Agricultural Economics Research Review
Vol. 26 (Conference Number) 2013 pp 139-147

Livelihood Security of Resource Poor Farmers through Alkali Land Reclamation: An Impact Analysis

K. Thimmappa*, R.S. Tripathi, R. Raju and Y.P. Singh

Central Soil Salinity Research Institute, Karnal-132 001, Haryana

Abstract

The impact of land reclamation has been explored on productivity, income and food security in the salt-affected regions of Uttar Pradesh. The study has revealed substantial farm-level benefits to the farmers due to sodic land reclamation. The cropping intensity has increased by 9.39 per cent during post- vis-à-vis pre-reclamation period. The gross cultivated area increased by 13.65 per cent after land reclamation. Paddy and wheat yields have increased by 95 per cent and 194 per cent, respectively after reclamation. Better farm income has influenced household expenditure and standard of living which has ultimately enhanced food security of the resource-poor farmers. The majority of farmers opined that purchasing of foodgrains especially of rice and wheat, has declined and expenditure on fruits and vegetables has increased. There is a rise in the expenditure on house construction and children education after reclamation due to increase in farm income. The land reclamation programme has made a positive and significant contribution to livelihood security of small and marginal farmers. The study has concluded that household income and food security of resource-poor farmers in salt-affected areas can be improved through land reclamation programmes. The study has suggested that the large tracks of salt-affected lands that are lying barren in Uttar Pradesh and other states of the country should be treated for soil reclamation to improve the livelihood security of the resource-poor farmers and to strengthen food security of the country.

Key words: Livelihood security, food security, resource-poor farmers, alkali land, reclamation, Uttar Pradesh

JEL Classification: Q01, O13, Q24

Introduction

Salt-affected soils are found in all the continents under diverse climatic conditions and are a major threat to agriculture for sustaining farm income and food production. These soils are present extensively in arid and semiarid regions and cover approximately 7 per cent of the total land area of the Earth (Ghassemi *et al*., 1995). In India, irrigation-induced salt-affected soils cover an area larger than naturally occurring salt-affected soils, and both are widespread in the arid and semiarid agro-ecological regions (Singh, 2005; Smedema and Shiati, 2002). Land degradation resulting from soil salinity, sodicity or a combination of both, is a major impediment to productive utilization of land resources for crop production. There are several practical methods for reclaiming these salt-affected soils. The soil salinity and waterlogging could be reclaimed through subsurface drainage technology. The provision of subsurface drainage through public interventions has significantly increased the productivity of land and has provided a source of regular income to resource-poor households (Chinnappa, 2005; Datta and Dejong, 2000; Joshi *et al*., 1987).

The management of alkali (sodic) soils is difficult due to their physical and chemical properties, which

* Author for correspondence
Email: Email: thimpu@rediffmail.com

affect field preparation, irrigation practices, drainage, choice of crops and other operations. The plant growth and productivity are adversely affected due to several factors like amount of exchangeable sodium, pH, nature and stage of crop growth, environment of the area and overall management of the soils. The exchangeable sodium percentage (ESP) must be lowered to increase the crop growth and productivity in alkali soils, which can be achieved by application of soil amendments (Chhabra, 1996). Several efforts have been made by the central and state governments to check soil degradation and increase agricultural productivity through land reclamation programmes in salt-affected regions of India. The amendments are being supplied by the state governments at subsidized rates to reclaim sodic lands through land reclamation programmes to improve the livelihood security of resource-poor farmers. In this background, the present study was undertaken to find the impact of alkali land reclamation on the livelihood security of the resource-poor farmers in Uttar Pradesh.

Methodology

The study was conducted in Unnao and Raebareli districts of Uttar Pradesh. These two districts were chosen purposively considering larger alkali area in these districts during the year 2000. From each district, two villages were selected having larger reclaimed alkali area. The primary data were collected for pre-reclamation period (1999-2000) and post-reclamation period (2011-12) from 60 farmers after a decade of reclamation to find the impact and sustainability of crop production with the help of interview schedule using survey method. Data were analyzed using percentage, benefit-cost ratio, Gini ratio and partial budgeting techniques.

