

A land use plan for Jorhat district of Assam State

S. Vadivelu, U. Baruah, B.P. Bhaskar, J. Thampi, D. Sarkar¹, C.S. Walia², D.C. Nayak¹ and A.K. Maji³

National Bureau of Soil Survey and Land Use Planning, North Eastern Regional Centre, Jorhat-785 004, India

¹NBSS&LUP, Regional Centre, Sector II, Block DK, Salt Lake, Kolkata-700 091, India

²NBSS &LUP, Regional Centre, IARI Campus, New Delhi-110 012, India

³NBSS &LUP, Amravati Road, Nagpur-440 033, India

Abstract

The soils of Jorhat district in the Brahmaputra valley of Assam were evaluated for growing crops such as rice, wheat, mustard, groundnut, potato, onion, cabbage, peas, french bean, tomato, fodder maize, alfalfa, cowpea and banana. Rice is grown during rainy months due to imperfect drainage though the soils are moderately and marginally suitable. Soil pH and coarse texture are the major limitations for crop growth. Several crops are recommended depending on their suitability for the post-rainy months in the soils which are kept fallow in the present land use system. Potato and mustard are suitable for almost all the soils in the post-rainy season. The river island of Majuli comes out as a vegetable basket where almost all the vegetables can be cultivated. The soils near foot hills covering an area of 40571 hectares are under tea cultivation with limitation of organic carbon, coarse texture and strong acidity. The Tiru and Disai soils are under natural forest covering 12286 hectares and mostly occurs on moderately steep to strong hillslopes. The 22,276 hectares of char lands adjoining to Brahmaputra river classified under the capability of class VI are evaluated as suitable for lowland forest and water associated species. The deep permanent marshy lands with open water bodies and scenic stream sides (6305 ha) are judged as best sites for bird sanctuary and active recreation. The study demonstrates the compatibility of land uses with regard to landscape ecological factors considered in evaluation and planning.

Additional key words : Soil suitability evaluation, Brahmaputra valley, Charland.

Introduction

Most of the cultivated area of Jorhat district remain inundated for most part of the rainy

season. Rice is cultivated during the rainy season and thereafter most of the cultivable lands remain fallow. It is a single cropped rice culture with a yield of 1.85 t/ha which is very low compared to 3.1 t/ha in Tamil Nadu and 3.4 t/ha in Punjab (Anonymous 1996). In Assam, the total production of food grains including rice, wheat and pulses stands at 36.72 lakh tonnes as against the demand of 45.33 lakh tonnes (Anonymous 1997; Mahanta 1997). Thus there is an urgent need for a continuous and sustained increase of crop production. A critical appraisal of land resources and then allocating them to the various cropping systems in both rainy and post-rainy seasons based on their potentials will improve the cropping intensity and compensate the crop loss suffered during rains and floods. In such attempts the soil maps prepared with sufficient ground truth play a vital role in fitting the site-specific cultivation. Therefore, the present investigation was taken up to evaluate the soils of Jorhat district for growing various crops, particularly introducing cultivation of some important oilseeds, vegetables, fodder and fruits during *rabi* season in the dominantly rice alone cropping system.

Materials and methods

Jorhat district in upper Assam lies between 26°20' to 27°10'N latitude and 93°57' to 94°37'E longitude and has a total geographical area of 2.86 lakh ha.

Physiography and geology : Most of the area represents the plains of the Brahmaputra valley and have an altitude of 60 to 140 m above msl. Some areas in south and southeast of the district have low hill ranges (150 to 450 m above msl) in continuation of the Naga Hills. Colluvial and alluvial materials are deposited at the foothill slopes forming the piedmonts which remain dissected. Geology of the area is alluvium of Pleistocene and recent periods in the plains and tertiary sedimentary rocks in the hill.

Climate : The climate of the area is humid subtropical. The mean annual precipitation is 2077 mm, about 87 per cent of which falling between April and September. The soil moisture regime is 'udic' and the soil temperature regime is 'hyperthermic' (Soil Survey Staff 1999).

