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Impact of Sprinkler Irrigation on Socio-economic Conditions and Environment in Eastern Part of Thar Desert

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Abstract: A case study in three arid villages of Sikar district in northwest Rajasthan revealed a transformation in the adoption of sprinkler irrigation, where the marginal and small farmers had owned more than 60% sprinklers. Joint ownership with agnatic kin was dominant over the individual ownership. The rate of diffusion varied among the villages due to availability of irrigation facilities. In one of the villages, sprinkler was introduced in the early seventies. Sprinkler irrigation has not only increased the area under irrigation, but has also put undulating land under cultivation. The micro-climatic conditions are changing gradually with the plantation of trees. The labor demand has drastically come down at the ratio of 3:1 compared to that under flood irrigation. Also, there is 30 to 35% water saving. Five factors were extracted from factor analysis, which accounted for 60.5% of the total variability. Factor 1, accounting for 15.1% of variability, recorded high loading on subsidy and bank loan. The study, therefore, underscores the importance of economic factors in the adoption of sprinkler system of irrigation, besides other social factors.

Key words: Sprinkler irrigation, agnatic, factor analysis, ownership, transformation.

Rural India is gradually undergoing transformation in socio-economic and political lives since independence. The community development programme, especially the *Panchayati Raj*, has influenced the lives of the rural masses. The green revolution has changed the entire scenario and India has become self sufficient in food production. The impact of green revolution was, however, more pronounced in better-endowed areas, having irrigation facilities. The vast arid land of Thar desert in western Rajasthan is under rainfed crops, the exception being Ganganagar district. As per the agricultural statistics abstract (1993-94), the arid zone of Rajasthan possesses 36.0% of the total irrigated land. Sikar district in the eastern part of Thar desert in Rajasthan owns 8.47% of total irrigated land, where the main sources of irrigation are the open wells and tubewells Irrigation through wells has undoubtedly brought the changes in agricultural productivity, but it has certain limitations as it can not go to sandy undulating areas with high infiltration rate. Kumar and Khanna (1993) reported that all seasonal crops, and most cereals (except paddy and jute), are suitable for sprinkler irrigation system. Singh (1993) reported that the saving of 30 to 40% water can easily be achieved from sprinkler irrigation. In the mid-seventies, progressive farmers in Narmada valley (MP), southern part of Haryana and northwest Rajasthan started using sprinkler system to overcome the shortage of water during summer. Sikar district of western Rajasthan is one of the potential areas of sprinkler system of irrigation, where more than 20,000 sprinkler

sets are in operation. Shelke *et al.* (1993) studied the socio-economic aspects of sprinkler use, mainly the educational level of adopters, size of land and age, besides overall performance. Malhotra and Bharara (1985) and Bharara (1985) studied the impact of canal irrigation and socio-economic aspects of minor irrigation in some parts of western Rajasthan.

Keeping this in view, the present study aims to investigate the status of sprinkler irrigation, various socio-economic and ecological characters influencing the introduction of sprinklers and farmers' perception of sprinkler irrigation.

Materials and Methods

The study was conducted in three villages viz; Rasidpura, Ajeetpura and Banura of Sikar district. All the three villages are situated within 15-20 km of the tehsil headquarters. The basic community facilities like drinking water, electricity, primary schools, health sub-center, etc., were available in these villages. Irrigation, through sprinkler systems, were available in these villages with little variation. Rasidpura had higher irrigated land than Ajeetpura and Banura. The villages were scattered far and wide with *dhani* settlement. Thirty six per cent households in Rasidpura had owned sprinkler sets, Banura had 22%, and Ajeetpura, 21%. The socio-economic characteristics like the level of literacy, occupational structure, type and size of family, age and sex composition of population, age at marriage, etc., did not vary significantly among the three villages.

Altogether 20 to 30% sample farm families, possessing sprinkler system of irrigation, were taken into consideration. Fifty eight farm families were selected randomly, with probability proportional to the farm households possessing the sprinkler system of irrigation. Factor analysis, a multivariate statistical technique that reduces the number of variables involved in a process, was adopted to find out factors influencing the adoption of sprinkler system. The objective was to find one or more hypothetical factors, each representing a set of characters carrying useful interpretation of the data. Altogether 14 factors were used for factor analysis.