Results and Discussion

The development of salt-affected soil depends on climate, topography, geology, soil mineral weathering, drainage, hydrology, source and method of irrigation, underground watertable, and quality and crop production practices (Ghassemi *et al*., 1995). In India, 6.73 Mha land is salt-affected, out of which 3.77 Mha are alkali soils and 2.96 Mha are saline soils (NRSA, 1996). The distribution of salt-affected soils in India, shown in Table 1, reveals that the salt-affected soils are widely distributed in different parts of the country. Across states, Gujarat has the largest salt-affected area (33.0%), followed by Uttar Pradesh (20.35%),

Table 1. Distribution of salt-affected soils in India

State	Saline soils		Sodic soils		Total salt-affected soils	
	'000 ha	% to the total	'000 ha	% to the total	'000 ha	% to the total
Andhra Pradesh	77.6	2.62	196.6	5.21	274.2	4.08
Andaman & Nicobar Islands	77.0	2.60	0.0	0.00	77.0	1.14
Bihar	47.3	1.60	105.9	2.81	153.1	2.28
Gujarat	1680.6	56.84	541.4	14.36	2222.0	33.03
Haryana	49.2	1.66	183.4	4.86	232.6	3.46
Karnataka	1.9	0.06	148.1	3.93	150.0	2.23
Kerala	20.0	0.68	0.0	0.00	20.0	0.30
Madhya Pradesh	0.0	0.00	139.7	3.71	139.7	2.08
Maharashtra	184.1	6.23	422.7	11.21	606.8	9.02
Odisha	147.1	4.98	0.0	0.00	147.1	2.19
Punjab	0.0	0.00	151.7	4.02	151.7	2.26
Rajasthan	195.6	6.61	179.4	4.76	374.9	5.57
Tamil Nadu	13.2	0.45	354.8	9.41	368.1	5.47
Uttar Pradesh	21.9	0.74	1346.9	35.72	1368.9	20.35
West Bengal	441.3	14.92	0.0	0.00	441.3	6.56
Total	2956.8	100.00	3770.6	100.00	6727.4	100.00

Source: NRSA (1996)

Table 2. Magnitude of alkali soils in Uttar Pradesh

District	Sodic land[1] (ha)	Sodic area to total geographical area (%)	Sodic area reclaimed by 2006-07[2] (ha)	Reclaimed area to total sodic land (%)
Mainpuri	123042	44.58	61963	50.36
Azamgarh	97751	23.09	34215	35.00
Etawah	97042	41.99	42830	44.14
Raebareli	86586	18.79	69146	79.86
Hardoi	84341	14.09	55729	66.08
Sultanpur	79389	17.90	68015	85.67
Jaunpur	78807	19.52	36867	46.78
Pratapgarh	72229	19.43	42702	59.12
Etah	69076	15.54	42829	62.00
Unnao	59687	13.09	53713	89.99
Farrukhabad	54373	24.93	22450	41.29
Kanpur	54218	8.78	44723	82.49
Aligarh	43670	11.96	37176	85.13
Lucknow	42704	16.89	17684	41.41
Allahabad	42333	8.24	18350	43.35
Other districts	283713	1.57	276464	97.44
Uttar Pradesh	1368960	5.68	924856	67.56

Source: [1]NRSA (1996). [2] Information provided by Uttar Pradesh Land Development Corporation, Government of Uttar Pradesh.

Maharashtra (9.02%) and West Bengal (6.56%). The land degradation due to alkalinity is also a serious problem across different states of India. Uttar Pradesh has the largest alkali area of 1.36 Mha (35.72%). The alkali soils are also extensively distributed in Gujarat (14.36%), Maharashtra (11.21%), Tamil Nadu (9.41%), Haryana (4.86%), and Punjab (4.02%). These present a serious threat to environment and livelihood security of the people living in the region.