Flooding and drainage : The northern part of the district particularly along the river Brahmaputra is often subjected to flooding during the rainy season. The rest of the district remains under inundation for most part of the rainy season. The drainage condition is poor during and immediately after flooding. It improves in the winter months as the water table starts receding gradually below the root zone.

Soil suitability evaluation : The soil map and some physical and chemical characteristics of the soils are given in the soil survey report (NBSS&LUP 1993). These data needed to

be translated into such a theme that is useful for farmers, administrators and land use planners. Therefore, these soils were evaluated for growing some important crops in the rainy and post-rainy seasons.

The suitability of the soils for growing rice, wheat, mustard, potato, cabbage, peas, french bean, tomato, maize (fodder), alfalfa, cowpea, tea and banana was evaluated following the method proposed by Sys *et al.* (1991). The soil characteristics were matched with the requirement of the crops at different limitation levels. The suitability classes and subclasses were decided by the most limiting soil characteristics. After the evaluation, the soil units comprising two or more soil series were allotted to these crops for which they are highly suitable (S1) and moderately suitable (S2). The crops which were in association with marginally suitable (S3) and presently not suitable (N1) classes are not recommended because their cultivation will not be economical.

The land units for forestry are classified as per USDA capability classification (Klingebiel and Montgomery 1966) and strengthened by landscape ecological factors approach of Cook *et al.* (1977) and the principles outlined in the workshop on land evaluation for forestry (Laban 1981). The principles involved in landscape ecological factors for multiple land use were used in evaluating the marshy lands for bird sanctuary as per the design of (McHarg 1969). His approach is based on different requirements for different kinds of land use with regard to physiography or land conditions. Thus the land use map (Fig. 1) for Jorhat district was prepared, highlighting mainly the crops to be grown on various soils.

Results and discussion

Soils : Twenty one soil series have been identified in the district (NBSS&LUP 1993). Four of these soil series are under permanent plantation of forest species. Therefore, they are not considered in suitability evaluation for suggesting land use options.

The remaining seventeen soil series are under cultivation of crops including tea. Some of their physical and chemical characteristics are given in Table 1. They have developed from the recent Brahmaputra alluvium which overlies Pleistocene deposits in the vast alluvial plains. The texture of the soils vary widely from sand to clay loam or silty clay loam. The soils of Majuli river island and the soils which occur closer to the river Brahmaputra in the zone of active flood plain are sandy loam or loamy sand in texture whereas the soils of the southern part of the district which lies between the Naga hills and the active flood plain zone of Brahmaputra are dominantly loam to clay loam or silt loam in texture. The clay content of most of these soils is less than 25 per cent which reflects the coarser nature of the alluvial deposits. Most of the soil series are strongly acidic with a pH close or lower to

5.5 which is critical for many crops (Sys *et al.* 1993). The organic carbon content is less than 10 g kg^{-1} in nine soils and more than 10 g kg^{-1} in eight soils. Majuli, Lahangaon, Kamalabari and Bangaon soil series of the Majuli island have more than 10 g kg^{-1} organic carbon due to higher intensity of cropping and addition of sediments rich in organic matter. The base saturation of the soils is less than 50 per cent in Rowriah, Titabor, Dohotia, Adhakota and Barholla. The cation exchange capacity is less than $10 \text{ cmol (p) kg}^{-1}$ in most of the soils.

Table 1. Some physical and chemical characteristics* of soils of Jorhat district**

