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Sustainable Land Resource Management Practices for Jute Cultivation through the Identification of Production Factors and Soil Nutrient Mapping

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Abstract

Jute is the second most important fibre crop in India after cotton. There is a problem of non-uniform productivity over 87 jute growing districts located in varying agro-climatic regions of the country including 17 jute growing districts of West Bengal. In West Bengal relatively higher productivity is observed in South Bengal than in North Bengal., Factors of production were identified through field survey and interaction with the farmers in a participatory mode. The experiment was conducted during 2007 to 2009 at Dakshin Dinajpur district of North Bengal with the aim of determining critical production factors of jute and also to overcome the productivity constraints through soil mapping followed by soil fertility management. The results revealed that fertilizer management is the most critical factor of production followed by weed management. The soil resource mapping indicated that the experimental soils were having acute acidity problem followed by deficiency in some macro and micro nutrients which are certainly responsible for yield decline of jute in these areas.

Highlights

* An Experiment was designed to determine critical production factors of Jute.
* Results revealed that fertilizer management is the most critical factor followed by Weed management.

Keywords: **:** Jute fibre, productivity enhancement, soil resource mapping, resource management, soil fertility, constrained acidic soils

West Bengal occupies a place of pride in production of jute contributing about 81% of the total production and occupying 73% of total area of the country. In West Bengal, the productivity of jute was less than 25 q/ha during 2002-03 in 59% (3, 76,200 ha) of total area (6, 37,696 ha). Jute productivity in South Bengal districts is just reverse. In West Bengal except Malda, all the North Bengal districts are having productivity below the present national average (22.52 q/ha) (Dakshin Dinajpur District Statistical Handbook 2006, Bureau of Economics & Statistics).

The major reasons of technical nature for low productivity of these areas were initially identified as soil acidity, intermittent dry spell, water stagnation and nutrient deficiency. The quality of jute in these districts is very poor and also heavily infested with diseases. Jute is grown mainly by small and marginal farmers. The production potential of jute is, however, around 35-40 q/ha (http://

www.pnbkrishi.com/jutetech). In the past few years, total production of jute is decreasing in North Bengal due to shrinkage of area over years and supplementation of jute with mesta. This decrease in jute cultivation was due to the soil acidity (Maji *et al.*, 2012), disease problem, agro-climatic situation encompassing vagaries of monsoon, land constraints (undulated with varying textural classes) and imbalanced nutrient use for jute cultivation. No attempt has so far been made to address the problem of low productivity of jute in the inefficient and constrained locations. Keeping all these facts in view the present study was undertaken to identify the factors of jute production and to develop management practices to be adopted for sustainable land use under jute cultivation on the basis of identified factors of production.

Materials and methods

Delineation of the study area

Dakshin Dinajpur district of North Bengal was selected for experimentation considering the acreage under jute, land situation and land holding size of the farmers. However, total production of jute is decreasing in the district due to shrinkage of area over the years. The decrease in acreage of jute is mainly due to replacement by mesta grown under least management. Higher and lower productivity regions of the district in the lower level i.e., block level to gram panchayat (GP) level were identified on the basis of area, production and productivity data of jute were collected from the District Agriculture Department of the State. Out of 8 blocks in the district, Kamarganj was found to have the lowest productivity of jute (16.20 q/ha) while Balurghat, being the highest productive block (26.19 q/ha) during initiation year of the experiment. The experiment was conducted from 2007 to 2009 in these two blocks of Dakshin Dinajpur district of West Bengal in collaboration with Dakshin Dinajpur Krishi Vigyan Kendra of Uttar Banga Krishi Viswavidyalaya.

Determination of production factors for jute

Five production factors of jute initially identified by the farmers of the selected blocks were nutrient management, pest and disease management, T4rigation, weed management and improved retting. The Randomised Block Design with five factors in combination (in a step down regression manner) as treatments with four replications each was employed for experimentation. The treatment combination was as follows : i) *Treatment 1* : Pest management (T1) + Fertilizer management (T2) + Weed control (T3) + Irrrigation (T4) + Improved Retting (T5) ii) *Treatment 2* : Pest management + Fertilizer management+ Weed control + Irrrigation. iii) *Treatment 3:* Pest management + Fertilizer management+ Weed control iv) *Treatment 4:* Pest management + Fertilizer management v) *Treatment 5 :* Pest management. This experiment was conducted for three years (2007-09) and in the last year improved retting was omitted.

Soil fertility status through soil nutrient mapping for identifying soil constraints

Soil nutrient mapping (GP wise) for the two selected blocks was done in order to assess the causes of productivity decline in jute from the point of view of nutrient management. After identification of soil problems proper management practices were used for the experiment (taking farmers' practice as control) for two years. The initial soil samples were collected from the respective fields and were analysed according to standard methodologies as outlined by Jackson, 1973. Finally the problems of the soil from the soil mapping were identified and accordingly the management practices were developed in those identified areas.

Determination of sustainability index for the soil management practices

The sustainability indexes for determination of sustainable management practices of the experiment was determined by the procedure outlined by Vittal *et al.*, 2002, where they indicated that, for rainfed agriculture (as in jute), the variability imparted by rainfall is mostly linear and becomes important. Hence, its effect should be adjusted from the overall standard deviation 'σ'.Then a crop yield could be predicted with the regression equation of yield as:

$$Y = \alpha+\beta\ RF \ \ldots\ldots\ (1)$$

where a is the intercept and b is the regression coefficient of rainfall (RF) for predicting yield. Depending on the significance of the effect of rainfall on yield, the error determined under equation 1 would represent estimate of the true deviation than the overall standard deviation 'σ' as used in equation 2. By incorporating an appropriate error in equation 2, instead of standard deviation, we can get the sustainability of a treatment during the experimentation.