Land degradation due to alkalinity is a serious problem in Uttar Pradesh. The alkali soils are widely distributed in different districts of Uttar Pradesh and occupy 1.36 Mha area, which is 5.68 per cent of the total geographical area of the state. The distribution of alkali soils in different districts of Uttar Pradesh is depicted in Table 2. Under alkali soils, largest area is in Mainpuri (123042 ha), followed by Azamgarh (97751 ha), Etawah (97042 ha), Raebareli (86586 ha) and other districts. The occurrence of soil alkalinity has adversely affected crop productivity in these districts. Several studies have shown that crop yield decreases with increase in the level of alkalinity (Dwivedi and Qadar, 2011; Abrol and Bhumbla, 1979).

In the study area, crop production was the major activity contributing 92 per cent to the total household income (Table 3). The rice (*Oryza sativa*) crop was grown during the *kharif* season, whereas wheat (*Triticum aestivum*) was the major crop grown extensively during the *rabi* season. The fruits and vegetables were also produced in a limited area. Livestock-rearing was the other important activity to supplement family income. Many farmers supplemented their household income by engaging themselves or their family members in off-farm activities. The average age of the selected respondents was 43 years. The farmers had long experience of farming, as it was their family occupation. The average farm-size was 1.61 ha. In terms of farm holdings, about 32 per cent farmers were marginal (<1 ha of land), 41 per cent were small (1-2 ha) and 27 per cent were medium (2-10 ha) farmers. The average family-size was of 7 members and 60 per cent farmers were literate. Ten per cent farmers owned tractors and 15 per cent had seed-cum-fertilizer drills. The average temperature ranges from 6 °C in January to 40 °C in May. The mean annual rainfall varied from 850 mm to 1000 mm,

Table 3. Socio-economic profile of sample farmers in Uttar Pradesh

Particulars	Percentage / number
General information	
Age (years)	43
Literacy level (%)	60
Family size (No.)	7
Average farm size (ha)	1.61
Classification of farm holdings (%)	
Marginal (<1 ha)	32
Small (1 - 2 ha)	41
Medium (2 - 10 ha)	27
Large (> 10 ha)	0
Sources of family income (%)	
Crop production	92
Livestock	3
Services	1
Business	2
Others	2
Farmers owning farm assets (%)	
Tractors	10
Seed-cum-fertilizer drills	15

about 80 per cent of which was received during June to September. The soils were generally alkali in nature and low to medium in organic matter content.

Investment on Soil Reclamation

The technology for reclamation of alkali soils has been standardized to prevent the adverse affects of soil degradation. The pH of saturated paste of alkali soils was more than 8.2 and exchangeable sodium percentage (ESP) was more than 15. For successful crop growth in alkali soils, the ESP of the soil must be lowered by the application of soil amendments like gypsum, pyrite, etc. (Chhabra, 1996). In India, gypsum is the major source of soil amendment used to reclaim alkali soils. The use of other amendments like phosphogypsum, pressmud, acid wash and molasses is limited (Chhabra *et al*., 1980). The investment depends on the quantity of gypsum required for reclamation, which depends on the amount of exchangeable sodium to be replaced, which in turn is governed by the amount of absorbed sodium in the soil, sodicity tolerance and rooting depth of the crop to be raised.

A study conducted at Central Soil Salinity Research Institute has shown that 10 to 15 tonnes of gypsum containing 70 per cent $CaSO_4 \cdot 2H_2O$ is sufficient to reclaim 15 cm surface soil of 1 ha (Abrol and Bhumbla, 1979). The actual quantity of gypsum required is calculated on the basis of laboratory tests carried out on the surface soil (0-15 cm).