Soil series	Textural sequence upto 100 cm)	Sand	Silt	Clay	pH	Organic carbon g kg^{-1}	CEC cmol (p+) kg^{-1}	Base saturation (%)
		-----(%)-----						
Rowriah	Sil, si, cl, c, cl	18.8	49.9	31.2	5.2	8.8	7.1	37
Bhogdai	Sil, sil, cl	19.9	52.2	27.8	5.3	9.7	13.8	60
Titabor	Sil, sil, cl	16.5	59.9	23.6	5.2	6.1	7.5	50
Dohotia	Sil, sil, sil	18.9	57.3	23.8	5.1	11.1	14.9	30
Jorhat	Sil, sil, sl	45.7	45.2	9.1	5.0	6.2	6.6	59
Bangaon	Sil, sil, sl	22.7	56.7	21.0	7.2	17.2	5.9	99
Matikhola	L, l, cl, cl	26.6	47.2	26.2	5.1	8.3	12.3	80
Lahangaon	L, sl, ls	49.6	39.5	10.9	7.4	19.4	5.9	97
Kakadanga	Sl, l, sl, sl	57.7	26.3	15.9	5.3	8.9	7.5	52
Kamalabari	Sl, l, s	51.7	35.2	13.1	6.6	20.8	5.5	73
Adhakota	Sl, sl, s	60.6	25.0	14.3	4.6	5.9	5.9	42
Kakilamukh	Sl, ls, ls	68.2	18.2	13.6	5.7	4.5	9.4	73
Borholla	Ls, sl, sl	71.3	18.4	10.3	5.2	6.2	4.9	19
Majuli	Sl, s, s	74.7	21.1	4.2	7.2	18.4	3.2	97
Mariani	Sl, sl	60.5	21.3	18.2	4.6	11.5	6.0	30
Sangosa	Sil, si, cl, sil	22.9	52.0	25.1	5.4	12.6	7.9	42
Teok	Sl, sl, sl	78.0	12.8	9.2	4.2	13.8	4.1	22

*Values are weighted mean of horizons up to 50 cm depth

**Source: NBSS&LUP, 1993

Soil suitability to crops : The tea growing soils such as Mariani, Sangosa and Teok series are evaluated only for tea. The suitability of the other fourteen soils were evaluated for cultivating annual crops.

Rice : Rice is grown on all the fourteen cultivated soils during the rainy season between May and November. During this period, 1725 mm of precipitation out of the annual total of 2077 mm is received. The drainage conditions remain imperfect or poor due to shallow water table and, therefore, only rice can be cultivated during the rainy season. Only seven of the soil series, viz. Rowriah, Bhogdai, Titabor, Dohotia, Jorhat, Bangaon and Matikhola, which have silt loam or clay loam texture are moderately suitable (S2) for rice and the remaining seven soil series which have dominantly sandy loam or loamy sand textures are marginally suitable (S3) for rice (Table 2). Soil texture denoted as (s) and soil pH denoted as (f) are the major limitations. Liming and addition of organic manure or growing green manure crops will improve the suitability of these soils for rice.

Table 2. Suitability class of the soils of Jorhat district for growing some crops

Soil series	Rice	Wheat	Mus-	Potato	Cab-	Peas	French	Tomato	Maize	Alfalfa	Cow-	Banana	Tea
				tard	tard	bage	bean		(fodder)		pea	Tea	
Rowriah	S2f	S3f	S3f	S2f	N1f	N1f	S3f	S3f	S3f	S3f	S3f	S3f	—
Bhogdai	S2sf	S3f	S2f	S2f	N1f	N1f	S2f	S3f	S3f	S3f	S3f	S2f	—
Titabor	S2sf	S3f	S3f	S2f	N1f	N1f	S3f	S3f	S3f	S3f	S3f	S2f	—
Dohotia	S2sf	S3f	S3f	S3f	N1f	N1f	N1f	S3f	S1f	S3f	S3f	S3f	—
Jorhat	S2sf	S3f	S3f	S2f	N1f	N1f	N1f	S3f	N1f	N1f	S3f	S3f	—
Bangaon	S2s	S1	S3f	S1	S1	S1	S1	S1	S1	S1	S1	S1	—
Matikhola	S2s	S2f	S2f	S3f	N1f	N1f	S3f	S3f	N1f	N1f	S3f	S3f	—
Lahangaon	S3s	S2s	S2f	S2f	S1	S1	S1	S1	S1	S1	S1	S2s	—
Kakadanga	S3s	S3s	S2f	S3f	N1f	S3f	S3f	S2sf	S3f	S3f	S3f	S3f	—
Kamalabari	S3s	S3s	S1	S1	S1	S2s	S2s	S1	S2s	S1	S1	S3s	—
Adhakota	S3s	N1f	N1f	N1f	N1f	N1f	N1f	N1f	N1f	N1f	N1f	S3s	—
Kakilamukh	S3s	S3s	S3f	S1	S3f	S3f	S2s	S2s	S2sf	S2sf	S2sf	S3s	—
Borholla	S3s	N1f	S3f	S3f	N1f	N1f	S3f	N1f	S3f	S3f	S3f	S3s	—
Majuli	S3s	S3s	S2s	S2s	S2sf	S2s	S2s	S2s	S2f	S2f	S2sf	N2sf	—
Mariani													S2f
Sangosa													S2f
Teok													S2f

