An Engineer's Evaluation of Water Conservation Efforts of Tarun Bharat Sangh in 36 Villages of Alwar District

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1
Introduction

1.1 It was in mid 1995 that Tarun Bharat Sangh, Bheekampura-Kishori, Distt. Alwar, (TBS) suggested that this author undertake an intensive evaluation of the various impacts of TBS activities, particularly those that had been supported by ICCO (Netherlands) in around 40 villages of Alwar District. It was thought that the students and faculty of Mahatma Gandhi Gramodaya Vishwavidyalaya, Chitrakoot, where the author is currently associated, could help in the rather laborious task of data collection, compilation and interpretation and a formal assignment was made by TBS in Aug. 1995 on this basis. Data collection could start only in Dec., 95 and went on until July, 96. Due to lack of experience or a clear insight, a lot of data and information got collected, especially on social and cultural aspects which was often confusing and self-contradictory. This made the task of compilation and interpretation difficult. The present report presents what in the opinion of this author, as a professional civil engineer, constitutes the most substantiated and scientific evaluation based on the data collection, analysis and interpretation.

1.2 There are serious differences between the methodologies adopted for evaluation and assessment of impacts, by social scientists on the one hand and physical scientists and engineers on the other hand. While social scientists rely on the narratives and response of a few individuals or a questionnaire survey conducted on a designed sample covering a number of aspects of life, many of which are not measurable, physical scientists and engineers prefer to rely on aspects that can be reasonably quantified. Both approaches have their advantages and shortcomings and were included in this intensive study. While reasonably quantified data was available from 36 villages on certain aspects, questionnaire surveys were also conducted on 500 families in these villages. A Social Scientist's Evaluation based on the data was compiled and submitted to TBS in end 1996 by Dr. R.C. Singh, Professor and Head of Rural Development Management at MG Gramodaya Vishwa Vidyalaya, Chitrakoot. The present report is the complementary Engineer's Evaluation. While there are bound to be differences in approach, findings and conclusions, the two reports should be taken together to form an integrated and comprehensive view. Also one should simultaneously look at

(i) Impact Evaluation Study by Prof. M.L. Jhanwar,

(ii) Report on Bhaonta-Kolyala by Rajesh Puri & Jinesh Jain

(iii) Story of Small Rivulet Arvari by Jash Bhai Patel

(iv) Impact on Wildlife Conservation by Pushpa Jain

(v) Afpro's technical evaluation of Deori Project and other such reports.

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2

Evaluation Methodology

2.1 While it is true that basic objectives of TBS and also of ICCO and other funding agencies were rather broad, aiming at overall improvement in the living conditions (or the quality of life) of people in this backward and economically deprived area and included programmes on education, health, sanitation, housing, transport, women's and children's welfare etc., it has to be accepted that in this water-scarcity-stricken area, the most crucial part of the action-programme was water conservation. Water harvesting and conservation constituted such an overwhelming (over 90%) part of all TBS efforts and financial investments that TBS is known, in this area and around, essentially for its water conservation and related soil and forest conservation (or what can together be called watershed management) work and not for it's education, health, social organisation or social welfare programmes. Shri Rajendra Singh, Secretary of TBS, has almost become a synonymn of water, soil and forest conservation in the area and is lovingly called "Johad-Baba" by some local people. Hence this report dwells only on the evaluation of water-conservation efforts of TBS, assuming this to be the essence and even the effective sum-total of all TBS effort.