Sustainability Index (SI) 'I' of a treatment 't' over a period of 'n' years was derived by the equation:

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$I = (Yt - \sigma) / Y_{max}$ …….. (2)

Where Yt is the yield at that period. The range of 'I' would vary from –1 to +1. In practice, the sustainability as an index would be not far from unity. The limits are not exceeded because we are comparing the deviation of a treatment mean with the maximum value in the population 'Y_{max}'. Any practice yielding SI >0.66 is considered as a recommendable component for production of a crop in a region and SI of 0.50 to 0.65 is considered as highly promising. A practice with SI <0.33 is undependable

Results and discussions

Determination of production factors for jute

For identification of factors of jute production on-station trial was conducted for three consecutive years. The yield attributes and other parameters of different factors of production are recorded in Table1. Except the second year of experiment no significant increase was observed in plant height and basal diameter over the treatments. Among the treatments, T_1 showed steeper increase than the other treatments in green stem weight. Disease and pest incidence were found to be non-significant in all the treatments in all the three years as the incidence was very less due to the prevalence of favourable weather condition. The fibre yield was reduced from 2.93 t/ha (T_1) to 0.91 t/ha (T_5), 2.57 t/ha (T_1) to 0.83 t/ha (T_5) and 2.70 t/ha (T_1) to 1.30 t/ha (T_4) respectively in all the three years of experiment. The yield decrement (from T_1 to T_5) by the step down of factors was 222%, 209% and 108% respectively during the three years of experiment respectively. The significant yield reduction level was observed from T_3 treatment onwards irrespective of the years of experiment. Stick yield of the experiment followed the same trend.

To determine the factors of jute fibre yield multiple regression equations were worked out where the coefficients of factor and individual contribution revealed the fact that fertilizer management was the most important factor (Table 2). Fertilizer factor contributes 30.95%, 60.8% and 75.2% in the consecutive three years while irrigation was found to be the second important factor for production as it contributes 29.72% for the first year while from the second year onwards weed management was the second important factor as it contributed >24% in both the years. The irrigation was an important factor in first year which was probably due to the climatic hazards (dry spell). The contribution from the improved retting was insignificant and hence the factor was omitted from 2nd year onwards. In case of stick yield fluctuating results were observed. However, weed management, irrigation and fertilizer management were found to be other three important factors of production.

Soil fertility status through soil nutrient mapping for identifying soil constraints

To identify the cause of the productivity decline due to soil factors five soil samples were collected randomly from each of the GPs of the two blocks randomly choosing 5 villages from the GPs. The results of the initial average soil fertility data are presented in Plates 1 to 8. In Balurghat block, the soils of all the GPs showed acidic pH range (4.4 to 5.4). The soils of Chakbhrigu, Boaldar, Nazirpur and Gopalbati GP showed pH below 5.0 indicating a high acidity as compared to the soils of other GPs. The soil pH of Chakbhrigu, Nazirpur, Patiram, Boaldar and Gopalbati GP, showed an increasing trend towards the downward horizon of soil. This unusual trend of increased pH down the horizon may be attributed to the accumulation of bases from the light textured surface soils. Similar findings of increased subsoil pH were reported by Preve and Martins (1990). Excepting Chingispur GP, all the GPs were having medium organic carbon content ranging between 0.44 to 0.72%. In general, the subsurface soils possess lower organic carbon than surface soils, but 5 to 60% of the soil samples were low in organic carbon content in different GPs of Balurghat block. Patiram, Amritakhanda and Gopalbati GP were low in nitrogen, whereas, Nazirpur and Bhatpara GP were having higher levels. Interestingly, the subsurface soils of most of the GPs were enriched with nitrogen than surface soils. This may be due to the mineralization of nitrogen in surface soils. About 63.3% of GPs of Balurghat block were found to be deficient in phosphate content. Phosphate content of surface soils of Balurghat block ranged from 16.8 to 89.5 kg/ha. Similar to the nitrogen content, phosphate content of the subsurface soils were much enriched than surface soils. Excepting Patiram and Danga GP, all the soils of the GPs of Balurghat were found to be deficient in potassium. Similar trend of increasing potassium content in the subsurface soils was also observed. The potassium content in surface soils varied from 59 to 180 kg/ha. The deficiencies of nitrogen, phosphate and potassium may be attributed to the lower pH of these soils. Due to acidity nitrogen mineralization rate would be lower. Phosphate may be blocked onto the iron rich soil surfaces. Potassium may also be displaced from solution to surface by iron during submergence and

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Table 1 : Determination of Production factors of Jute cultivation