Results and Discussion

Caste and ownership pattern: The area is dominated by *Jat,* an agricultural caste (79.31%). More than 86.0% sample respondents adopting sprinkler irrigation were of upper caste (Table 1). One of the farmers belonging to weaker section of the population also owned sprinkler system of irrigation. Among the total sample farm families 40% had owned sprinkler sets individually, whereas 60% had owned jointly. Joint ownership pattern was dominant because of higher installation cost and limited water availability. The rotational system of water distribution among the partners was being followed strictly among the sample farm families.

Size of holding and ownership pattern: It was observed that the marginal and small farmers together had owned 64% of the total sprinkler sets, where the maximum numbers were owned by small farmers (38%). On the other hand, the medium and large farmers had owned 36% of the total sprinklers.

Family type and size and sprinkler irrigation: Joint families owned 74%

sprinklers and nuclear families 26%. Similarly, medium size families (6 to 8 persons per family) owned maximum sprinklers (40%). It is clear that due to limited water in wells and higher installation cost, members of extended families go for sprinkler system.

Settlement pattern and sprinkler irrigation: The settlement pattern was either compact (5.17%), *dhani* (48.27%), or a combination of compact and *dhani* (46.55%). Since agricultural land is mostly associated with *dhani* settlements, 95.0% sample respondents living in *dhanis* as well as in compact plus *dhanis*, adopted the sprinkler system of irrigation.

Category of farmers and year of installation: In Rasidpura sprinkler irrigation was introduced in the late 70s, whereas in Ajeetpura and Banura the sprinkler irrigation was introduced from 1981 onwards. The inter-village variation in adoption of sprinkler system was mainly due to non-availability of irrigation wells and financial paucity. The marginal and small farmers could install sprinkler irrigation with the financial assistance from Government agencies (Table 2). Agriculture is the only source of income for small and marginal farmers. The maximum adoption of sprinkler irrigation was observed in the period 1986-90 (38%), followed by 91-96 (34%), 81-85 (17%), and 76-80 (11%).

Impact of sprinkler irrigation

Adoption of improved farm practices: The adoption of improved farm practices like seeds of high yielding varieties, chemical fertilizers and insecticides, were not encouraging, despite the availability of irrigation (Table 1). It was observed that the high yielding varieties of pearl millet were adopted by only 36% sample farm families. HYVs of wheat were used most (68%), followed by mustard (52.0%), and cumin (16%). The use of chemical fertilizers for *kharif* crops was very limited, while in case of *rabi* crops, widespread application of chemical fertilizers and insecticides was noticed. The number of irrigation provided in *kharif* crops was quite low, as only 20% farmers gave life-saving irrigation in pearl millet. In *rabi* crops, farmers used to give on an average 6 to 12 irrigations, depending on the type of crop. Wheat, gram, mustard, barley, onion, *methi* (Fenugreek), and fodder crop, *rezika* (Lucerne), were the major *rabi* crops. The land use pattern of *kharif* crops during 1994-95 in the three villages revealed a declining trend in various crops, except pearl millet (100 per cent), *moth* (65%), *jowar* (60%), *mung* (12%), etc.

Type of land and sprinkler: The introduction of sprinkler irrigation gradually increased the area under irrigation to even the dune-covered areas of desert. It was observed that 26% of the land was sandy undulating (Table 1). Selling of water depended on geographical location of the boundary, as only 7% farmers in one of the villages sold water to neighboring farmers. The interface of caste was not observed in selling of water.