2.2 Water and soil-conservation are essentially engineering activities, and are covered in detail in curricula of civil as well as agricultural engineering. Planning, design, construction, operation and maintenance technologies, developed or adopted for water and soil conservation in India by British engineers and by modern engineering education, are taught to engineering students and are supposed to be practiced by irrigation and agricultural engineers. Due to various constraints, these technologies have not even reached the areas where they are needed most, such as the area under study, and if and when they are tried, they prove inappropriate and unsuccessful. As a people's organisation, TBS had a basic distrust in government or outside enforced technologies or practices as far as appropriateness for this area was concerned. A basic tenet of TBS philosophy was and has been that rural communities have traditional knowledge of all needed appropriate technologies for their welfare and all that is needed is encouragement and regeneration of their self-confidence (which has been deliberately destroyed by successive governments and educated elite specialists over the past few centuries) and of course by some physical facilitation and financial support. All water and soil conservation work in which TBS is involved, is essentially based on this tenet and hence on the traditional knowledge and understanding of villagers and all decisions in this regard were taken by them themselves through their Gram-Sabha (not the legal, statutory Gram-Sabha but an impromptu Gram-Sabha constituted under TBS guidance). Thus from engineering point of view, two types of evaluation become relevant for the water-conservation efforts of TBS :

(a) How well the works undertaken would fare if tested on well-accepted engineering principles and practices and

(b) What have been the significant quantifiable impacts of the above works?

2.3 Methodology Adopted for Evaluating Soundness of Water Conservation Technology of Structures under study: This again could be considered to be made up of two parts:

(i) Appropriateness of the hydraulic capacity of storage chosen in the absence of any detailed hydrological calculations and

(ii) Appropriateness of the choice of site, type of structure, and design details including material of construction, bed width, side slopes, arrangements for surplussing etc. As is obvious, the second category of choice of various design details could only be checked by physical visits to a number of work-sites by some competent engineers. The first, viz. hydraulic capacity could and was checked against detailed calculations for a number of works.

2.4 Methodology for Evaluation of Impacts of Water Conservation works carried out : The direct impact of water-conservation efforts would be to increase the water-availability in the area, all round the year, particularly during the dry summer periods. In the hot semiarid to arid conditions of Rajasthan uncovered surface storages shall suffer severe losses from evaporation and percolation while covered, water proof storages shall be too costly to be practical. Also long term surface storage shall take away valuable valley land from cultivation. Thus the traditional technology of "Johad", which harvests and detains precipitation and runoff for short periods to allow the water to percolate down to recharge ground water and later releases bulk of the submerged land for Rabi season cropping is obviously the best, cheapest and most appropriate technology. Thus the most direct impact of water harvesting and conservation by the Johad technology would be the rise in the ground water table of the area. A clear and significant correlation between the extent of water-conservation effort as indicated by the storage capacity created per unit cultivated area and the extent of rise in ground water table shall establish that such rise was due to the conservation effort. If the rise in ground water table was due to natural causes, like better monsoons it shall be more or less similar in all villages and shall not correlate with level of conservation effort. Such a correlation hence was adopted as the touchstone for the evaluation.

2.5 Methodology for Evaluation of Impact of Watershed Management on Economic Condition of the Area: Increased water availability in wells directly increases potential of irrigation of and hence production of both Rabi and Kharif crops. Some direct irrigation of Kharif and Paleo (presowing) irrigation of Rabi also becomes available from Johad storage. The land that was submerged in the Johad during rains and is later released for Rabi is covered with fertile silt and soaked with water to yield bumper harvests. Also through the water shed management, erosion of soil is eliminated and soil moistures improve. As a result, not merely sown crops but natural vegetation and grass and fodder availability improve when incomes from agriculture, forests produce and from live stock, all increase, economic conditions of the area are bound to improve. To quantitatively examine the situation on field, the estimated per capita cost of the water conservation work in a village would be a proper indicator of the investment made while the per capita increase in the value of the Gross Village Product in that village would be a proper indicator for the impact caused. A clear and significant correlation between the two indices should reasonably establish that the latter is the impact of the former, since if the increase in productivity and incomes was due to other causes (like better seeds, fertilizers, pesticides, better technology, better season, more committed farming, better breeds of cattle etc.) it shall not correlate well and significantly with investment on water conservation. Correlation between these two indices was hence chosen as the criteria of evaluation of impact of water conservation work on economics and incomes in the area.

