

SOIL DEGRADATION IN SUGARCANE FARMING : A MICROLEVEL ANALYSIS

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ABSTRACT : The effect of surface irrigation on agricultural production has received considerable attention during the past few years. It has been established that the irrigation in association with high-yielding varieties, chemical fertilizers etc. has substantially increased agricultural production. However, recently there are complaints about the mismanagement of surface irrigation water and its negative effects on soil. The main objective of present paper is to measure the impact of mismanagement of agricultural inputs on the quality of soils, particularly in sugarcane farming. Shirol taluka of Panchaganga basin of Maharashtra is selected as a study region for microanalysis. The analysis reveals that the soil degradation is coming up as a serious problem in sugarcane tract of the region, resulting in decline of crop yield and soil fertility. Intensive cultivation, excessive input consumption, continuous mon-cropping without crop rotation etc. have led to disturb the physical and chemical composition and properties of soil exposing them to the hazards of soil degradation. This challenging issue need be faced by creating awareness among farmers regarding soil and water management and also to go for fish farming as an alternative land use rather keeping them fallow and unproductive.

INTRODUCTION

The sustainability of food production increasingly depends on sound and efficient water use and conservation practices consisting primarily of irrigation development and management. But the sustainability of irrigated agriculture, particularly in sugarcane tracts of the country is faced with challenge of alkalinity and salinity problems associated with soil and irrigation water. Most of these problems of irrigated agriculture arise due to an inefficient use and management of irrigation water especially in canal and lift irrigated areas. The intensive anthropogenic stress on

the land and water resources of country has disturbed the fertility of the soils. This problem, resulting in decline of crop yield and soil fertility has become the focus of attention of many scholars from different disciplines.

OBJECTIVES

In view of above present paper seeks :

1. To analyse changing cropping pattern in the study region.
2. To examine the extent of agricultural inputs such as irrigation water and fertilizers in sugarcane farming.

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3. To analyse soil degradation in study region.
4. To recommend viable measures for promoting soil condition.

METHODOLOGY

The importance of the study lies in the fact that the entire work is based on empirical data collected through intensive fieldwork supplemented by secondary data. For the soil analysis, about 40 samples from each villages of the study area have been collected. After soil testing, village wise results are aggregated for the purpose of analysis. the quality of the soils is measured through standardized soil testing methods which are, (1) 'pH' or the soil reaction that indicates acidity and alkalinity and (2) Salinity, in terms of soluble salts, which is determined through electrical conductivity test (EC). Similarly the facts regarding salt affected area were obtained from Agricultural Officer of Shirol Taluka which were also confirmed by field work and represented by choropleth method. The interview and questionnaire techniques were employed to collect the first hand information about the use of irrigation water and fertilizer, area affected by salinity, alkalinity and area waterlogged. For the calculation of water applied to the sugarcane, the quantum of water use is computed on the basis of number of waterings, average duration of each watering, capacity of pump set (H. P.) and area irrigated during the each watering. Further stratified random sampling method is employed for the selection of case study villages. As such 12 villages out of 52 are selected for intensive field work; where as the stratified random sampling design is also adopted for the selection of the farmers. Accordingly, interviews of 120 selected farmers were conducted. The data collected regarding irrigation water use and applications of chemical fertilizer by sampled farmers were

aggregated and shown by line graphs. The data pertaining to all other parameters of agriculture are collected for all the villages, an areal unit for the present study. A triennial averages for the year 1976-79 and 1997-2000 have been taken to set aside the effects of weather hazards on agricultural practices. Conclusions are drawn by inductive method.

THE STUDY REGION

Shirol taluka of Kolhapur district is selected as a study region for present investigation. It lies in the lower reaches of the Panchaganga basin, which is one of the well-watered parts of the Maharashtra-state. The region comprises an area of 507.90 sq. km. and supports 3,05,032 persons (1991) of 52 villages (Table II). The important irrigation sources available in the region are lift and well. The preponderance of lift irrigation is observed all over the region which shares 80.61 percent of irrigated area. The region is benefited by four rivers, namely the Warna to the north, the Krishna to the east, the Dudhagana to the south and the Panchaganga which flows through the centre of the study area (Fig. 1). The Panchaganga basin has benefited from an unparalleled sedimentation and has developed into one of the most productive areas of the state (Dikshit, 1986). The study region is endowed with very fertile soils. Black and deep black soils have covered 71 percent of total geographical area. Rest of the area is covered by coarse shallow soils. The soils are very rich in nitrogen and potash, but poor in phosphate (Table II). Climatically, the region enjoys a moderate type of climate with very little extremes of heat and cold (Shinde, 1973). The study region is located in the rain shadow zone of the western Ghats and receives about 600 mm of rain fall. Sugarcane, Soyabean and groundnut are the important cash crops, which occupy 63.27 percent of gross cropped area.

