Journal of Agrometeorology 6 (1) : 76 - 84 (Jun 2004)

Agroclimatic analogues of rice (*Oryza savita* L) and sugarcane (*Saccharum officinarum* L) in Assam

P. GOGOI KHANIKAR and K. K. NATH
Department of Agrometeorology, Assam Agricultural University, Jorhat, Assam

ABSTRACT

Soil climatic analogous areas for rice (*sali & ahu*) and sugarcane have been carved out in Assam by superimposing monthly rainfall and mean temperature maps on soil suitability maps of the respective crops. The analogous zones for the crops have been categorized as 'most suitable', 'suitable', 'fairly suitable', and 'unsuitable' depending on degree of suitability of the zones for the crops. It is seen that *Sali* & *Ahu* rice can be grown almost throughout the state except the flood prone/affected as well as the well drained upland areas. Sugarcane can be cultivated in all the regions of the state except flood prone/affected or low land waterlogged areas. These analogous maps will help to suggest viable and beneficial cropping patterns in the state through replacement of crops by more efficient ones thereby enhancing the productivity of these crops.

Key words : Climatic analogues, soil suitability, *Sali* rice, *Ahu* rice, and sugarcane.

Assam state (24° 'N to 27° 56'N, 89° 46 'E to 96° E) situated in the north-east region of India having 23 districts with six different agroclimatic zones (Anon. 1981) namely North Bank Plains (NBPZ), Upper Brahmaputra Valley (UBVZ), Central Bramahputra Valley (CBVZ), Lower Brahmaputra Valley (LBVZ), Barak Valley (BVZ) and Hills (HZ) (Fig.1) . Rice is the main food grain in the state occupying about 74 % of total cropped area out of which *Sali* rice (winter rice) occupies 52.6 % and *Ahu* rice(autumn rice) occupies 18.5% of the total cropped area. Sugarcane is also an important crop, which is grown in 1.1% (Anon. 1994) of the total cropped area of the state. But a large number of crops including the above are being grown traditionally in areas without considering the agroclimatic suitability of the areas. This might be one of the reasons for poor yield of these crops in the state, which is far below the potential yield. One way to overcome this bottleneck is to carve out agroclimatic analogous areas for a crop of the state by superimposing soil and climatic maps. Such maps will act as useful tools for exploiting the agroclimatic resources of the state to boost up agricultural production. Bishnoi (1974a) determined soil climatic zones of Haryana based on different cropping patterns followed in the state. Bishnoi (1974 b) further delineated soil climatic zones separately for both rainy and winter seasons. Boshell and Neild (1975) determined agroclimatic analogues in Colombia with respect to production of tea in that country. Mavi *et.al* (1979) delineated

the agroclimatic regions of Punjab state by superimposing the maps of relief, annual rainfall and availability and quality of underground water. Here, an attempt has been made to delineate agroclimatic analogous areas of Assam for rice and sugarcane crops.

MATERIALS AND METHOD

Soil suitability maps

Soil information from National Bureau of Soil Survey and Land Use Planning,Nagpur, (Sen *et. al.* 1999) were collected and the thematic maps of slope, soil drainage, particle size, flooding and soil reaction (pH) were superimposed to carve out the soil suitability maps for rice (*Sali* and *Ahu*) and sugarcane (Figs. 2&3) in Assam following the criteria listed in Table 1 and 2.

Since rice plants require sufficient water, so clayey and fine soils with suitable combinations of soil slope and soil drainage (Table 1 and 2) are considered suitable for rice cultivation. Similarly fine loamy, fine silty, coarse loamy and coarse silty soils, with proper slope and drainage, are suitable for growing these crops. Fine and clayey soils with moderate slope and good drainage are also suitable for sugarcane.