Wheat : The climatic conditions are suitable for wheat. Nine soil series are marginally suitable and two not suitable for wheat due to lower soil pH (5.5) and coarse texture (Table 2). The soils of Bangaon series is highly suitable and Matikhola and Lahangaon series are moderately suitable. Liming will improve the suitability class of the soils for wheat.

Oilseed crops : For mustard, Kamalabari series is highly suitable (S1) and six other series, viz. Bhogdai, Bangaon, Matikhola, Lahangaon, Kakadanga and Majuli are moderately suitable (S2). Seven of the remaining soil series (Rowriah, Titabor, Dohotia, Jorhat, Bangaon, Borholla and Kakilamukh) are marginally suitable (S3) and Adhakota is not suitable due to strong acidity (pH of 4.6).

Vegetable crops : The soils were evaluated for growing potato, cabbage, tomato, french-bean and peas. Potato can grow well in most of these soils which are strongly acidic and light textured. Three of the soils, viz. Bangaon, Kamalabari and Kakilamukh, are highly suitable (S1) due to coarse texture. However, six other soil series, viz. Bhogdai, Titabor, Jorhat, Lahangaon, Rowriah and Majuli, are moderately suitable (S2) and Dohotia, Matikhola, Kakadanga and Borholla soil series are marginally suitable; one not suitable due to pH lower than 5.2.

With regard to cultivation of cabbage and peas, viz. Bangaon, Lahangaon, Kamalabari and Majuli soil series are suitable (S1 and S2). The remaining soil series are not suitable for cabbage and peas due to pH lower than 5.8. For the cultivation of french-bean, Bhogdai, Bangaon, Lahangaon, Kamalabari, Kakilamukh, and Majuli soil series are suitable (S1 and S2) while Bangaon, Lahangaon, Kamalabari, Kakilamukh and Majuli soil series are suitable (S1 and S2) for formato. Cultivation of french-bean and tomato is not economical on other soils which may produce low yields. The soils of the river island Majuli are highly suitable for vegetable cultivation. The Majuli island alone can fulfill the vegetable needs of entire district of Jorhat if more area is brought under the vegetable cultivation during post-rainy season.

Forage crops : Maize, alfalfa and cowpea are acid sensitive and, therefore, Bangaon, Lahangaon, Kamalabari, Kakilamukh and Majuli soil series are suitable (S1 and S2) for their cultivation. The remaining soil series are either marginally suitable or not suitable due to strong acidity (pH less than 5.1).

Horticultural crops : Four soil series, viz. Bhogdai, Titabor, Bangaon and Lahangaon are suitable (S1 and S2) for banana. The remaining soil series are either marginally suitable or not suitable for banana due to pH lower than 5.2 and coarser texture than loam or sandy clay loam. The adverse effect of low pH and coarse texture on banana was also reported by Walia and Chamuah (1991).

Tea : The three dominant soil series viz. Mariani, Sangosa and Teok which are presently under tea cultivation and cover an area of 40,572 ha (Table 3), were evaluated for their suitability to grow tea (Table 2). These soils are moderately suitable with soil limitations of organic matter, coarse texture and strong acidity (Teok, pH of 4.1).

Land use plan : The land use map (Fig.1 with legend in Table 3) shows plantations over an area of about 63000 ha retained without any change and the rest of the cultivated soils with several crop options. During the rainy season between May and September, the soils have a poor drainage environment. The water table also fluctuates within one metre of the soil surface. Therefore, during this season, the options are limited and only rice can be grown profitably (Table 3).