The item-wise break-up of initial investment is given in Table 4. The total investment incurred on alkali land reclamation without subsidy was ₹ 49680/ha. In total cost, the cost of gypsum was the major item (57.97%), followed by cost on farm development activities (26.87%). The soil amendment application, irrigation and flushing of salts were the other cost items amounting to ₹ 7530/ha constituting 15.16 per cent of the total investment on soil reclamation.

Often additional investment on tube-well is required to create irrigation facility. A shallow tube-well of 8 HP motor costing ₹ 20,000 needs to be installed by the farmers. The drilling and pipe installation costs are fully subsidized by the state government if farmers are covered under reclamation programmes. This indicates that a large amount of capital is required to reclaim alkali land and it may not be possible for the resource-poor marginal and small

Table 4. Investment on sodic soil reclamation

Particulars	Cost*(₹/ha)	Percentage share in total cost
Gypsum @12 t/ha	28800	57.97
Farm development activities	13350	26.87
Gypsum application, irrigation and flushing of salts	7530	15.16
Total cost (without subsidy)	49680	100.00
Total cost (with subsidy**)	13108	-

Note: *based on 2011 prices, **The subsidy amount given to 'B' class land and the percentage of subsidy varied among the different components.

farmers to bear this cost. Experience in Haryana and Punjab revealed that there was negligible response for land reclamation without subsidy on gypsum (Joshi and Agnihotri, 1982; Tripathi, 2009). In order to encourage farmers for reclaiming the sodic land, the Government of Uttar Pradesh provides subsidy on soil amendments ranging from 50 per cent to 90 per cent through different anti-poverty schemes. For instance, subsidies being given to the farmers on various components required for reclaiming sodic land, varied based on the extent of sodicity[1] under sodic land reclamation programme in Uttar Pradesh. In 'C' class sodic land, all activities except cost of pump set and labour component of cultivation cost of crops have been subsidized to the extent of 100 per cent. The higher rate of subsidy is provided due to poor investment capacity of the landholders. In 'B' class sodic land, the subsidy level has been reduced considerably because the field is already under cultivation, although with very low productivity. The farm development cost is 100 per cent subsidized for class 'C' land and 44.8 per cent for class 'B' land. The cost of soil amendments is 100 per cent subsidized for class 'C' land and 90 per cent for class 'B' land. The cost of boring is free and subsidy on cost of pump set is 50 per cent to all the categories of the farmers (Anonymous, 1999). The reclamation cost of 'B' class land categories with subsidy amounted to ₹ 13108 per hectare.

After the application of amendments and leaching of salts, rice–wheat–sasbania or rice–berseem crop rotation is recommended for successful reclamation of the alkali soil.

Crop Productivity, Income and Employment

The rice–wheat rotation is most common in the Indo-Gangetic Plains of Uttar Pradesh. It was noticed that land reclamation had a profound impact on productivity of rice and wheat. Before reclamation, the productivity of rice was 16.84 q/ha and of wheat was 9.35 q/ha (Table 5). After reclamation, the productivity of rice increased to 32.96 q/ha, depicting a gain of 95.72 per cent, and of wheat increased to 27.49 q/ha, indicating a remarkable gain of 194 per cent.

The increased productivity provided additional farm income to the farmers. The net income obtained from rice in post-reclamation period was ₹ 17628/ha, as against the loss of ₹ 193 per ha in the pre-reclamation period. The B-C ratio of rice, which was 0.99 in pre-reclamation period, increased to 1.89 in post-reclamation period. A similar change was also observed in wheat which depicted an appreciable increase in net income (₹ 15265/ha) after reclamation as against the loss of ₹ 4281/ha in pre-reclamation period.

The cropping intensity and labour employment increased by 14 per cent and 11 per cent, respectively in post-reclamation period. Thus, the land reclamation had a remarkable positive impact on cropping intensity, productivity, income and employment.