Parameter	Treatment	(T_1)	(T_2)	(T_3)	(T_4)	(T_5)	CDat 5%
Plant height (cm) at harvest	1st yr	279.3	269.3	280.1	281.3	213.5	108.4
	2nd yr	252.7	269.3	243.7	233.3	178.3	57.7
	3rd yr	—	319.3	317.3	218	245.7	11.6
Basal dia.(mm) at harvest	1st yr	1.62	1.66	1.48	1.50	1.47	0.196
	2nd yr	1.49	1.41	1.53	1.27	0.99	0.120
	3rd yr	—	1.16	1.13	0.86	0.55	0.095
10 green stem weight (kg)	1st yr	0.610	0.574	0.559	0.482	0.308	0.020
	2nd yr	0.513	0.469	0.468	0.434	0.207	0.037
	3rd yr	—	1.08	1.13	0.70	0.50	0.083
Disease infestedplant/ mt^2	1st yr	0	0	0	1	2	1.03
	2nd yr	0	0	0	1	1.3	0.972
	3rd yr		0	0	1	3.66	0.987
Pestinfestedplant/ mt^2	1st yr	0	0	0	1	1	1.11
	2nd yr	0	0	1	1	1	0.972
	3rd yr		0	0	3	2.66	1.04
Fibre yield(t/ha)	1st yr	2.93	2.63	1.52	1.25	0.91	0.46
	2nd yr	2.57	2.34	2.30	1.58	0.83	0.12
	3rd yr	—	2.70	2.66	1.98	1.30	0.35
Stick yield (t/ha)	1st yr	4.86	4.44	2.52	1.93	1.71	0.74
	2nd yr	4.37	4.07	3.53	2.34	1.66	0.78
	3rd yr	—	5.85	5.75	4.45	2.35	0.34

Table 2: Step up regression equation for determination of Production factors of jute in relation to jute yield and jute stick yield for three years of experiment

Year	Regression Equation	R^2	Individual Contribution (%)
1st	JY* = 2.461 + 0 T1**	0.000	0.000
	JY = -0.343 + 0 T1+ 1.56 T2	0.310	30.95
	JY = -0.713 + 0 T1+ 0.448 T2 + 1.480 T3	0.572	26.20
	JY = -1.27 + 0 T1+ 0.448 T2 + 0.365 T3 + 1.67 T4	0.869	29.72
	JY = -1.47 + 0 T1+ 0.448 T2 + 0.365 T3 + 1.47 T4 + 0.394 T5	0.881	1.24
1st	SY* = 4.123 + 0 T1	0	0
	SY = -0.021 + 0 T1+ 2.30 T2	0.256	25.61
	SY = -0.693 + 0 T1+ 0.286 T2 + 2.69 T3	0.583	32.72
	SY = -1.64 + 0 T1t+ 0.286 T2t + 0.796 T3 + 2.84 T4	0.908	32.42
	SY = -1.92 + 0 T1+ 0.286 T2 + 0.796 T3 + 2.55 T4 + 0.563 T5	0.917	0.96
2nd	JY = 2.532 + 0 T1	0.000	0.000
	JY = -0.66 + 0 T1+1 .73 T2	0.608	60.8
	JY = -0.922+ 0 T1+ 0.987 T2 + 1.05 T3	0.846	24.2
	JY = -1.04 + 0 T1t+ 0.987 T2 + 0.807 T3 + 0.363 T4	0.864	1.80
	JY = -1.19 + 0 T1+ 0.987 T2 + 0.807 T3 + 0.213 T4 + 0.3 T5	0.868	0.41
2nd	SY = 4.26 + 0 T1	0.000	0
	SY = -0.358 + 0 T1+2.56 T2	0.384	38.4
	SY = -0.908+ 0 T1+ 0.913 T2 + 2.20 T3	0.736	35.1
	SY = -1.22 + 0 T1t+ 0.913 T2t + 1.58 T3 + 0.927 T4	0.781	4.5
	SY = -1.42 + 0 T1+ 0.913 T2 + 1.58 T3 + 0.723 T4 + 0.407 T5	0.770	0
3rd	JY = 2.160+0T1	0	0
	JY = 0.148+0T1+1.15T2	0.751	75.1
	JY = -0.086+0T1+0.682T2+ 0.702T3	0.999	24.8
3rd	SY = 4.608+0T1	0	0
	SY = -0.665+0T1+3.013T2	0.853	85.3
	SY = -1.1055+0T1+2.132T2+ 1.322T3	0.999	13.7

*Jy = Jute fibre yield ; SY = Jute stick yield

let it block into the wedge zone of clay surface during dry period. Chakbhrigu , Danga, Chingispur, Bolla and Boaldar GPs were found to be deficient in sulphate content. The sulphate content in the surface soils of Balurghat block ranged from 16.5 to 25.1 kg/ha. About 30% of the GPs were deficient to likely to be deficient in boron content as it ranged from 0.12 to 0.42 mg/kg. The available zinc content in the GPs of Balurghat block were observed deficient to likely to be deficient as the levels varied below 0.35 and 0.86 mg/kg. However, down the horizon some soils of GPs were enriched with sulphur, boron and zinc. The reason behind the enrichment for sulphur and boron may be leaching of nutrients in these light textured soils. Leaching of nutrients in the light textured soils was also reported by Takkar, 1996. But unlikely the zinc, the deficiency were observed in these acidic soils. The higher iron content in these soils may co-precipitate zinc thus rendering deficiency (Alloway, 2008). Though the percentage deficiency level of sulphur, boron and zinc in surface soils of some GPs showed negligible levels, yet considerable number of soils were deficient.