Micro-climatic environment: The introduction of sprinkler irrigation also brought about changes in micro-climatic environment. Majority of farmers, irrespective of their farm size, perceived that movement of sand had come down gradually. It was further perceived that with

Table 1. Some characteristics of farmers possessing sprinkler system of irrigation

Socio-economic character	Percentage
Caste	
Upper	86.20
OBC & SC/ST	3.46
Muslim	10.34
Ownership pattern	
Individual	40.00
Joint	60.00
Land holding (ha)	
Marginal (0-3.5)	25.86
Small (3.6-7)	37.93
Medium (7.1-10)	18.96
Large (>10)	17.24
Family type	
Nuclear	25.86
Joint	74.14
Family size	
Small (0-5)	22.42
Medium (6-8)	39.65
Large (>8)	37.93
Settlement pattern	
Compact	5.18
Dhani	48.27
Compact + Dhani	46.55
Selling of water	
Sell water	6.89
Do not sell water	93.11
Adoption of HYV of *kharif* crops	
Pearl millet	36.20
Mung bean	6.89
Moth bean	27.58
Cluster bean	5.17
Adoption of HYV of seeds: *Rabi* crops	
Wheat	68.96
Raya (Mustard)	37.93
Type of land	
Sandy plain	74.14
Sandy undulating	25.86

the operation of sprinklers temperature came down slightly in summer months. Tree plantation increased in field boundaries and around the irrigated wells. Besides *Tecomella undulata, Acacia nilotica* and *Prosopis cineraria* in agricultural fields, trees like *Alianthus excelsa*, and to a limited extent Eucalyptus, were introduced. Nearly 60% farm families planted trees during the last five years, with more than 50% survival rate. Fruit plants like guava, lemon, mango, pomegranate, etc., have also been introduced by the farmers.

The introduction of sprinkler irrigation has also changed the labor requirement. The labor requirement has come down to one-third of that required during flood irrigation, and there is now minimum surveillance, as well as 30 to 35% water saving.

Factors contributing to adoption of sprinklers

Factor analysis: The mean score and coefficient of variation presented in Table 3 show that there is high variability in the characters under study. Caste (16.41) and occupation (17.35) had the least coefficient of variation, whereas education (95.97), year of installation (50.44), settlement pattern (46.02), size of land (45.36) and type of family (44.92) had high coefficient of variation. The coefficient of variation in education was quite high because the level of education was not uniform, e.g, some people were illiterate and some others had crossed primary, middle or high school, or reached college level. However, in case of caste, the variation was less because of near-homogeneous composition of caste. The area was largely

Table 2. Categories of farmers and year of installation of sprinklers

Category	Year				Total	Percentage
	1976-80	1981-85	1986-90	1991-1996		
Marginal	1	5	5	4	15	25.86
Small	3	2	8	9	22	37.93
Medium	1	2	3	5	11	18.96
Large	1	1	6	2	10	17.25
Total	6 (10.34%)	10 (17.24%)	22 (37.93%)	20 (34.48%)	58 (100%)	

dominated by an agricultural caste. Similarly, in case of occupation, agriculture was largely practised in the absence of a diversified occupational base.

The correlation between the different characters and their significance are presented in Table 4. These correlations were used for factor analysis. Five factors were extracted, which accounted for 60.5% of the total variability. The factor matrix was rotated using varimax method. The factor loadings and their commonalities are presented in Table 5, arranged in the order of percentage variation accounted for by the factors. The characters within the factors are also arranged in the order of their loading on the factor. Factor-1, accounting for 15.1% of variability, recorded high loading on subsidy and bank loan. Thus, factor-1 can be regarded as the economic factor. Factor-II, accounting for 14.9% variability, had high loading on extent of adoption of agricultural innovations, settlement pattern, year of installation and type of land; it can be regarded as socio-innovative and spatial factor. Factor-III, accounting for 12.0% variability, had high loading on caste, occupation and type of family, while factor-IV, accounting for 11.5% of variability, had high loading on size of family and ownership pattern. These can be regarded as socio-economic factors.

Table 3. Mean score, variance and coefficient of variation (cv) of different characters

Characters		Mean score	Variance	Co-variance (%)
Caste	(X1)	2.83	0.61	16.61
Age	(X2)	2.95	1.07	39.98
Education	(X3)	1.36	1.14	95.97
Occupation	(X4)	2.02	0.59	17.35
Type of family	(X5)	1.76	0.65	24.55
Size of family	(X6)	2.00	0.94	66.92
Size of land	(X7)	2.45	0.70	65.38
Type of land	(X8)	1.55	1.00	32.33
Ownership pattern	(X9)	1.41	0.70	35.14
Year of installation	(X10)	2.00	0.66	50.44
Subsidy	(X11)	1.55	0.74	32.33
Bank loan	(X12)	1.74	1.34	25.37
Settlement pattern	(X13)	1.22	0.74	66.02
Adoption of agricultural innovations	(X14)	5.59	1.34	32.52