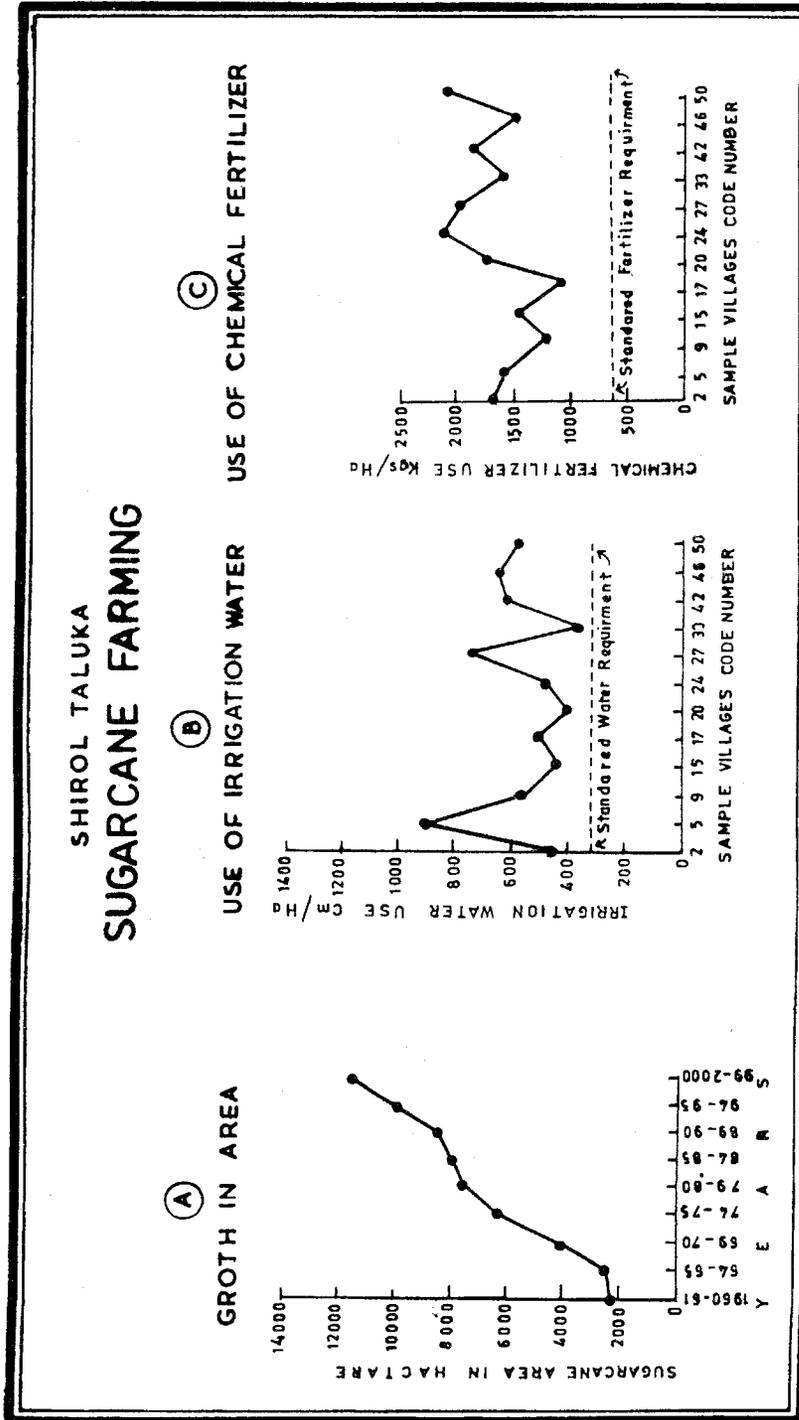


Fig.2

Fig. 1 : Shirol Taluka

ANALYSIS AND RESULTS : CHANGES IN THE CROPPING PATTERN

Sugarcane is more significant in cropping pattern. It influences commercialization and mechanization of agriculture. The number of crops have been reduced with the increasing intensity of sugarcane in the region. The eastern and central part of the region, the highly, commercialized part, have sugarcane