In Kumarganj Block, the pH status of most of the GPs were alarmingly low (<5.0) excepting three GPs namely (Safanagar, Mohana and Bhomar having pH (Plates 1 to 8). The pH of surface soils of this block ranged from 4.58 to 5.66. Except Samjhia, Jakhirpur and Ramkrishnapur, the soils of the other GPs showed higher pH than the surface soils. This may be due to the leaching of bases in these soils favoured by the light textured surface soil. Almost 100% samples were found acidic in reaction. All the GPs of the Kumarganj block were having medium organic carbon content (0.56 to 0.71%) in the surface soil whereas in subsurface soil, due to leaching of organic matrices from surface, the organic carbon content was found higher in

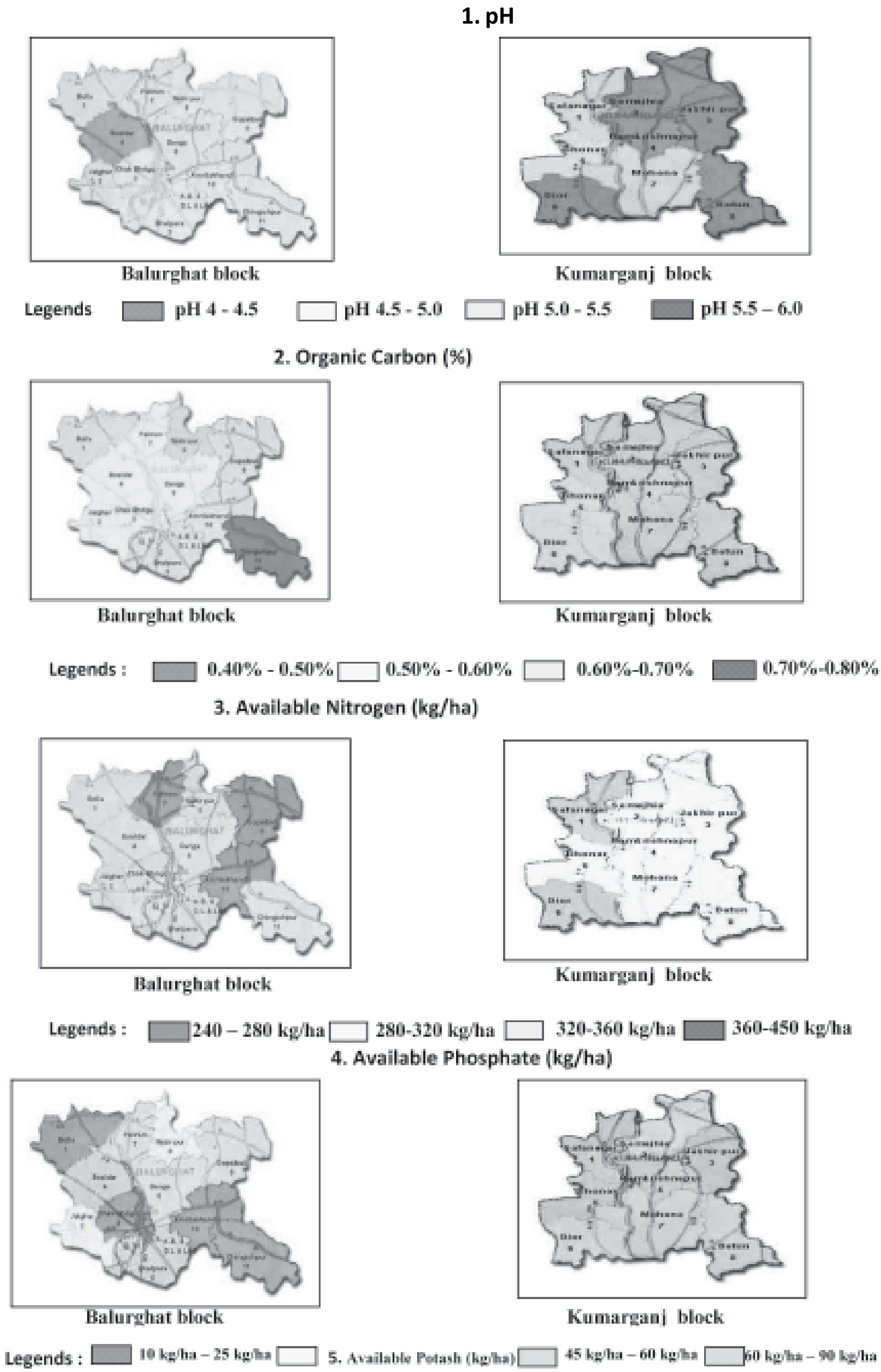

Figure 1: Soil fertility maps of the two experimental blocks under study

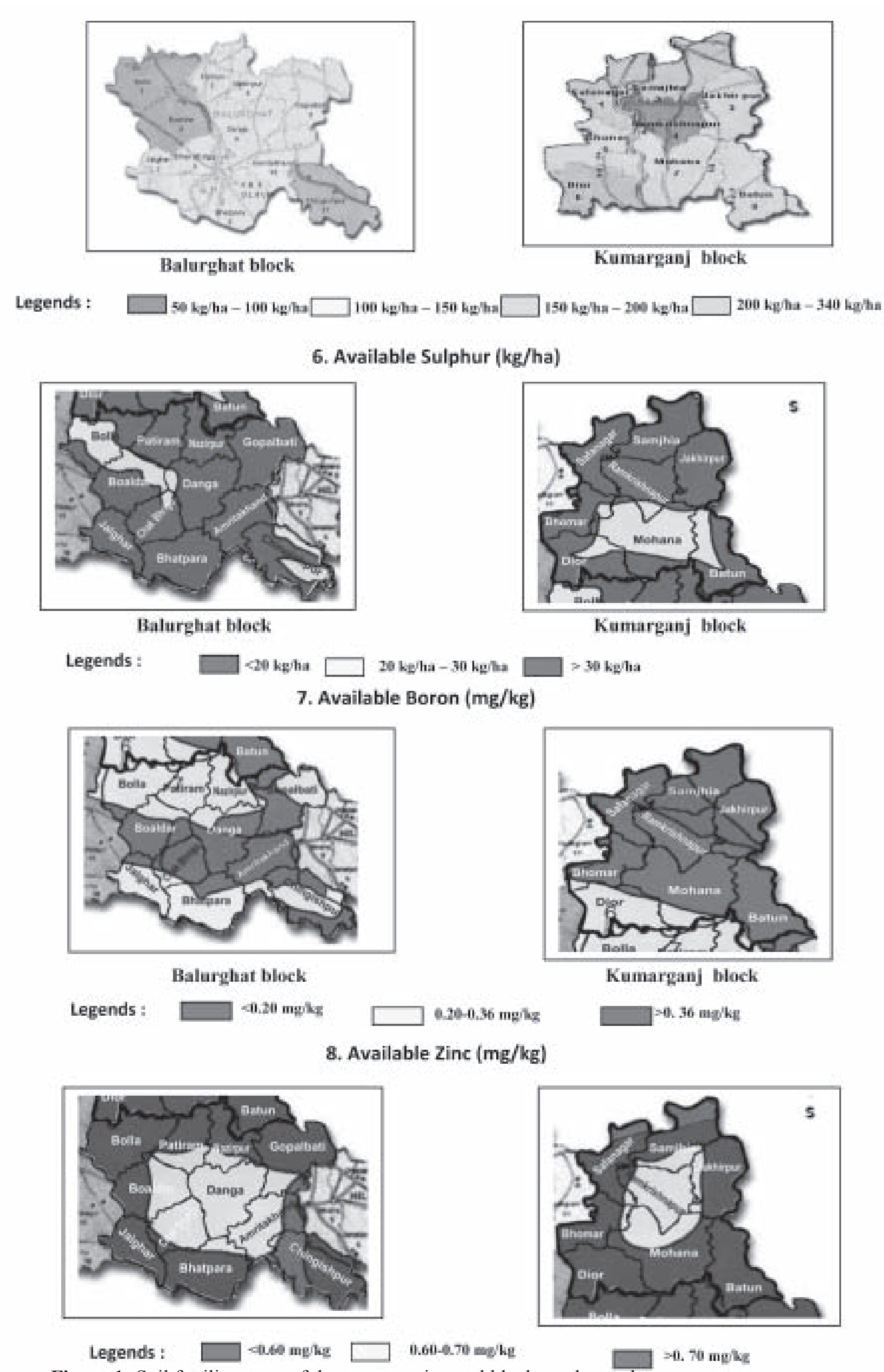

Figure 1: Soil fertility maps of the two experimental blocks under study

some GPs, namely, Safanagar, Ramkrishnapur, Jakhirpur, Bhomar, Batun. Around 0-40% samples were low in organic carbon content. In general, the soils of Kumarganj block were medium in nitrogen (304-368 kg/ha) except Safanagar and Samjhia GPs. Among all the samples, 20% of the samples were deficient in nitrogen. In general, decreasing trend of nitrogen in subsurface soil was observed in almost all the GPs. Though average phosphate content was found in the medium range in most of the soils yet the deficiency level was acute in all the GPs and it varied from 25% to 100% (Plates 1 to 6). The reason of such deficiency may be attributed to Fe related lower pH in these soils rendering phosphate unavailable to plants. Phosphorus deficiency in Fe enriched soils of West Bengal was reported by Bandopadhyay and Chattopadhyay, 1997 and Bhat *et al*., 2007.

