Goats	47.1	60.9	67.5	94.7
5.	Pigs	4.4	5.2	6.9	9.5
6.	Horses & ponies	1.5	1.3	0.9	0.9
7.	Camels	0.6	0.9	1.1	1.0
8.	Other livestock	1.3	1.2	1.1	1.8
	Total	292.0	336.3	353.2	415.8

Future Projections

Growth of population is an important determinant of total demand. Several projections of the future population are available (Raghavachari, 1974).

Based on fertility assumptions, the estimated population of India in 1991 and 2001 is presented in Table 12 (Raghavachari, 1974; NCA, 1976a).

Table 12: Projected population under different fertility assumptions

Fertility assumptions*	Population (in millions)	
	1991	2001
High–2	837.6	1032.1
High–1	817.7	996.3
Medium–2	801.2	945.4
Medium–1	786.2	924.3
Low–2	751.3	846.4
Low–1	736.5	830.6

* High, medium and low fertility assumptions correspond to a birth rate of about 50, 35 and 20 per thousand respectively.

The estimates for 1981 were 668.2 million and 677.5 million for high-1 and high-2 growth assumptions respectively, which were very near to the exact population of 685, which indicates that the population of India should be somewhere about 995 million during the year 2001 (NCA, 1976a).

The livestock population has also been continuously increasing. The population of livestock for the years 1990 and 2000 has been projected as under (Table 13).

Table 13: Projected population of livestock (Anon., 1987a)

Category	Population (in millions)	
	1990	2000
Cattle	202.0	218.0
Buffaloes	81.0	100.0
Sheep	51.2	55.1
Goats	106.8	131.8
Camels and others	2.9	3.0
Total	443.9	507.9

The basic requirements of food, fodder, fuel, shelter, clothing, etc., for this large human and livestock population have to be worked out. NCA (1976a) made estimates of some of the requirements of agricultural commodities for the year 2000 as under (Table 14).

The requirement for fodder is also very important. Various estimates of the requirements of feed and fodder for livestock are available. NCA (1976b), on the basis of average rate of feeding worked out the requirements of green fodder, dry fodder and concentrates for the projected livestock population of 2000 A.D. as 590, 373 and 70 million tonnes respectively.

Table 14: Demand for selected agricultural commodities (million tonnes)

	Item	*Projected requirement for 2000 A.D.	
		Low	High
1.	Foodgrains	205.3	225.1
2.	Sugar and gur	24.0	29.9
3.	Oilseeds	8.0	10.0
4.	Cotton (million bales)	10.4	17.2

*These are exclusive of export demands.

On the basis of fodder requirement for different categories of livestock, recommended by the National Dairy Research Institute, the total requirement works out to be as under (Table 15).

Table 15: Estimated fodder requirement for 2000 A.D. (Anon., 1987a)

Item	Fodder requirement (million tonnes)
Dry fodder	949
Green fodder	1136

The above estimates are considerably higher than the estimates made by the National Commission on Agriculture.

Fuelwood and timber are also the basic necessities of life. Fuelwood is important domestic energy source for cooking, heating, etc., in rural India. Timber is important for construction and for various industries as a raw material. The demand for wood and wood products is going to increase due to increase in population and standard of living of the people. The projected demand for timber, fuelwood and bamboo is given in Table 16.

Table 16: Projected demand for forest products (NCA, 1976b; Anon., 1981; Anon., 1986b)

	Item	Projected demand for 2000 A.D. (million m^3)
1.	Firewood	300
2.	Industrial timber	65
3.	Bamboo*	35

*The figures of bamboo are in million tonnes.

There are similar other projections. Vohra (1986) estimates the need of firewood for 2000 at 325 million m^3. The Advisory Board of Energy also puts this figure as 300 million m^3 (Anon., 1982b). It can, therefore, be concluded that the firewood need is quite large, is not going to be met from the present production levels and concerted efforts are urgently required.

If we look at the demand position for 2000 A.D. and the present produc-

tion of foodgrains, fodder, fuel and other agricultural and forestry products, the situation is not at all satisfactory. There is no need to be alarmed but there is no room for complacency either. We have to find ways and means to maximise production so that increasing demands are met.