monocropping. Sugarcane is the principal cash crop in the study region, it covers 27.66 percent area and stands as first ranking crops. The period under investigation has witnessed the significant increase in area under sugarcane from 72 91 hectares to 11,989 hectares (Fig. 2 A). The sugarcane has replaced the traditional crops such as jowar, rice, wheat, gram etc. to a great extent (Table No. I). A dramatic change is observed

Table No. I

Shirol Taluka - Cropping Pattern and Changes

Crops	1976 to 1979		1997-2000		Volume of change 1976-79 to 1997-2000
	Area in hectare	% to G.C.A.	Area in hectare	% to G.C.A.	
Rice	4032	9.09	1150	2.65	-6.44
Wheat	1746	3.93	959	2.21	-1.72
Jowar	12800	28.85	4029	9.29	-19.56
Bajara	282	0.63	155	0.35	-0.28
Ragi	20	0.04	1	0.002	-0.03
Other crops	494	1.11	33	0.07	-1.04
Total cereals	19354	43.63	6462	14.91	-28.72
Gram	1000	2.25	1117	2.57	+0.32
Tur	1390	3.13	1043	2.40	-0.73
Other pulses	2338	5.27	3581	8.26	+2.99
Total pulses	4728	10.65	5738	13.23	+2.58
Total foodgrains	24082	54.29	12200	28.15	-26.14
Sugarcane	7291	16.43	11989	27.66	+11.23
Chillies	1129	2.54	-	-	-2.54
Condiments & spices	1142	2.57	390	0.89	-1.68
Fruits and vegetables	296	0.66	979	2.25	+1.59
Total food crops	32811	73.97	25558	58.97	-15.00
Cotton	162	0.36	05	0.01	-0.35
Other fibers	21	0.04	07	0.01	0.03
Total fibers	183	0.41	12	0.02	-0.39
Groundnut	6593	14.86	3558	8.20	-6.66
Soyabean	20	0.04	11880	27.41	+27.37
Total oil seeds	6613	14.90	15438	35.62	+20.27
Tobacco	2800	6.31	189	0.43	-5.81
Other drugs narcotics	36	0.08	45	0.10	+0.02
Total drugs & narcotics	2836	6.39	234	0.53	-5.87
Mise none food crops	1911	4.30	2097	4.83	+0.53
Total non food crops	11543	26.02	17781	41.02	+15
Gross cropped area	44354	100.00	43339	100.00	±5

Source : Socio-Economic Review and District Statistical Abstracts of Kolhapur District.