2.6 Methodology for Evaluation of Social and General Impacts: As stated in Para 1.2, these are often non-quantifiable and subjective and were not the subject of this report and have been covered under other evaluation reports indicated at the end of Para 1.2.

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Summary Details of Studied 36 Villages and Water Conservation Works carried out Therein with TBS Involment

3.1 Fig. 1 shows the 36 villages included in this study while Table-1 gives the names, Tehsil, Village Directory Code Number (for an unambiguous identification), total area, land use and the 1991 census - population for the villages as also the village-wise summary of the water conservation works implemented in each of the villages till June 1995. The information was collected from the District Census Handbook, other official records and records of Tarun Bharat Sangh and checked on site during the survey where any doubts arose. Appendix-1 indicates the method of compilation of the last 4 columns of Table-1 by a few examples.

3.2 As may be seen from Table-1, the village include 24 from Thana Gazi Tehsil and 12 from Rajgarh Tehsil and present a very wide range in respect of size. Total land areas vary from as small as 13 Hect. for the smallest Guwada Lala Bhaiya to as large as 2507 Hect. for Bigauta. Seven of the villages (or 20% of total) are larger than 1000 Hect. while another 7 (or 20% of total) are smaller than 250 Hect. Population wise the villages range, from 108 for Tilwari to 2269 for Bigauta. Again 7 of the villages (or 20% of the total) have populations above 1000 while another 7 are below 250 population. Thus size-wise the range and distribution of villages appears alright for survey.

3.3 The amount of work of water conservation carried out with TBS involvement also varies widely from village to village. In 7 of the 36 villages only a single work was implemented, and these included at least one large (Lal Pura) and several medium sized villages. On the other side, in Bhaonta Kolyala as many as 19 works had been completed. In 4 of the villages (viz. Bhaonta Kolyala, Koondla, Bhooriyawas and Piplai) 10 or more works each had been implemented, while in 8 others the number of works implemented varied from 5 to 9 each. In terms of the water storage capacity so created the village-wise total ranged from a low of only 4000 m^3 for Gopalpura, a village not much larger than Roopbas. The estimated total cost of the works implemented ranged from the lowest of Rs. 9,000 for Roopbas (which was a rather late entry to TBS participants list) to the highest figure of over Rs. 4.3 lakhs for Bhaonta Kolyala (which was one of the earliest to join) and above Rs. 1.0 lakh for 10 of the 36 villages.

3.4 To this author the 36 villages included in this evaluation thus present a reasonably large and well distributed sample both from point of view of size and of TBS effort. Being in the same general area with same topography, climate, soil-types, life-styles and culture of people, villages can be assumed to be essentially similar, except for the level and amount of effort that has gone in on water conservation and watershed management over the past years.

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4
Evaluation of Appropriateness of Hydraulic Capacities of Storage for Various works with TBS Involvement

4.1 Hydrological calculations to compute storm runoffs, flood-flows and amounts of water likely to be available or be needed are essential prerequisites to engineering design of any hydraulic structure including all types and sizes of water-retaining structures such as promoted by TBS. However, in this case, no one involved seemed to have knowledge of modern hydrology and no calculations were ever done on paper. All decisions on the height of the retaining structure which essentially determined the storage capacity were done on basis of discussions and "consensus" among villagers (and TBS workers) on the basis of their instinct (traditional knowledge, experience and "gut-feeling"). All these persons appear to have a good and clear understanding of water-divide or ridge line and of demarcating watershed on site and then estimating catchment areas. But no idea of amount of rainfall or storm intensity ever appeared and no calculations were ever done. Under these circumstances one would be afraid that the works built would be either too small or too excessive, and it will be relevant to test the appropriateness of the storage capacity that emerged from the "consensus" of these illiterates as against engineering calculations.