Table 5. A comparison of cropping intensity, productivity, income and employment before and after reclamation of soil

Particulars	Pre-reclamation period	Post-reclamation period	Change (%)
Cropping intensity (%)	171	194	14
Labour employment (human days/ha/annum)	109	121	11
Rice productivity (q/ha)	16.84	32.96	96
Wheat productivity (q/ha)	9.35	27.49	194
Net income of rice over cost C_1 (₹/ha)	-193	17628	Remarkable
Net income of wheat over cost C_1 (₹/ha)	-4281	15265	Remarkable
B-C ratio of rice	0.99	1.80	>1
B-C ratio of wheat	0.76	1.89	>1

[1] Farm lands have been classified as class 'A', class 'B' and class 'C' based on the extent of salt-content in soil for providing subsidies. The class 'C' represents barren lands with pH more than 9.5 and no crop can be cultivated on these lands due to high salt concentration. The class 'B' represents single cropped area without irrigation facilities and pH ranges from 9.0 to 9.5. The class 'A' represents double cropped area with irrigation facilities and pH ranges from 8.5 to 9.0.

Food Security Status

According to the FAO (2003), food insecurity exists when all people, at all times, do not have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. The Government of India has been implementing a wide range of programmes to achieve food and nutritional security at the household and individual levels. Land reclamation programme is one of the programmes implemented by the central and state governments to improve the income and livelihood security of resource-poor farmers.

A clear impact of reclamation was noticed on the food-security status of households. Table 6 shows the distribution of households by food-security status. The total rice and wheat requirement per family was estimated from 55^{th} round NSSO survey (2000) for pre-reclamation period and 66^{th} round NSSO survey (2010) for post-reclamation period. The foodgrain requirement was calculated as the difference between the total annual production of rice or wheat and total annual family consumption. It was found that all the categories of farmers produced more rice than the annual family consumption. In the case of wheat, small farmers were not able to meet the annual family consumption requirement from their own farm. After land reclamation, all the categories of farmers produced excess rice and wheat in their farms due to significant increase in land productivity.

In the rural areas, purchasing of foodgrains, particularly rice and wheat, from the market is not considered a good practice. The farmers acknowledged that the attainment of food self-sufficiency in food provides satisfaction to them and raises their social status. The production of excess foodgrains varied across different categories of farm households. Across farm-size groups, medium farmers produced highest quantities of excess rice and wheat due to larger size of landholdings and smaller size of households as compared to marginal and small farmers. Hence, farmers were benefited with ensured food-security and sustained livelihood even after a decade of land reclamation.

Table 6. Foodgrain production status of different categories of farmers during pre- and post-reclamation periods

Particulars	Marginal farmers	Small farmers	Medium farmers
No. of farmers	19 (31.67)	24 (40.00)	17 (28.33)
Family size (No.)	7	7	6
Average farm-size (ha)	0.66	1.31	3.09
	Pre-reclamation period		
Milled rice			
(a) Production (q/family/year)	8.26	13.30	38.22
(b) Consumption (q/family/year)	3.60	3.60	3.08
(c) Deficit/Excess (q/family/year)	4.67	9.71	35.14
Wheat			
(a) Production (q/family/year)	5.92	12.06	29.53
(b) Consumption (q/family/year)	7.47	7.47	6.40
(c) Deficit/Excess (q/family/year)	-1.55	4.59	23.13
	Post-reclamation period		
Milled rice			
(a) Production (q/family/year)	15.09	28.18	72.02
(b) Consumption (q/family/year)	3.56	4.36	3.05
(c) Deficit/Excess (q/family/year)	11.53	23.81	68.96
Wheat			
(a) Production (q/family/year)	16.91	35.16	91.80
(b) Consumption (q/family/year)	6.33	7.14	5.91
(c) Deficit/Excess (q/family/year)	10.58	28.02	85.89

Note: Figures within the parentheses indicate percentage to the total.