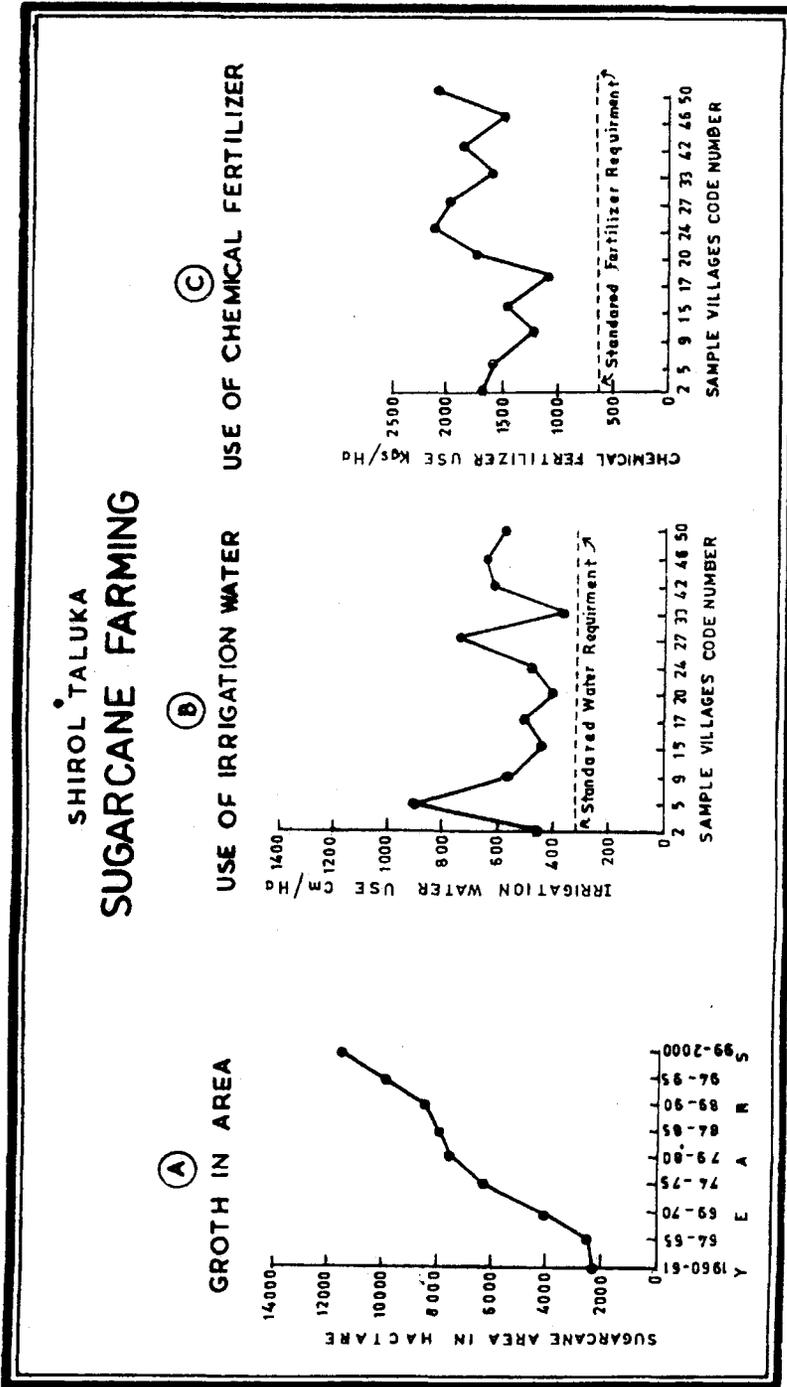


Fig. 2 : Shirol Taluka - Sugarcane Farming

from the food based cropping pattern to commercial cropping pattern practicing monoculture and violating the principle of ideal cropping sequence.

INPUT CONSUMPTION : IRRIGATION WATER

The quantity of water used in irrigation is of immense significance in the context of land degradation. The abundance of water in the study region is responsible for its lavish and indiscriminate use. The high intensity of sugarcane irrigation also provides a ground for erratic water use. The major share is consumed by sugarcane (91%) alone leaving other crops in destituted position in terms of water use. The actual average water use of 610 ha. cm. (Fig. 2 B) to sugarcane is far more than the standard requirement of 300 ha. cm. in the region (Government of Maharashtra, 1985). Heavy water use is confined to the highly irrigated sugarcane belts in eastern and central plains adjoining river banks. The extreme use of water of 960 ha. cm. is observed in Udgaon village followed by Shirdhon, Alas, Dattawad and Rajapur. The ample availability of water through private and co-operative lift irrigation schemes and misconception and ignorance of water use among farmers are responsible for over use of irrigation water in the study area.

CHEMICAL FERTILIZERS

The study region witnesses heavy fertilizer consumption, particularly for sugarcane crop. There is common misbelief that continued and intensive use of chemical fertilizers would give high returns in term of yields. Sugarcane is the single most important crop consuming the bulk of fertilizer (84%) applied in the study area. The average per hectare fertilizer use of 1,819 kgs for sugarcane (Fig. 2 C) is far more than the standard requirement of fertilizer of 740 kg / ha. (Government of Maharashtra,

1985). The excessive fertilizer consumption is confined to the sugarcane belts in the eastern and central parts. It seems that high intensity of irrigation, developed infrastructure of co-operative societies through which fertilizers are easily accessible, encouragement and financial loan facilities through sugarcane factories etc. are also partly responsible for the application of excessive doses of fertilizer in these parts.