4.2 As stated in Para 2.4 earlier, the objective here was not to create long term surface storage, but to retain storm flows for adequate time to allow their percolation to recharge groundwater. The average annual total rainfall in this area is very close to 600 mm (662 mm at Thana Gazi, 556 mm at Rajgarh). Of this 500 mm could be falling during the 3 monsoon months, most of it distributed in 4-5 rain-break periods of a few days each and separated by several days. What needs to be retained by the created storage is all the storm flow of one such rain-break period and hope very realistically in this type of soil strata that it would have percolated to ground water by the time that the next rain-break comes. And a realistic total rainfall over such a major rain-break period shall be 150 mm. Thus an appropriate water-retaining structure for these conditions should be able to hold the runoff generated by 150 mm rainfall. Assuming a 66% runoff coefficient for this rocky, steep, undulating, denuded terrain, this implies a storage capacity of 1000 m^3/Hectare catchment area (10^4 m^2 area × 0.66 × 150 mm ÷ 1000 mm/m). Since the catchment areas for all works were known, checking the appropriateness of storage provided became easy and was carried out for all the 166 works. Appendix-2 shows a few examples of such checking.

The findings of the checking can be summarised as below:

	Storage Capacity provided in m^3/Hectare Catchment	No. of Works	Remarks : Capacity is
(i)	Below 500 m^3/Hect.	35	Too small
(ii)	500 - 800 m^3/Hect.	49	Small
(iii)	800 - 1200 m^3/Hect.	61	OK
(iv)	1200 - 2000 m^3/Hect.	16	Superfluous
(v)	Over 2000 m^3/Hect.	5	Excessive
		166	

4.3 It might be noted that a small capacity may not be a disadvantage as the surplus flowing down may be arrested in a downstream storage, thus dividing a large capacity requirement into several small storages. What appears amazing is that as many as 61 (or 36%) works had the right capacity even when no calculations had been done and only 10% and 3% respectively fell in the superfluous and excessive category. People's "gut-feeling" may not be too bad.

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5
Evaluation of Appropriateness of Design and Construction Details

5.1 All design details like selection of site, type of structure, construction materials, bed-width, side-slopes, height, curvature etc. and construction details like preparation of foundation and abutments, compaction etc. are decided by discussion among the villagers with little engineering or construction expertise. College educated engineers will obviously doubt the safety and adequacy on the one hand and the economy, optimality and appropriateness on the other end of such structures.

5.2 While the author has personally visited and examined at least 45 (about 30%) of these structures and found such doubts by and large unfounded, 16 of these structures were examined by Prof. S.K. Lunkad, Professor and Head of Geology Department, Kurukshetra University and Shri Dinesh Kumar Mishra, a Civil Engineering expert on Flood-control during October, 1996 and both found the selection of site, design and construction most appropriate. Dr. R.H. Siddiqui, Retired Professor and Head Civil Engineering Department, Aligarh Muslim University visited another 7 structures in November, 96 as a part of this evaluation and could find no major flaws.

5.3 The best proof of adequacy and safety is that these works have stood the test of time and the ravages of intense rainfalls of 1995 and 1996 when scores and scores of engineer designed structures maintained by the government failed creating tragic floods. The crux lies not in design or construction but in maintenance and protection. And villagers maintain and protect their possessions with utmost care and manage them so as to cause minimum damage when emergencies arise.

5.4 An interesting aspect is the extremely low costs at which the storages have been created. The cost of creating these storages in these 36 villages, as can be seen by relating the last two columns of Table-1, ranges from as low as Rs. 0.2 per m^3 storage capacity in case of Kala Lanka and Rs. 0.3 per m^3 for Gopalpura and Rs. 0.4 per m^3 for Ban Chhari to the highest of Rs. 3.0 per m^3 for Govindpura. In over half of the villages, the costs came to between Rs. 0.5 and Rs. 1.5 per m^3. The overall average cost for the 166 works comes to Rs. 0.95 per m^3. The somewhat large range owes partly to different site conditions, but also a lot to the fact that the works were implemented at different times during 1986 to 1995 when prices rose sharply. Thus Gopalpura, the early beginner had cheap storage created while latecomer Govindpura had the highest cost. But obviously no engineering organisation would be able to create storage at such low costs.