Table 3. Land use plan for Jorhat district

Soil series association	Land use unit number	Rainy season	Post-rainy season	Year round plantation/ use	Area (ha)
Tiru-Disai	1	-	-	Forest	12,286
Nagini-Tiru Sildubi-Nagini Sangsoa-Teok	2	-	-	Forest-tea	10,130
Teok-Mariani	3	-	-	Tea	40,572
Matikhola-Bhogdai	4	Rice	Wheat, mustard, potato french bean	Banana	4,603
Kakdanga-Adhakota Dohotia-Kakadanga	5	Rice	Mustard,potato,french bean	-	16,225
Bhogdai-Jorhat Bhogdai-Jorhat-Adhakota	6	Rice	Mustard,potato,french bean	Banana	14,516
Titabor-Borholla Rowriah-Titabor Barholla-Titabor	7	Rice	Potato	Banana	37,880
Jorhat-Kakilamukh	8	Rice	Potato, tomato, french bean, fodder, maize, alfalfa, cow pea	-	6,322
Bhogdai-Kakilamukh -Majuli	9	Rice	Mustard, potato, french bean, tomato, fodder maize, alfalfa, cowpea	Banana	14,155
Kakadanga-Kakilamukh	10	Rice	Mustard, potato, french bean, tomato, fodder maize, alfalfa, cow pea	-	4,865
Dohotia-Jorhat	11	Rice	Potato, wheat, mustard, cabbage	-	3,616
Kamalabari-Bangaon Kamalabari-Lahangaon Bongaon-Lahangaon	12	Rice	potato, tomato, french bean, peas,fodder maize, alfalfa, cow pea	Banana	29,819
Kakilamukh-Majuli	13	Rice	Mustard, potato, tomato, french bean, cabbage, fodder maize, alfalfa, cowpea	-	6,434
Majuli-Kamalabari	14	Rice	Mustard, cabbage, potato, tomato, french bean, peas, fodder maize, alfalfa, cowpea	-	23,687
Brahmaputra (Sand bar)	15	-	-	Social-forestry, Fishery	22,472
Marshes and swamps	16	-	-	Bird sanctuary	6,305

Post-rainy season cropping : With the withdrawal of monsoon in October, the district receives very less rainfall up to April. The drainage environment also improves with receding water table. At the same time, the soils remain sufficiently moist to support crop plants (personal observation). This observation is supported by Mandal *et al.* (1999) whose climatic data calculations show that there is very little water deficit (4-38 mm) in the period between November and March. Therefore, there is a good chance of growing crops in the post rainy season with minimum irrigation wherever required.