SOIL DEGRADATION

Soil degradation is a process of changing a soil from one type to another more highly leached one; particularly bringing about replacement of sodium by hydrogen by leaching a saline or alkali soil (Kadam and Jagtap, 1992). Whittow (1984) stated that the process by which soil becomes weathered or more highly leached' denotes degradation. In the context of present study soil degradation defined by Pawar (1989) that "soil which is lying unproductive or has recorded reduction in the optimum potential production due to certain constraints like salinity and alkalinity" has been considered.

Panchaganga basin is agriculturally one of the developed and productive areas in Maharashtra. The region is endowed with rich fertile soil which is well known for sugarcane cultivation (Shinde & Patil, 1987). In the study region, high proportion (71%) of soils are black and they are very fertile with poor drainage. In these soils high proportion of nutrients like Nitrogen, Potassium, Lime Iron, Zinc are observed. But in the recent past decline in fertility of these soils due to salinity and alkalinity has been reported. As stated by Jadhva (1984), thousands of hectares of cane lands have gone out of cultivation in upper Krishna Basin due to salinity and alkalinity of soils. The flooded water of Panchaganga river spreads upto just 2 km where this problem is

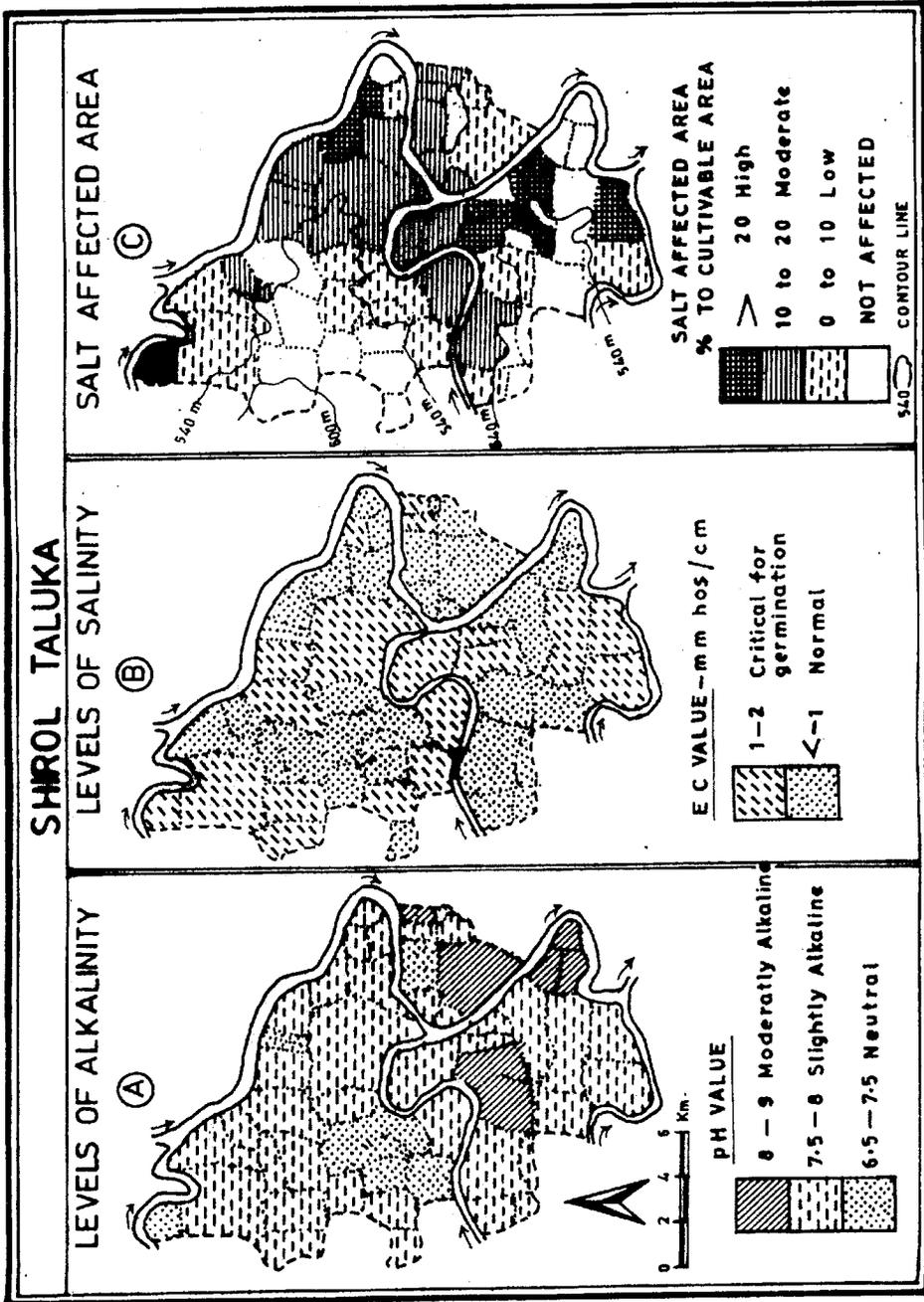


Fig. 3 : Shiroli Taluka - (a) Levels of Alkalinity, (b) Levels of Salinity, (c) Salt affected area

not observed due to leaching of salt by flooded water. And also it is not observed in coarse shallow soils having elevation above 540 meters. (Fig. 3. C.).

Alkaline and saline soils are the classes of the salt affected soils. Alkalinity is related to hydrogen-ion concentration (pH) and salinity is related to the proportion of the soluble salt in the soils measured through electrical conductivity (EC). The spatial analysis of levels of alkalinity reveals that 15.38 percent of the soils are normal, 71.15 percent of the soils are weakly alkaline and 13.46 percent of the soils are moderately alkaline in the study region (Fig. 3. A).

The saline soils are those in which salt content is high enough to impair crop production (Parthasarthy, 1972). Generally, salts are leached from higher elevation and concentrate on the lower parts, where drained or seepage water evaporates. Lack of drainage and nearness of water table within the reach of capillary action are also responsible for salt accumulation. The spatial distribution of levels of salinity in the region also reveals that about 53.84 percent of soils are in the normal category well suited for plant growth. But 46.16 percent of soils are critical for the germination of seeds (Fig. 3 B).

