

AGRI-HORTI PRODUCTION SYSTEMS FOR REHABILITATION OF SUB-HUMID CALCAREOUS SODIC LANDS OF NORTH BIHAR

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ABSTRACT

Reclamation of calcareous sodic lands was undertaken under farmers participatory mode by the use of pyrite in four villages of district Muzaffarpur, Bihar during 1996 and 1997 for assessing the possibility of agri-horti System with higher sustainable productivity in sub-humid region. Suitable agro techniques were used to reclaim sodic soils for enhancing food grain crop yield besides pit treatments for mango and litchi plantation. The site-specific agro techniques for establishment of mango and litchi with their various components, management practices as well as for rice and wheat crop were adopted for efficient utilization of sodic lands. The reclamation practices reduced the level of ESP (54.5 to 32.7), bulk density (1.65 to 1.55 gm/cm³), penetration resistance (1.73 to 1.20 Mpa), pH (9.83 to 8.82) and EC (2.33 to 0.97 ds m⁻¹). There was an increase in cumulative infiltration rate (1.4 to 1.8 cm/hr in 306 minutes) besides increase in hydraulic conductivity (0.26904 to 0.39878 cm/hr). Survival of mango and litchi plants in treated plots were 177% more as compared to untreated plots indicating good possibilities for growing horticultural plants such as mango and litchi alongwith 2.52 times high yield of rice and wheat.

Key words : Participatory approach, Agri-horti systems, and salt affected soils

In dense populated sub-humid region of the country, the possibility of horizontal expansion of farming is limited. Use of degraded/problem soils along with intensive farming on reclamation can fulfil the basic needs of increasing population. A sizeable land in Bihar state is subjected to various kinds of land degradation problems of which about four

lakh hectares lands suffer from sodicity. These soils are characterized by high pH, excess chloride, sulphate, and exchangeable sodium, imbalance of EC, low infiltration rate, high bulk density, poor drainage, and poor fertility status. A large area has gone out of cultivation or only rice is grown with very poor yield (1.0 - 1.5 t/ha). If such lands are reclaimed properly, sustainable farming may be achieved by putting them under agri-horti systems.

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In spite of several limitations, these lands can be managed for cultivation of crops and trees by adopting scientific management practices (Singh and Singh 1997). Growing horticultural trees is considered an integral part in various agro-horti farming systems from production management of sodic soils and protection point of view (Singh and Singh, 1990; Saroj, 1996). An effort has been made to grow fruit trees such as mango and litchi plants after reclaiming the salt affected soils so that permanent vegetation cover may be kept to check the rise of water table and stop further degradation and also rehabilitation of these lands.

MATERIALS AND METHODS

The Gandak Command Area Development Agency (CADA) undertook a massive programme on reclamation of Sodic lands in Muzaffarpur, Siwan & Champaran districts of north Bihar. The area falls in sub-humid sub-tropical zone with an average annual rainfall of about 1050 mm. The topography of the area was almost flat. Based on chemical characteristics the sodic lands are categorized as (A) (Good lands pH (7.5-8.0), (B) Moderate society pH (8.1-9.0) and (C) High society pH > 9.0. The farmer's fields of C and B class were reclaimed in participatory mode after imparting proper training with respect to reclamation, management techniques etc. The study was done during 1996, 1997 at farmers' fields in five villages namely;

Mathina, Baburban, Tajpur, Gokula and Birahima under Baruraj block of district Muzaffarpur. The sodicity affected agricultural lands used for food grain production were treated with pyrite followed by green manuring by *sesbania*. In the same field, pits were dug out and treated with pyrite along with pit filling mixtures for plantation of fruit trees viz., mango and litchi. Subsequently, the observations were taken on soil and saplings of mango and litchi, which were planted to evaluate agri-horticultural production system. Grain yields of rice and wheat were recorded under both the conditions.

After assessing the alkalinity levels (based on soil testing), the land was leveled and divided into beds by making bunds. The beds were treated with pyrite (requirement is based on pH value), if objective is to grow the crops in whole area otherwise only pits were treated. Besides pyrite use, dhaincha (*Sesbania aculeata*) was grown in early rainy season as a green manure. FYM was applied where green manuring was not done. The plant spacing for mango and litchi was 10x10 m and 8x8 m, respectively while pit size is 1x1x1 m³ for mango and litchi in square system.

The pits were left open for at least 30 days. Pit filling was done in April-May by filling mixture as per details given in Table 1. In pits BHC or neem cake and Zn SO₄ was mixed in soil before 7-10 days of plantation.

Table 1. Pitfilling mixture for salt affected soils.

Filling materials	Fruit plant	
	Mango	Litchi
Pyrite I (Kg)	2-3	2-3
FYM (Kg)	30	25
Sand (Kg)	15	15
BHC/Neem cake 100/500	(g)	100/500
Zn SO ₄ (g)	50	50
SSP/MP (g)	1500/50	1500/50

Undisturbed soil cores (7 cm dia and 7.5 cm length) were collected and analyzed for saturated hydraulic conductivity with constant head parameter. (Klute 1972) which water retention was determined using pressure plate apparatus (Richards, 1954). The bulk density determined by core sampler method and water infiltration rate was estimated using double ring infiltrometer by falling head method (Black, 1965).