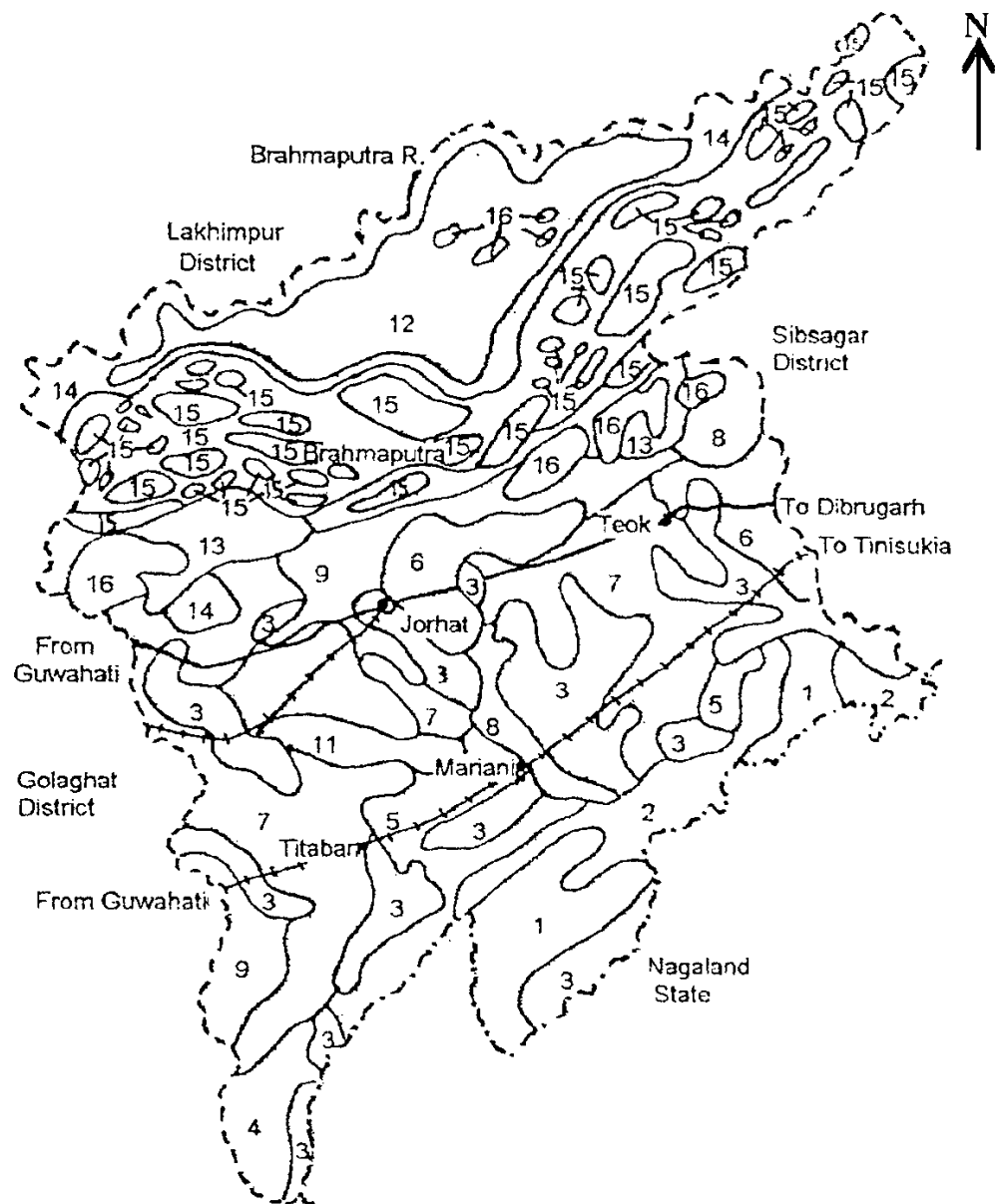


Fig. 1. Land Use Map of Jorhat District (See table 3 for legend).

The land use units 4 to 7 spread over about 73,224 ha (Fig. 1, Table 3) has limited crop options in the post-rainy season. In this area crops such as wheat, mustard, potato and french bean can be grown successfully. The remaining land use units (8 to 14) spread over 88,898 ha can support wide variety of crops such as potato, tomato, french bean, mustard and forage crops.

Besides these short duration crops, banana which is grown successfully only in the backyards is recommended for an area of 86,818 ha. But the area suitable for banana has been over estimated as it includes some of the marginally suitable soils which are in association with those suitable soils (Table 2). However, even these marginally suitable soils can be converted to moderately suitable with the provision of drainage and application of lime.

Social forestry and entertainment : The channel of the river Brahmaputra has many raised sand deposits which are locally known as Chars. These char lands are totally/partially flooded during rainy season with the flood period varying from year to year. The soils of char lands are sandy with the fine sand fractions dominating the composition. The water table remains within 150 cm even in dry months between November and March. These soils are not suitable for economic crop cultivation due to their location, flood hazards and sandy texture. These lands are, however, suitable for social forestry, which can also serve as recreational/educational parks as they are in close proximity with the Vaishnavite cultural centres of Majuli. These soils of land capability class VI are preferentially used under forest and need seeding or planting to protect the banks from river wash. The natural forests and long established planted forests have always been recognized as ecosystems and, in general, a more or less ecological management prevails in the absence of industrial inputs. However, since there is a constant influence of human beings, these forests may be recognized as cultural ecosystems of the region.

Bird sanctuary : An area of 6,305 ha is under marshes and swamps. The area is characterised by several stagnant water bodies and waterlogged soils with grasses and other hydrophytic vegetation. The landscape ecological factors considered according to the design of McHarg (1969) in evaluating the compatibility of land use with regard to natural land requirements. It is already under the use of birds migrating from long distances, but the birds face danger from the local population. The birds are to be protected in an organized way and the sanctuary developed through measures like prevention of fishing to preserve the ecosystem.

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