Down the horizon the phosphate in some GPs decreased while in some soils it increased. The increment may be favoured by the light texture nature of the surface soils in those GPs. Similar to the phosphate, average potassium content in these soils showed medium levels, though, 20 to 80% of the soil samples of the GPs were found low in potassium. In case of potassium also subsurface soils of some GPs were found to be enriched than surface soils. The fact remained the same as described for phosphate. The phosphate and potassium content in these soils varied from 25.5 to 103 kg and 96 to 318 kg/ha, respectively. The soils of Batun, Deor and Mohana GPs were deficient in sulphate while others contained medium range of sulphate. The sulphate content ranged from 14 to 21 kg/ha. Excepting Mohana and Batun, boron content of all the soils of the other GPs were deficient. But in Zinc content only Samjhia and Safanagar were deficient while others were observed to be in medium level. The boron content in these soils varied from 0.11 to 0.41 mg/ka while zinc, varied from 0.47 to 0.75 mg/kg. In 0-35% samples, boron deficiency was recorded whereas, for zinc the deficiency was 0 to 50%. The sulphur, boron and zinc of the subsurface soils fluctuated very much due to the texture and pH status of soil favouring leaching down the profile. In general, the lower productivity in Kumarganj Block may be attributed to the pH status and to some extent sulphur status of the soil, as no other marked variation observed between the nutrients of the two blocks.