Salt affected lands are the lands left unused or underused due to excessive salt accumulation in upper layer of the soils. These soils have become a common feature of sugarcane tract in eastern and central parts of the study region (Fig. 3 C). It appears that continuous monocropping of sugarcane, excessive water and fertilizer consumption (Fig. 2), absence of drainage in the field, gentle slope of the land and fine clay loam textured soils are the contributory factors responsible for the emergence of salt affected soils. The salt affected area is about 23.38 percent of

sugarcane area which is known saline west land. As pointed out by Jugale (1997), in major parts of the Maharashtra, the sugarcane yield has tremendously come down due to soil salinity in sugarcane belt. The study area is not exception to that where yield of sugarcane per hectare has declined from 140 metric tones to 95 metric tones during the period under review.

CONCLUSION AND RECOMMENDATIONS

Study region is one of the well watered parts of the Maharashtra state. The preponderance of lift irrigation is observed all over the region which shares 80.61 percent of irrigated area. Sugarcane is the principle cash crop in the study region that covers 27.66 percent area and ranks first in cropping. The major share of irrigation is consumed by sugarcane (91%) alone, leaving other crops in destituted position in terms of water use. The average water use of 610 ha. cm. to sugarcane is far more than the standard requirement of water. The study region also witnesses heavy fertilizer consumption particularly in sugarcane belt. Sugarcane is the single most important crop consuming the bulk of fertilizer (84%) applied in the study area. The average per hectare fertilizer use of 1819 kgs. to sugarcane is far more than the standard requirement of fertilizer. Therefore, the salt affected lands have become a common feature of sugarcane farming. The salt affected area is about 23.38 percent of sugarcane area, and is known as the Saline Waste land. These salt affected soils show steady decrease in per hectare yield. It has declined from 140 metric tonnes in 1976-77 to 95 metric tones in 1999-2000 in the context of per hectare sugarcane yield.