RESULTS AND DISCUSSION

Effect of reclamation on chemical properties of sodic soils

High amount of soluble salt, mainly of sulphate, chloride, nitrate, carbonate and bicarbonate of sodium which not only adversely affected the physical properties but also availability of nutrient and ultimately to plant growth considerably besides increase in pH. All these adverse

effect decreased both under pits and field soils.

There was decrease in adverse characters of sodic soils like, pH, EC, ESP, bulk density and penetration resistance. This could increase favourable effect on soil thereby increasing infiltration rate, hydraulic conductivity water retention and available soil moisture (Table 2 and 3).

Effect on crop yield

Rice yield was increased by 2.11 times under treated plot as compared to untreated. The magnitude of increase was higher under C class land although the higher yield was under B class land. Similarly the mean wheat yield was also increased by 2.5 times due to sodic land reclamation by pyrite and follow up recommended package of practices. Thus, the yield increased from 1.9 t/ha to 5.99 t/ha (Table 4).

Based on above study it may be inferred that involving the farmers in all activities at all stages beginning from planning to execution could bring a great success in bringing barren unused land under Agri-horti system during initial 4-5 years. After full land cover such lands may be used only for fruit production.

Survivability of planted saplings

The survival of planted mango and litchi was 1.2 to 2.3 times higher under pit treated condition than that under untreated. (Table 5.)

Table 2. Effect of Pyrite treatment on physicochemical properties of sodic soil

Villages	Hydraulic Conductivity (cm/hr)		Bulk density (g/cm ³)		Penetration resistance (MPa)		pH(1:2)		EC (1:2)		ESP	
	Initial	After	Initial	After	Initial	After	Initial	After	Initial	After	Initial	After
Mathina	0.021	0.068	1.5-1.8	1.4-1.7	1-2.5	2.8-1.8	9.5-10.2	8.7-9.5	0.7-2.9	0.5-1.0	44.5-60.0	24.5-32.5
Baburban	0.475	0.880	1.5-1.8	1.4-1.7	1-2.5	0.8-1.9	9.6-9.7	8.6-8.9	1.1-4.7	0.6-2.3	32.5-71.6	22.2-42.3
Tajpur	0.119	0.136	1.5-1.8	1.4-1.7	1-2.4	0.8-1.5	9.5-10.9	8.4-9.5	0.5-8.4	0.2-2.2	42.5-68.4	28.5-37.6
Gokula	0.424	0.502	1.5-1.8	1.4-1.6	1-2.5	0.7-1.4	9.6-9.8	8.5-8.8	0.7-1.3	0.3-0.9	37.8-65.3	26.3-36.9
Birahima	0.305	0.405	1.5-1.8	1.4-1.7	1-2.3	0.8-1.5	9.5-10.0	8.6-9.4	0.6-2.4	0.4-1.3	44.5-77.3	28.5-48.3

Table 3. Effect of Pyrite treatment on infiltration rate and available soil moisture in sodic soils.

Village	Basic		Cumulative 306 min		Water retention MPa		0.033 MPa		Available Moisture (%)	
	Initial	After	Initial	After	Initial	After	Initial	After	Initial	After
Mathina	0.033	0.066	1.0	1.4	12.00	9.7	24.0	27.2	12.0	17.5
Baburban	0.033	0.066	1.1	1.4	13.5	11.1	24.5	30.1	11.0	19.0
Tajpur	0.66	0.100	1.6	2.1	9.7	8.9	23.2	26.6	13.5	17.7
Gokula	0.100	0.130	1.6	3.0	11.5	9.8	25.0	26.1	13.5	16.3
Birahima	0.100	0.120	1.7	2.8	14.5	10.4	25.7	30.3	11.2	19.5
					8.9	7.4	22.2	24.5	13.3	17.0

Agri-horti production systems

Table 4. Effect of calcareous sodic land reclamation on crop productivity (Average of 45 farmers' field for 1996 & 1997)

Sodic land class	Grain Yield (t/ha)				Increase in crop yield over untreated (%)		Increase in annual food grain productivity (t/ha)
	Rice		Wheat		Rice	Wheat	
	Untreated	Treated	Untreated	Treated			
C	0.81	2.82	0.50	2.23	24.8	346	3.74
B	1.40	3.83	1.21	3.12	174	158	4.34
Mean	1.10	3.32	0.85	2.67	211	252	4.04

Table 5. : Effect of pit treatment in sodic lands on survival (%) of newly planted mango and litchi (Average of five villages sites for 1997&1998).

Sodic land Class	Average of surviving plants / 100 planted saplings after one year				Average Increase in survival rate of planted sapling (%)
	Mango		Litchi		
	Untreated	Treated	Untreated	Treated	
C	15	54	23	72	231
B	26	76	36	87	126

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