Simple correlation coefficients (level of significance of r value is indicated by *for significance at $P<0.05$ and ** for significance at $P<0.01$)were determined among the soil properties where no such significant correlation was obtained among the soil chemical properties in surface soils excepting the relationship between phosphate and potassium content of these soils (Table 3). But interestingly in the subsurface soil of Balurghat block significant negative correlation was observed between pH and available boron (r = -0.609*), and positive significant correlations between available nitrogen and organic carbon (r = 0.734*), phosphate and potassium (r = 0.868**). In surface soils of Kumarganj block significant positive correlations were obtained between potassium and boron content (r = 0.877**). No other significant relationship was observed between other soil chemical parameters. In the subsurface soils of Kumarganj block only significant positive correlation was observed between available nitrogen and zinc content (r = 0.755*) of these soils. These soils are Inceptisols developed on the alluvium deposited by the river and poses variation in soil texture and mineralogy. The fluctuations in alluvial soil due to differences of mineralogy were reported by Ghosh et al., 2002. While the surface soils of the two productive regions are considered, additional significant relationships were obtained. Positive significant relationship existed between pH and available potassium (r = 0.478*), available sulphate and boron (r = 0.585**), available boron and zinc (r = 0.660**). In subsurface soils, positive significant relationship existed between organic carbon and nitrogen (r = 0.656**), available phosphorus and potassium (r = 0.647**), while negative significant correlation was observed between pH and available nitrogen (r = -0.478*). The change in correlation pattern may be due to the difference in soil pH which governs the chemical properties of the soils. pH facilitates leaching and also it facilitates adsorption over the clay surfaces.

Field experiment with the identified management practices

On the basis of identified soil problems farmers' field experiment was set accordingly in the GPs with the management practices to overcome the identified problems. From the soil nutrient mapping problems like imbalance NPK fertilization, soil acidity with no or suboptimal liming practices, deficiencies in sulphur and macronutrients namely zinc and boron were identified. So experiments were set keeping all these issues separately in the selected GPs. The average three year yield data are recorded in Table 4. It was observed from the table that the response of liming coupled with the balanced fertilization was more pronounced in Kumarganj block as compared to Balurghat

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Table 3: Correlation Coefficient of different soil properties of two blocks under study

Blocks		Layers	pH	Org. C$^{\Delta}$ (%)	Av$^{\Delta\Delta}$. N. (kg/ha)	Av. P_2O_5 (kg/ha)	Av.K_2O (kg/ha)	Av. SO_4^{2-} (kg/ha)	Boron (mg/kg)	Zinc (mg/kg)
Balurghat Block	pH	0-15cm	1	-0.017	-0.335	0.087	0.510	0.325	-0.348	-0.174
		15-30cm	1	-0.291	-0.512	0.356	0.064	-0.162	-0.609*	0.602
	Org C. (%)	0-15cm	-0.017	1	0.481	-0.005	0.001	0.394	0.046	0.149
		15-30cm	-0.291	1	0.734*	0.203	0.148	0.280	0.246	-0.185
	Av. N. (kg/ha)	0-15cm	-0.335	0.481	1	-0.076	-0.161	-0.117	-0.123	0.243
		15-30cm	-0.512	0.734*	1	0.413	0.457	0.297	0.320	-0.257
	Av. P_2O_5 (kg/ha)	0-15cm	0.087	-0.005	-0.076	1	0.637*	-0.159	0.052	-0.058
		15-30cm	0.356	0.203	0.413	1	0.868**	0.178	-0.282	0.110
	Av. K_2O (kg/ha)	0-15cm	0.510	0.001	-0.161	0.637*	1	0.121	-0.322	-0.012
		15-30cm	0.064	0.148	0.457	0.868**	1	0.198	-0.332	0.044
	Av. SO_4^{2-} (kg/ha)	0-15cm	0.325	0.394	-0.117	-0.159	0.121	1	0.251	0.337
		15-30cm	-0.162	0.280	0.297	0.178	0.198	1	0.195	-0.038
	Boron (mg/kg)	0-15cm	-0.348	0.046	-0.123	0.052	-0.322	0.251	1	0.575
		15-30cm	-0.609*	0.246	0.320	-0.282	-0.332	0.195	1	-0.298
	Zinc (mg/kg)	0-15cm	-0.174	0.149	0.243	-0.058	-0.012	0.337	0.575	1
		15-30cm	0.602	-0.185	-0.257	0.110	0.044	-0.038	-0.298	1
Kumarganj Block	pH	0-15cm	1	0.225	-0.218	-0.203	0.387	0.097	0.191	0.344
		15-30cm	1	0.262	-0.397	0.214	0.554	-0.468	0.203	0.089
	Org C. (%)	0-15cm	0.225	1	0.573	0.215	0.414	-0.473	0.526	0.540
		15-30cm	0.262	1	0.038	-0.492	0.133	-0.311	-0.171	0.352
	Av. N. (kg/ha)	0-15cm	-0.218	0.573	1	-0.076	-0.024	-0.548	0.242	0.492
		15-30cm	-0.397	0.038	1	0.143	-0.363	0.324	0.291	0.755*
	Av. P_2O_5 (kg/ha)	0-15cm	-0.203	0.215	-0.076	1	-0.445	0.120	-0.571	-0.461
		15-30cm	0.214	-0.492	0.143	1	0.266	0.329	0.547	0.351
	Av. K_2O (kg/ha)	0-15cm	0.387	0.414	-0.024	-0.445	1	-0.450	0.877**	0.197
		15-30cm	0.554	0.133	-0.363	0.266	1	-0.460	0.394	-0.138
	Av. SO_4^{2-} (kg/ha)	0-15cm	0.097	-0.473	-0.548	0.120	-0.450	1	-0.548	-0.078
		15-30cm	-0.468	-0.311	0.324	0.329	-0.460	1	-0.418	0.375
	Boron (mg/kg)	0-15cm	0.191	0.526	0.242	-0.571	0.877**	-0.548	1	0.522
		15-30cm	0.203	-0.171	0.291	0.547	0.394	-0.418	1	0.179
	Zinc (mg/kg)	0-15cm	0.344	0.540	0.492	-0.461	0.197	-0.078	0.522	1
		15-30cm	0.089	0.352	0.755*	0.351	-0.138	0.375	0.179	1