Table 7. Distribution of households by food-security status during pre- and post-reclamation periods

(in per cent)

Farm category	Foodgrain	Pre-reclamation period		Post-reclamation period	
		Deficit	Excess	Deficit	Excess
Marginal	Milled rice	26.3	73.7	0.0	100.0
	Wheat	68.4	31.6	15.8	84.2
Small	Milled rice	16.7	83.3	0.0	100.0
	Wheat	20.8	79.2	0.0	100.0
Medium	Milled rice	0.0	100.0	0.0	100.0
	Wheat	0.0	100.0	0.0	100.0

The farm-size varied even across the same category of farm households. It ranged between 0.38 and 0.88 ha in marginal farmers, 1.0 ha - 2.0 ha across small farmers and 2.1 ha – 5.0 ha across medium farmers. Consequently, foodgrain production also varied across the same category of the farm households. Each category of farmers were again sub-classified into deficit foodgrain-producing households and food self-sufficient households. This classification is based on the difference between per-household per-annum total rice or wheat requirement for consumption and production. The households with annual consumption requirement more than annual production were classified as food-deficit households and were assumed to have low food-security status. The households with annual production more than annual consumption requirement were classified as food self-sufficient households.

The distribution of households by food-security status, depicted in Table 7, reveals that 26.3 per cent of marginal farmers and 16.7 per cent of small farmers were not producing sufficient quantities of rice for family consumption in pre-reclamation period. Similarly, 68.4 per cent of marginal farmers and 20.8 per cent of small farmers were not producing sufficient quantities of wheat required for family consumption. Farmers opined that the entire scenario has changed after land reclamation due to increase in crop productivity as well as profitability. Due to more marketable surplus, they could even sell excess rice in the market. Even after land reclamation, still 15.8 per cent marginal farmers could not produce sufficient wheat required for family consumption due to smaller farm-size. Irrespective of farm-size, farmers have acknowledged the land reclamation technology to be a big innovation in bringing improvement in their food-security status and standard of living.

Household Expenditure Pattern

The household expenditure pattern was also influenced by the enhanced farm income. The majority of farmers (92%) opined that purchasing of foodgrain, especially of rice and wheat, from the market had declined (Table 8). A considerable number of farmers (65%) opined that the purchasing of non-food commodities like clothes and other household items has increased after reclamation. A few farmers opined that the expenditure on fruits and vegetables purchase

Table 8. Farmers' opinion on household expenditure pattern after land reclamation

(in per cent)

Particulars	Increased	Decreased	Constant	No difference
Foodgrain purchase	0	92	8	0
Fruits purchase	17	0	83	0
Vegetables purchase	18	13	68	0
Purchasing of clothes	65	0	25	10
Investment on house construction	78	0	22	0
Education expenditure	73	0	17	10

Table 9. Percentage share of farmers in total income during pre- and post-reclamation periods

Share of bottom farmers (%)	Pre-reclamation period (1999-2000)	Post-reclamation period (2011-12)	Change over the initial year (%)
10	3.20	5.06	58.17
20	8.37	11.06	32.04
30	15.44	17.59	13.91
40	23.24	24.58	5.77
50	31.40	32.20	2.57
60	40.23	40.55	0.80
70	49.78	49.81	0.06
80	59.65	61.90	3.78
90	71.80	77.82	8.39
Gini ratio	0.2938	0.2589	-

had increased. A rise in expenditure on house construction and children education was also reported after reclamation. This indicates that land reclamation made a substantial improvement in the socio-economic well being of the farm families in the study area.

Social Benefits of Land Reclamation

The indirect social benefits of land reclamation included improvement in income distribution among farm households. Table 9 provides a comparative picture of the percentage share of decile groups of farm households in total income during pre- and post-reclamation periods. The total income included income from farm, labour, business and other services. The share of bottom 10 per cent farmers in total income increased from 3.20 per cent to 5.06 per cent, registering a net increase of 58.17 per cent. Similarly, the share of bottom 20 per cent farmers registered a net increase of 32.04 per cent. The Gini concentration ratio further suggests that the income inequality reduced over time. It indicated that the land reclamation helped in reducing income inequality among the farm households.