5.5 And if the works under study have proved to be safe and have been really cheap, and have served the job well, why doubt or even talk of the technology.

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Evaluation of Impact of Water Conservation Efforts on Ground Water Table

6.1 Assessment of the depth of ground water table as it existed before the water-conservation effort was taken up in the village and the situation after the works was a major part of the survey undertaken. Appendix-3 indicates the methodology of how this was done. Where documentary information was not available, considerable cross-checking with several persons was done.

6.2 Table-2 presents the rise in groundwater table in various villages as also the level of effort in the village on conservation works as indicated by storage capacity created per hect. of cultivated land. To examine whether correlation exists between the storage capacity created in m^3/hect. and the rise in ground water table, Spearman's Rank-order Coefficient of Correlation was computed. For this the villages are ranked separately for the two variables. Let p be the rank of a village in respect of storage capacity per hect. (the highest value being given rank 1, the next highest given rank 2 and so on) and q be the rank of that village for rise in ground water table then. Spearman's Coefficient of Correlation -

$$R = \frac{1-6\ E\ (p-q)^2}{n(n^2-1)}$$

where n is the total number of villages involved. Here n = 36

$$R = \frac{1-6\,E\,(p-q)^2}{36(36^2-1)} = \frac{1-E\,(p-q)^2}{7770}$$

From table-2 we see that for village Nangal Bani p=22 and q= 10, thus (p-q) = 12 and (p q)^2= 144. Similarly for Raipur Bhal p=19 and q=28, thus (p-q) = -9 and (p-q)^2 = 81. Computing and adding E(p-q)^2 = 1795.5. This gives R = 1 - 1795.5/7770 = 1-0.23 -0.77 or 77%. This is a reasonably high coefficient of correlation, establishing that the two are closely correlated. The correlation might have been even higher, if it was not for the differences of geology, terrain and water abstraction rates which do vary from village to village. For all practical purposes, the high value of R shows that the groundwater table rise is a direct impact of the conservation effort.

6.3 Fig-2 plots the groundwater table rise in various villages against the storage created in m^3/Hect. A relationship between the two is clearly discernible, though there is bound to be scattering of the points due to variations in ground features. In fact one could say that there are two separate curves -

(A) for villages which have relatively plain and less rocky lands with somewhat larger percolation and water-holding capacities and

(B) for more rocky and undulating terrains with low porosities, so that even small quantities of water considerably boost the water-table. And from the data 1000-1500 m^3/hect. of cultivated area would seem to be the optimal storage for this region. Such a storage capacity shall raise the annual average groundwater table by about 20 ft.

6.4 To this author, the data and the above analysis clearly and adequately establishes the role and the success of the TBS inspired water-conservation effort in raising Ground Water table in the area.

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Evaluation of Impact on Economic Production

7.1 Table-3 presents the level of estimated financial investment on water-conservation effort against the level of rise in economic production of the various villages from before such effort to after such effort. The procedure for computing the increase in economic production for a village is detailed in Appendix-4 by the example of one of the villages. As may be seen, the evaluation is not affected by change in prices over the years, since it works out the increase in commodity production and then values it at a reasonable current rate.

7.2 The Spearman's Rank Order Coefficient of Correlation for the rank-orders of the 36 villages for level of investment vs. rise in annual production works out to a very high value of 0.905 or 90.5%. In case the increases in production were due to factors like better weather, use of fertilizers, pesticides, improved seeds or such other factors, the rise in production could not have such a high correlation with investment on water conservation.

7.3 Fig.-3 which plots the increase in economic production per-capita against the investment on water-conservation per-capita, clearly shows the direct and almost straight-line relationship between the two. Thus an investment of Rs. 100/- per-capital on Johads, raises the economic production in the village by as much as Rs. 400/- per capita per annum. Obviously this becomes the increase in income of the people and brings the affluence so much observed in these villages. An investment of Rs. 1000/- per capita on Johads would raise per-capita economic production by over Rs. 2,500/- per annum.