* Correlation is significant at the 0.05 level (2-tailed) ** Correlation is significant at the 0.01 level (2-tailed).
$^{\Delta}$Org. C.- Organic Crabon, $^{\Delta\Delta}$Av.- Available

Table 4: Yield data of different management practices for productivity enhancement of jute in some identified problematic experimental areas.

Blocks	Gram Panchayat	Famers' Practice	Balanced NPK fert.	LR based Lime	LR based Lime + Balanced NPK fert.	Organic matter + Balanced NPK	Sulphur + Balanced NPK	Zinc + Balanced NPK	Boron + Balanced NPK
		On the basis of average yield data of three years of experiment							
Balurghat Block	ChakBhrigu	2.33 (4.24)				2.41 (4.35)	2.65 (4.83)		3.01 (4.73)
	Patiram	1.99 (4.97)	2.21 (5.54)	2.34 (5.87)	2.55 (6.31)				
	Jalghar	2.91 (6.69)	3.33 (7.81)	3.64 (8.46)	3.78 (8.56)				
	Danga	2.70 (4.06)				3.22 (5.38)	3.27 (5.88)	3.73 (5.82)	
	Amritakhanda	1.61 (2.72)				1.86 (3.11)		2.60 (3.98)	2.76 (4.75)
Kumarganj Block	Safanagar	1.65 (4.67)				2.00 (5.29)		2.41 (5.48)	3.23 (6.78)
	Samjhia	1.33 (3.30)				1.62 (3.42)		1.66 (3.35)	2.39 (4.80)
	Jakhirpur	2.05 (5.23)	2.30 (5.71)	2.42 (6.16)	2.72 (6.55)				
	Ramkrishnapur	1.69 (3.87)	1.98 (5.24)	2.09 (5.25)	2.32 (5.68)				
	Deor	2.01 (3.60)				2.19 (3.76)	2.46 (4.12)		
	Batun	2.20 (4.01)				2.27 (4.56)	2.48 (4.76)		

block. This was probably due to the fact that the soils of Kumarganj block were more acidic compared to the Balurghat block and hence greater responses were expected. In Balurghat block balanced fertilization in soil increased jute fibre yield to 12% while liming without fertilization increased 21% jute yield. When these two factors were coupled, the yield increase was found to the tune of 29%. Similar response of Lime coupled with balanced fertilization in jute was observed by Bandopadhyay, 2003 and Saha *et al.*, 2008. Whereas in Kumarganj Block the same experiment revealed the yield increase in jute for these factors as 15%, 21% and 35% respectively. The stick yield in this set of experiment revealed the same trend. Application of organic matter along with the balanced fertilization in the two blocks showed an yield increase of >12%. However, the application of balanced fertilization coupled with sulphur or zinc or boron in the deficient areas of Balurghat block showed an average yield increase to the tune of 17.7%, 46.9% and 46.4% respectively while these for Kumarganj block was 17.4%, 36.6% and 88.6% respectively. Response and yield increment of jute by integrated nutrient management was also reported by Ghosh *et al.*, 2008, Ghosh (2008). Saha *et al.,* 2002 and Mitra *et al.,* 2010. Average Stick yield of jute also showed marked increase on the addition of these deficient nutrients. Similar yield was reported by Mazumder *et al*., 2010

Determination of sustainability index for the validation of soil management practices

The sustainability index for all the treatments was determined by the average yield of jute in the GPs representing each block (Figures 1 and 2). According to the criteria of Vittal et al 2002, the fibre yield of jute in the Farmers practice of Kumarganj block was least sustainable. However the same for Balughat block was more sustainable. This might be due to the fact that Balurghat belongs to the higher jute productivity zone and the soil types are also favourable. Regarding the treatments the sustainability index (according to the criteria, >0.66 – recommended) for Fibre yield in Balurghat block followed the order as Balanced NPK + Zn > LR based lime + Balanced NPK > Balanced NPK + S > Balanced NPK + B > Balanced NPK > Organic matter + Balanced NPK > LR based lime application whereas in Kumarganj block the order for the same criteria is Balanced NPK + S > Balanced NPK + Zn. Kumarganj block has more constraints than Balurghat block, hence most of the sustainability index for the other treatments falls under highly promising management practices (as SI -0.5 to 0.65). The stick yield was sustainable in both the blocks in farmer's practice while the management practices increased the sustainability towards the recommendation.