Soil climatic analogues of rice and sugarcane

From a study of the district wise historical yield data for 22 years of each crop, the district with the highest and the most stable values of crop yield as well as area under cultivation was selected as the reference district for the crop in the state. The soil class and climatic parameters (rainfall, mean temperature and mean relative humidity) of the reference districts (Table 3) were taken as the basis for mapping out the agroclimatic analogues for each crop. The life cycle of a crop was divided into vegetative and reproductive stages (Table 4). The suitable ranges of rainfall and temperature for the crops were determined by allowing a variation of ± 20% from the mean value of rainfall and ± 2°c of temperature of the reference district of the crop. For *ahu* season, decrease of rainfall from the mean value was not considered ideal due to lows rainfall being normal during the season. For all these crops during each growth phase, allowance for RH was ± 5 % of the mean values of the reference district.

Corresponding to each stage of the crop, climatic parameters were then mapped out from an average monthly data of 20 years for each district. The analogous soil climatic zones for each crop were then found out by superimposing the maps of all the soil and climatic parameters excluding mean relative humidity, because this parameter did not change much for a particular season and was almost constant throughout Assam. Thus, five parameters including soil suitability were ultimately used for superimposition and the areas with all or most of the parameters suitable for the crop were demarcated. Taking into consideration the total number of favourable parameters during the vegetative and reproductive phases of a crop at a place different suitability zones for each crop have been demarcated.

The different suitability classes identified for *Sali* rice, *Ahu* rice and sugarcane were 'most suitable' (all parameters favourable), 'suitable' (four

Table 1: Characterization of soil physical properties and flood situation for preparation of soil suitability maps in Assam.

Particle size (P)	Soil slope (S)	Soil drainage (D)	Soil pH (R)	Flooding (F)
P (1) = Loamy skeletal	S (1) = Level (0 -1%)	D (1) = Very poor to poor	R (1) = Strongly to moderately acidic up to 5.5	F (1) = No flooding
P (2) = Sandy	S (2) = Very gentle (1-3%)	D (2) = Imperfect	R (2) = Moderately to slightly acidic (5.5-6.5)	F (2) = Slight
P (3)= Coarse loamy	S (3) = Gentle (3 - 8%)	D (3) = Moderately well	R (3) = Slightly acidic to neutral (6.5-7.5)	F (3) = Moderate
P (4) = Fine loamy	S (4) = Moderate (8-15%)	D (4) = Well		F (4) = Severe
P (5) = Coarse silty	S (5) = Mod steep (15-30%)	D (5) = Somewhat excessive		F (5) = Very severe
P (6) = Fine silty	S (6) = Steep (30 -50%)	D (6) = Excessive		
P (7) = Clayey				
P (8) = Fine				

Fig.1 : Administrative districts and zones of Assam

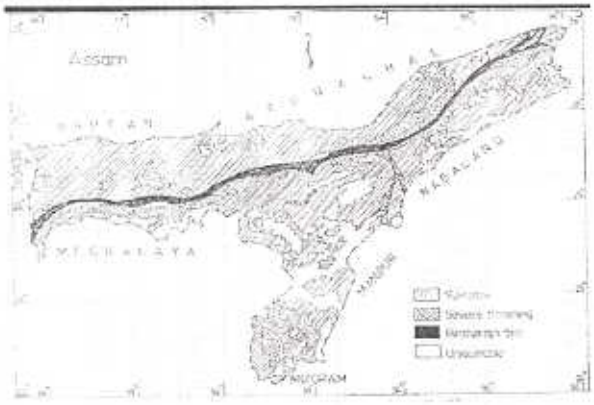

Fig. 2 : Soil suitability area of rice (*Ahu* and *Sali*) in Assam

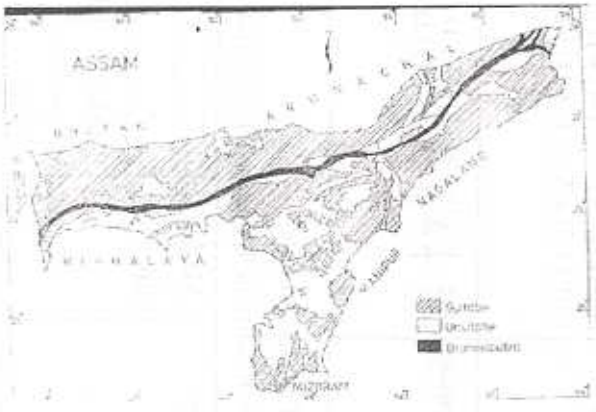

Fig. 3 : Soil suitability area of sugarcane in Assam

Table 2: Combinations of soil physical properties recognized in Assam as suitable / unsuitable for rice and sugarcane