Table 4. Correlation matrix

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14
X1	1.0	0.04	0.19	0.23	0.31*	-0.12	0.08	0.18	0.23	-0.03	-0.18	-0.13	0.08	0.01
X2		1.0	0.45	-0.04	-0.23	0.13	-0.13	0.04	-0.05	-0.05	0.01	-0.02	0.04	0.00
X3			1.00	0.10	-0.06	0.19	-0.04	0.25*	-0.09	-0.18	-0.17	-0.19	-0.01	-0.09
X4				1.00	0.14	0.05	0.07	0.04	0.05	0.00	0.14	0.14	0.15	-0.09
X5					1.00	-0.27	0.19	-0.02	0.31*	-0.04	-0.10	0.12	0.08	0.02
X6						1.00	-0.14	-0.03	-0.35	-0.17	-0.03	0.13	0.17	-0.10
X7							1.00	0.02	-0.02	-0.06	-0.10	0.06	-0.02	0.23
X8								1.00	-0.22	-0.27*	-0.04	-0.13	-0.25*	0.06
X9									1.00	0.17	-0.15	-0.06	0.03	-0.04
X10										1.00	-0.10	0.03	0.15	-0.16
X11											1.00	0.57	0.23	0.02
X12												1.00	0.23	-0.09
X13													1.00	-0.31
X14														1.00

* Significant at 5% level.

Factor-V was not considered as the variability was only 7.5%. As per Hagood and Price (1960), the component whose factor explained less than 10% of the total variations, are not considered.

So far as the repayment of loan was concerned, majority of farmers repaid the loan instalments as per the terms and conditions laid down by the banks.

It is, therefore, clear that the economic and social factors played a significant role in the adoption of sprinkler system of irrigation.

It is concluded that there has been a transformation in the adoption of sprinkler irrigation, as a sizeable number of marginal and small farmers has adopted sprinkler system of irrigation, cutting across the class

Table 5. Varimax rotated factor matrix

Characters	Factor I	Factor II	Factor III	Factor IV	Factor V	Communality
Subsidy	0.9102	0.0525	-0.0689	-0.0018	0.0830	0.8428
Bank loan	0.8181	-0.1210	0.1108	-0.0758	-0.1175	0.7157
Settlement pattern	0.3053	-0.5884	0.3501	-0.1954	0.0444	0.6021
Education	-0.2596	0.1891	0.3284	-0.2324	0.6502	0.6877
Caste	-0.2241	0.0967	0.6939	0.2490	0.1320	0.6204
Occupation	0.2113	-0.0605	0.6291	-0.1131	-0.0158	0.4571
Type of land	-0.1269	0.6136	0.2015	-0.1512	0.1743	0.4864
Ownership pattern	-0.1229	-0.2925	0.2163	0.7189	0.0283	0.6650
Year of installation	-0.0940	-0.6114	-0.1559	0.2779	-0.0673	0.4887
Age	0.0584	0.0765	-0.0236	0.0020	0.8308	0.7000
Adoption of innovation	0.0533	0.6227	-0.1988	0.2490	-0.1662	0.5197
Type of family	0.0072	0.0208	0.5771	0.3798	-0.3421	0.5948
Size of land	-0.334	0.3085	0.2712	0.0025	-0.4887	0.4086
Size of family	-0.0070	-0.1325	0.0099	-0.8080	0.1111	0.6829

and caste barriers. The joint ownership was quite dominant with agnatic kin, due to higher installation cost and limited availability of irrigation sources.

The introduction of sprinkler irrigation has brought sandy undulating land under cultivation. The micro-climatic environment is gradually improving with the plantation of trees and has restricted sand movement. Sprinkler irrigation is not only advantageous in water saving, but also in labor saving. The labour demand was reduced by one third, as compared to that in flood irrigation. Factor analysis suggested the importance of economic and social factors.

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