The projected demands of food, fodder, firewood, timber, etc., can be met from the existing land resource of the country but with the following conditions:

(i) The demand for agricultural commodities can be met from existing arable lands with improved management.
(ii) The demand of firewood and timber can be met substantially by increasing the productivity of existing forest lands and partially bringing more areas under forest vegetation. Agroforestry practices in arable lands can help substantially in meeting the demand.
(iii) The demand of fodder can also be met by fodder cultivation in arable lands and practising silvipasture and agroforestry systems in grazing lands and wastelands.
(iv) The production systems have to be so designed that the land is able to produce the maximum on a sustained basis without deterioration of the land.
(v) The lands classified as 'other uncultivated lands' are likely to be under maximum pressure from competing and conflicting land use demands. Some land use adjustments according to land suitabilities might be possible in lands presently under agricultural and non-agricultural uses.
(vi) The most productive lands are to be utilised for the production of agricultural crops.

Land-use Planning

For meeting the projected demands for 2000 A.D. one way could be the procurement of additional land for agriculture, forestry and fodder production. Some of the wastelands could certainly be reclaimed for agriculture, forestry and range land development. Experience in wasteland development, however, indicates that proper restoration of productivity is a long-term process and substantial gain is not available immediately. Secondly, the process of wasteland development requires heavy investment which is not easily available.

Another way of increasing the production could be to increase the inputs per unit area. There is certainly some scope for increasing the production but there are several limitations. One subject which has not been properly attended to in India is proper land use planning and an efficient production system.

Man's demand for food from the land has increased considerably. The productive capacity of the land is limited. Also, some areas converted for

agriculture are not suitable and have caused serious land degradation. In several areas, reduction in quality and quantity of land under agriculture and forestry is being observed. The land use pattern may vary from area to area depending upon the land characteristics and the climate. It has also to be seen that the land has a limited population-supporting capacity, beyond which, there will be degradation and irreversible loss of productivity because of improper and excessive use.

NCA (1976c), regarding land use observes that: (i) A primary concern of the land use policy should be to continuously increase the productive capacity of the land and to prevent its deterioration. Soil conservation should be looked upon as an integral part for the programmes for maximising land use. (ii) Land use should be optimised by putting it to the best use as is consistent with ecology and capability of the land. Good agricultural land should not ordinarily be diverted to other uses. The land use planning should be based on a resources survey and production potential of the land. (iii) Diversification in land use should be encouraged by introducing various cropping patterns including pulses, oilseeds, fodder, etc. (iv) For diversifying production, increasing returns from the land, employment and income and ensuring balanced supply of food and fodder, the farmer should be encouraged to take up mixed farming, dovetailing cultivation with subsidiary occupations such as animal husbandry, poultry, pisciculture, sericulture, apiculture, etc., to provide year-round use of resources and labour. (v) The cropping patterns should be so structured as to suit the rainfall and soil conditions. The main policy regarding crops should be to evolve technologies to secure substantial increase in yields. Considerable emphasis should be given to grow crops and plants resistant to insect pests and diseases, droughts, floods, etc. (vi) The domestic needs of the people for timber, firewood and fodder should be met from forest and social forestry programmes.

The land should be under such a production system which does not deteriorate the land and produces the most. Most annual crops require intensive soil working and addition of manures and fertilisers as there is considerable drain of nutrients. In most of the agricultural lands, there is considerable soil erosion. Therefore, several farming systems aim at providing effective soil cover and providing soil conservation measures. Sometimes the lands are left fallow to regain the productivity. In some farming systems, annual and perennial crops are combined. The perennial crops, e.g., shrubs, trees, etc., help to conserve soil productivity, meet the demand of timber and firewood and bring about ecological restoration. Agroforestry systems hold promise to provide such land use systems. The production of foodgrains, fodder, fuel, etc., can be obtained simultaneously. The total production-mix can be selected depending upon the area, climate, demand, etc.