Crop	Suitable combinations	Unsuitable Combinations
Rice	(i)P (4,6,7,8) + S (1-4) + D (1- 4) + R (1-3) + F (1-3) (ii)P (3,5) + S (1-3) + D (1-3) + R (1-3) + F (1-3)	a) P (1,2) + S (1-6) + D (1-6) + R (1-3) + F (1-3) b) P (3,5) + S (4) + D (4) + R (1-3) + F (1-3) c) P (1-8) + S (5,6) + D (5,6) + R (1-3) + F (1-3) d) P (1-8) + S (1-6) + D (1-6) + R (1-3) + F (4,5)
Sugarcane	(iii) P (3-6) + S (1-4) + D (1-4) + R (1-3) + F (1-3) (iv) P (7,8) + S (4) + D (4) + R (1-3) + F (1-3)	e) P (1,2) + S (1-6) + D (1-6) + R (1-3) + F (1-3) f) P (7,8) + S (1-3) + D (1-3) + R (1-3) + F (1-3) g) P (1-8) + S (5,6) + D (5,6) + R (1-3) + F (1-3) h) P (1-8) + S (1-6) +D (1-6) + R (1-3) + F (4,5)

N.B. (1-4)=1 to 4 etc.

Table 3: Suitable ranges of climatic parameters in vegetative and maturity phases of rice and sugarcane

Crop	Model distrrict	Ideal range of climatic parameters in					
		Vegetative phase			Maturity phase		
		Mean temperature (°C)	Rainfall (mm)	Mean daily relative humidity (%)	Mean temperature (°C)	Rain fall (mm)	Mean daily relative humidity (%)
Rice (*Sali*)	Sibsagar	27 – 30	1200 – 1800	79 – 87	19 - 23	150 - 210	75 – 83
Rice (*Ahu*)	Nagaon	22 – 26	300 – 600	71 – 79	27 – 31	500 – 850	80 – 88
Sugercane	Golaghat	24 – 28	1400 – 2200	76 – 83	17 – 21	70 – 110	72 – 79

parameters favourable), 'fairly suitable' (three parameters favourable) and 'unsuitable' (soil is unfavourable).

RESULT AND DISCUSSION

The soil climatic analogue maps Figs. (4-6) show the specific areas most suitable for a specific crop and also give ideas about alternate cropping patterns. In Assam *Sali* and *Ahu* rice can be grown almost throughout the state with different suitability level except for the flood prone/ affected or well drained upland areas. Excess or deficit rainfall is the main constraint for *Sali* rice cultivation under 'suitable' class areas. Rainfall is excess in the north-east and north-west regions of the state, but is deficient in parts of the Hills Zone. The main constraint of 'fairly suitable' class for cultivation of *Sali* rice is the quantum of rainfall received. Rainfall during both the phases of the crop growth is not suitable. Except the BVZ and extreme northeast region of the state, other areas of this class get deficit rainfall during the maturity phase. Similarly, rainfall during the vegetative phase is also not adequate except in the extreme northwest districts of the LBVZ where rainfall is in excess of the amount required during the corresponding phase.