Conclusions

The study has revealed a significant impact of sodic land reclamation on livelihood security of small and marginal farmers in the salt-affected areas of Uttar Pradesh. A substantial increase has been recorded in cropping intensity, crop productivity, farm income and employment opportunities which have resulted in improvement in the food security and standard of living of the beneficiaries. The study has concluded that the livelihood security of resource-poor farmers can be improved in the salt-affected environment through execution and intensification of land reclamation programmes. The study has suggested that the large tracts of salt-affected lands that are lying barren in Uttar Pradesh and other parts of the country should be reclaimed on priority basis to improve the livelihood security of resource-poor farmers and to strengthen food security of the country.

References

Abrol, I.P. and Bhumbla, D.R. (1979) Crop response to differential gypsum application in a highly sodic soil and tolerance of several crops to exchangeable sodium to under field conditions, *Soil Science*, **127**(1): 79-85.

Anonymous (1999) *UP Sodic Land Reclamation Project*, Project Report, Uttar Pradesh Land Development Corporation Limited, Government of Uttar Pradesh, Lucknow.

Chhabra, R. (1996) *Soil Salinity and Water Quality*, Oxford and IBH Publication, New Delhi.

Chhabra, R., Singh, A. and Abrol, I.P. (1980) Fluorine in sodic soil, *Soil Science Society of America Journal,* **44**: 33-38.

Chinnappa, B. (2005) An economic analysis of land reclamation technologies for amelioration of irrigation-induced soil degradation, *Agricultural Economics Research Review*, **18**(1): 103-116.

Datta, K.K. and Dejong, C. (2000) Reclaiming salt-affected land through drainage in Haryana, India: A financial analysis, *Agricultural Water Management,* **46**: 55-71.

Dwivedi, R.S. and Qadar, Ali (2011) Effect of sodicity on physiological traits, In: *Sustainable Managrment of Sodic Lands*, Eds: D. K. Sharma, R. S. Rathore, A. K. Nayak, and V. K. Mishra. Central Soil Salinity Research Institute, Regional Research Station, Lucknow.

FAO (2003) *Trade and Food Security: Conceptualizing the Linkages*, Commodities and Trade Division, Food and Agriculture Organization of the United Nations, Rome.

Ghassemi, F., Jakeman, A.J. and Nix, H.A. (1995) *Salinization of Land and Water Resources: Human Causes, Extent, Management and Case Studies,* CAB International, Wallingford, United Kingdom.

Joshi, P.K. and Agnihotri, A.K. (1982) Impact of input subsidy on income and equity under land reclamation, *Indian Journal of Agricultural Economics*, **38** (3): 252-260.

Joshi, P.K., Singh, O.P., Rao, K.V.G.K. and Singh, K.N. (1987) Subsurface drainage for salinity control: An economic analysis, *Indian Journal of Agricultural Economics,* **47** (2), 198-206.

NRSA (1996*) Mapping Salt-affected Soils of India on 1:250,000*, NRSA, Hyderabad.

NSSO (2000) *Consumption of Some Important Commodities in India*, Report Number 461, NSS 55th Round, National Statistical Office, Ministry of Statistics and Programme Implementation, Government of India.

NSSO (2010) *Household Consumer Expenditure Across Socio-economic Groups*, Report Number 544, NSS 66th Round, National Statistical Office, Ministry of Statistics and Programme Implementation, Government of India.

Singh, N. T. (2005) *Irrigation and Soil Salinity in the Indian Subcontinent: Past and Present.* Lehigh University Press, Bethlehem, Pennsylvania.

Smedema, L.K. and Shiati, K. (2002) Irrigation and salinity: A perspective review of the salinity hazards of irrigation development in the arid zone. *Irrigation Drainage System,* **16**: 161-174.

Tripathi, R.S. (2009) *Alkali Land Reclamation.* Mittal Publications, New Delhi.