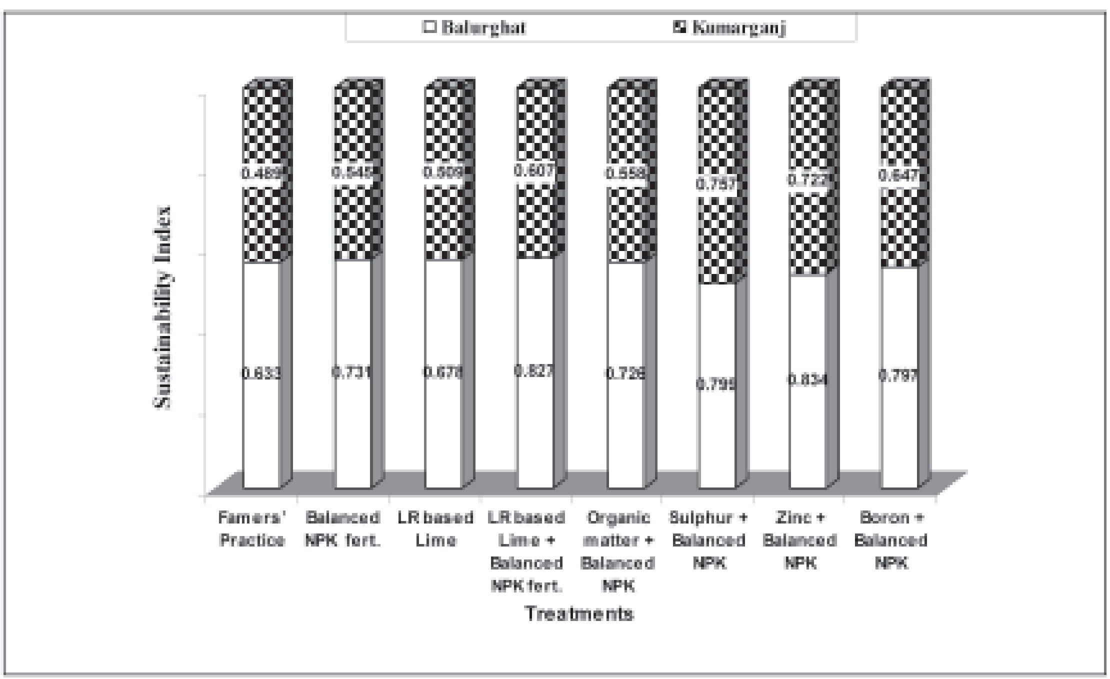

Figure 1. Sustaibanility index of Fibre yield of jute in the experimental blocks

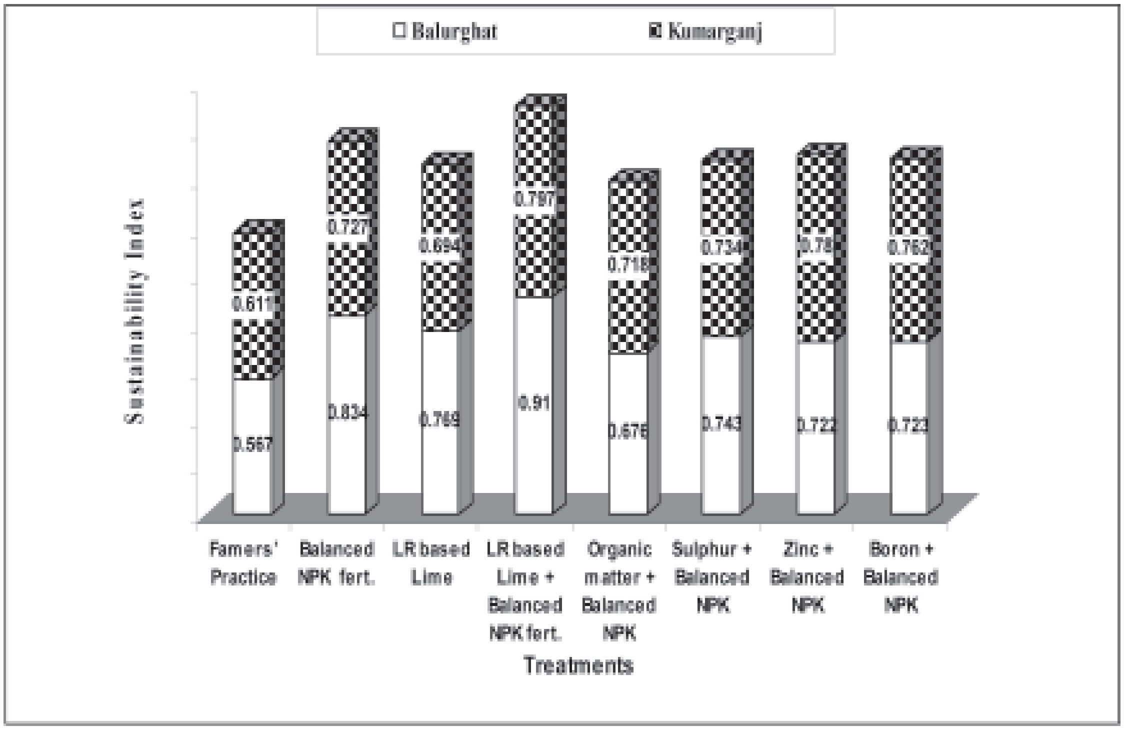

Figure 2: Sustainability index of Stick yielf of jute in the experimental blocks

Conclusion

From the above experiment it may be concluded that the jute productivity in these acidic soils are dependent on the soil-fertilizer management. To keep pace with the sustainable production of jute in these constrained soils, the soil acidity problem should be eliminated first and then balanced fertilization and supply of deficient micronutrients may be followed. Prior to soil amelioration the deficient macro and micronutrients are to be added to have economic profitability and good quality jute yield.

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