Excessive rainfall over most parts of 'suitable' class during maturity phase is a major constraint for growing *Ahu* rice. However, in Karbi Anglong district the major constraint is inadequate rainfall during the vegetative or maturity phase of the crop. In almost all parts of 'fairly suitable' class the main constraint is excess rainfall both during vegetative and maturity phases as in the districts of UBVZ, LBVZ,

Table 4 : Occurrence and duration of vegetative and maturity phases of rice and sugarcane

Crop	Vegetative phase		Maturity phase		Total duration of crop period
	Definition	Period	Definition	Period	
Rice (*Sali*)	Sowing to 50% flowering	June to September	50%flowering to harvesting	October to November/ December	June to March to July
Rice (*Ahu*)	Do	March to May	Do	June to July	
Sugarcane	Planting to Grand growth phase	March to October	Grand growth phase to harvesting	NovembertoFebruary	March to February

NBPZ and BVZ or less rainfall in both the phases as in the districts of CBVZ and Hills Zone.

Sugarcane can also be planted almost in all the regions of the state with different suitability level excepting flood prone/ affected or low land waterlogged areas. For almost all the areas of 'suitable' class the negative parameter is rainfall either during the vegetative phase or during the maturity phase. Generally rainfall is in excess during the vegetative phase, except in some regions of Nagaon and the Hill districts where rainfall is less in vegetative phase. Another pocket of less rainfall during the maturity phase is seen in some parts of Kamrup, Darrang, Morigaon, Nagaon and Karbi Anglong districts.In some parts of Jorhat, Sibsagar, Cachar and Karimganj districts, rainfall during the maturity phase is excessive. The main constraint in the cultivation of sugarcane in most parts of 'fairly suitable' class is excessive rainfall during both the growth phases of the crop. In Kokrajhar and Dhubri districts the negative parameter is excess rainfall during the vegetative phase and less rainfall during the maturity phase. Rainfall is less during both the phases in Morigaon and Nagaon districts.

Suggestions for alternate cropping patterns

It is seen from analogous maps of rice (*Sali* & *Ahu*) and sugarcane, some areas of Jorhat, Sibsagar, Dibrugarh and Tinsukia districts with gentle and moderate sloping, well drained, coarse loamy soils not suitable for rice, lie under 'suitable' or 'fairly suitable' class for sugarcane. So these areas can be utilised for growing sugarcane. Similarly some parts of Karbi Anglong and N.C.Hills districts are agroclimatologically 'fairly suitable' both for *Sali* and *Ahu* rice, but 'suitable' for sugarcane. Hence sugarcane cultivation could be more profitable in these areas. Parts of Kamrup district 'most suitable' for sugarcane, are only 'suitable' for *Sali* and *Ahu* rice (Figs. 4-6). Sugarcane may be a viable and profitable crop in these areas. However rice being the staple food, farmers will not easily shift to sugarcane cultivation at the cost of rice crop.

Some parts of Karimganj district are 'fairly suitable' for sugarcane and *Ahu* rice but are 'suitable' for *Sali* rice. So *Sali* rice may be more profitable crop in these areas. Similarly some parts of Karbi Anglong district which are 'suitable' for sugarcane are only 'fairly suitable' for *Sali* and *Ahu* rice. In these areas also farmers may choose the crops accordingly. Some areas show the same degree of suitability for *Sali* rice, *Ahu* rice and sugarcane with overlapping growing periods. In such cases planners have to look into the economy of a crop before planning.

In case of flood prone areas, the farmers can opt for the late planting short duration *Sali* rice under post flood situation without greater reduction in yield. *Ahu* rice of short duration variety can be grown in most of the flood prone areas, which are inundated during the monsoon season, so that it may be harvested before the monsoon starts. The *Bao* rice, which is deep water or floating rice, requires marshy land. It can be sown in March- April on the land that becomes dry during February and can be harvested during November-December. This group of rice has the special adaptability to grow in height along with