The reclamation methods such as physical, chemical and agronomical need be used for the improvement of salt affected areas. Physical

Table No. II

Soil Analysis of Shirol Taluka

Location Code	Name of the Village	pH	EC mmhos/cm	OC%	P (Kg/ha)	K kg/ha
1.	Kawatesar	7.50	1.08	0.66	7.33	303
2.	Danoli	7.75	1.00	0.69	6.75	354
3.	Kothali	7.62	0.43	0.66	9.98	371
4.	Umalwad	7.80	0.47	0.73	14.28	359
5.	Udgaon	7.32	2.00	0.69	4.23	334
6.	Chinchawad	7.32	1.10	0.72	7.38	383
7.	Arjunwad	6.69	0.71	0.65	5.36	646
8.	Jaysingpur	7.78	1.69	0.54	9.00	247
9.	Chipri	7.72	0.50	0.56	5.44	157
10.	Jainapur	7.97	0.73	0.62	12.08	310
11.	Tamadalge	7.56	1.32	0.66	3.11	241
12.	Nimshirgaon	7.80	0.45	0.50	8.96	275
13.	Kondigre	7.73	0.18	0.70	3.65	380
14.	Shapur	7.73	0.18	0.70	3.65	380
15.	Yadrav	7.23	0.55	0.75	4.64	367
16.	Jambhali	7.23	0.55	0.75	4.64	367
17.	Haroli	7.76	0.80	0.80	4.78	410
18.	Nandani	7.13	0.95	0.69	4.97	360
19.	Dharangutti	7.08	0.89	0.87	4.75	354
20.	Shirol	7.59	1.13	0.62	5.82	400
21.	Ghalwad	7.70	0.99	0.73	15.22	544
22.	Kutwad	7.71	0.69	0.58	5.95	332
23.	Kanawade	7.70	0.55	0.73	11.03	494
24.	Hasur	7.70	0.68	0.72	9.62	435
25.	Shirathi	7.50	0.77	0.65	5.09	422
26.	Narsobawadi	7.66	0.74	0.61	4.88	370
27.	Shirdhon	7.40	1.98	0.67	5.50	322
28.	Takavade	7.42	0.58	0.73	5.51	278
29.	Lat	7.50	0.82	0.73	7.81	408
30.	Shirdwad	7.55	0.56	1.32	5.20	317
31.	Shivnakwadi	7.73	1.08	0.66	4.77	337
32.	Latwadi	7.23	0.72	0.89	3.57	290
33.	Herwad	8.23	0.72	0.89	3.57	290
34.	Terwad	8.40	1.10	0.78	5.84	370
35.	Majarewadi	7.66	1.22	0.78	5.64	353
36.	Aurwad	7.09	0.49	0.71	11.21	507
37.	Gaurwad	7.09	0.46	0.74	10.75	464
38.	Kavathegulang	7.50	1.21	0.68	5.94	383
39.	Shedashal	7.90	1.13	0.60	11.34	456
40.	Ganeshwadu	8.34	1.03	0.63	11.06	402
41.	Alas	8.05	0.75	0.45	5.97	367
43.	Bastawad	7.26	0.58	0.66	7.57	384
44.	Akiwat	7.26	0.74	0.77	3.49	347
45.	Ghosarwad	7.61	0.72	0.53	2.64	326
46.	Dattawad	7.67	0.73	0.66	4.58	416
47.	Danwad	7.60	1.28	0.64	3.98	330
48.	Takali	7.85	1.51	0.56	7.89	507
49.	Rajapurwadi	7.50	2.90	0.47	2.83	331
50.	Rajapur	7.41	0.81	0.35	8.13	378
51.	Khidrapur	8.05	1.02	0.70	11.55	392
52.	Kurundwad	7.53	1.22	0.75	7.15	370

Source : Soil Analysis Centre, Sri Datta Co-operative Sugar Factory, Shirol, Computed by authors.

measures include construction of surface drains, relief wells, scraping of surface salt and leaching of salts etc. Gypsum and molasses application cover the chemical measures. The agronomical measures consist of green manuring of *dhaincha*, heavy application of organic manures and crop rotation. To utilize such soils for fish farming as an alternative land use has been proved successful both as a measure to reclaim the saline soils and to get good economic returns from such deserted soils. (Pawar, 2001). Sugarcane cultivation has certainly occasioned much concern as a degradation threat in the irrigated tracts of the region either through its continuous monocropping or erratic input consumption associated with it. This certainly calls for minimizing the area under sugarcane and

devoting it to other crops. This necessitates a restructured crop land use planning based on diversified pattern suited to the climate and soil quality of the study region. Besides all these, in sugarcane farming scenario, prevention is the only answer. And this can only happen when cane growers have a greater awareness about such hazardous problem of soils degradation, which is creeping like a cancer in sugarcane tracts of the country.

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