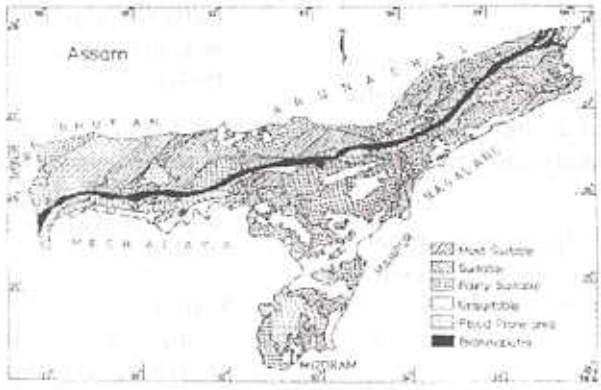

Fig. 4 : Soil climatic analogues of rice (*Sali*) in Assam

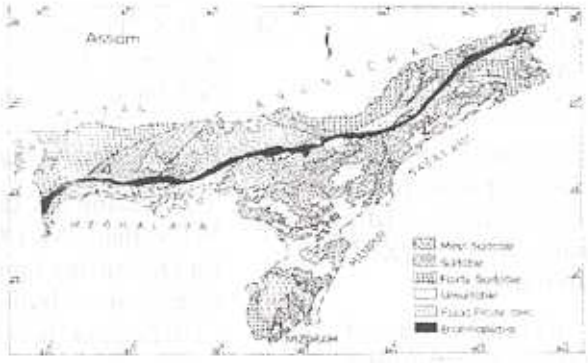

Fig. 5 : Soil climatic analogues of rice (*Ahu*) in Assam

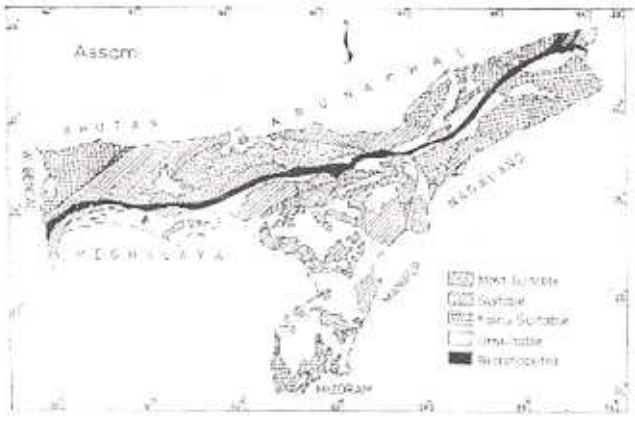

Fig. 6 : Soil climatic analogues of sugarcane in Assam

the rise of water level.

In very deep areas or the peripheries of the perennial water logging and marshy lands, the *Boro* rice can be transplanted during December-January and harvested in April –May.

Thus with the help of agro-climatic analogous maps it will be beneficial to select a more profitable crop for a given locality by comparing net return of the crops.

REFERENCES

Anonymous 1981. Agroclimatic Zones. *Report of the ICAR Research Review Committee for A.A.U.*, New Delhi NARP Document No 39, pp. 25-52.

Annonymous 1994. Agroclimatic planning for Agricultural Development in the state of Assam, *Draft outline*. VIIIth plan. Eastern Himalayan Region, ZPT, Zone-2, A.A.U. Jorhat. pp. 17.

Bishnoi, O.P. 1974a. Soil climatic zones of Haryana in relation to cropping patterns during rainy and winter seasons. *Indian J. Agric. Sci.*, 44(11): 694-72.

Bishnoi, O.P. 1974b. Soil climatic zones of Haryana in relation to cropping patterns during rainy and winter seasons, *Annals Arid Zones* 13(4): 293-303.

Boshell, F. and Neild, R E. 1975. A computer statistical procedure to determine agroclimatic analogues for tea production in Colombia. *Agric. Meteorol.*, 15: 221-230.

Mavi, H.S. Tiwana, D.S., Grewal, S.S., Raghbir Singh; Bhajan Singh; N.T.Singh; S.D. Khepar and Sondhi, S.K. 1979. Agroclimatic Regions of Punjab. *Research Bulletin*, PAU.

Sen, T.K. Chamuah, G.S. Sehgal, J. and Velayutham, M. 1999. Soils of Assam for Optimising Land Use. *NBSS Publ.* 66 b (Soils of India Series) NBSS and LUP Nagpur, India.pp. 1-40.