7.4 It may be noted that the correlation between increase in economic production and level of investment on Johad work is much stronger than that between the Johad work and the rise in GW table. This is because the rise in GW table does not include the gains of soil-conservation, rise in soil moistures and the improvement in forest and grassland vegetation. It may also be noted that there can be no other type of investment in the conditions of these villages which can yield quicker or better returns. To this author all investment in these areas on education, roads, health etc. is waste of money. Every paisa available should be put into Johads. Everything else can be taken care of by people themselves from their rising incomes.

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8

Conclusions

8.1 From the above this author concludes that :

(i) The water-conservation structures built with involvement of TBS at extremely low costs of Rs.1.00 to 2.00 per m^3 storage costs have not only stood the test of time but are, by and large, engineering-wise sound and appropriate.

(ii) A high coefficient of correlation establishes that the rise in GW table was an impact of the Johad building effort. The optimal Johad storage for these areas would be 1000-1500 m^3/hect. which would raise annual average GW table by 20 ft.

(iii) An extremely high correlation (over 90%) shows the immediate and definite impact of investments on water conservation on village incomes. There can be no better rural investment than that on Johads.

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TABLE 1
SUMMARY DETAILS OF 36 STUDIED VILLAGES AND OF THE WATER CONSERVATION WORKS IMPLEMENTED THEREIN WITH TBS INVOLVEMENT

Sl No.	Name of village	Tehsil	Directory Code No.	Total land Hect.	Forest Hect.	Unculturable Hect.	Culturable Waste Hect.	Cultivated Hect.	Irr. hect	Population	Johads with TBS Participation			
											No.	Catchment	Storage.M^3	Cost Rs.
1	Nangal Bani	Thana Gazi	62	1063	-	645	208	210	71	1519	4	129	62,000	96,036
2	Raipur Bhal	Thana Gazi	73	310	-	212	27	71	13	353	4	59	27,000	31,370
3	Jaisinghpura	Thana Gazi	76	188	-	71	16	101	31	340	4	220	73,000	126,150
4	Bhooriyawas	Thana Gazi	86	701	-	316	147	238	62	1299	11	214	91,000	114,662
5	Bhaonta Kolyala	Thana Gazi	87	221	-	145	11	65	16	288	19	1104	236,000	432,715
6	Doomoli	Thana Gazi	89	410	-	306	35	69	29	387	3	85	43,000	44,553
7	Kabligarh	Thana Gazi	90	911	-	663	76	172	82	664	6	340	105,000	120,410
8	Kala Lanka	Thana Gazi	92	373	-	116	84	173	41	635	4	460	272,000	61,960
9	Ban Chhari	Thana Gazi	95	154	-	35	34	85	26	528	6	427	212,000	86,550
10	Gopalpura	Thana Gazi	97	360	-	213	67	80	13	396	9	964	616,000	210,200
11	Ban Kala	Thana Gazi	99	259	-	92	66	101	19	416	3	85	41,000	39,128
12	Kyara	Thana Gazi	100	654	-	316	133	205	45	822	2	28	25,000	16,320
13	Lalpura	Thana Gazi	106	501	132	117	89	163	122	1049	1	150	23,000	21,840
14	Nagel	Thana Gazi	110	396	-	365	22	9	-	171	4	60	35,000	36,389
15	Chaha Ka Was	Thana Gazi	111	426	-	297	55	74	44	464	1	45	24,000	26,630
16	Hamirpur	Thana Gazi	117	1487	-	826	250	411	115	1651	4	332	65,000	49,160
17	Jaitpur Gujran	Thana Gazi	118	346	-	254	25	67	16	401	7	450	112,000	99,480

18	Piplai	Thana Gazi	123	1533	-	1022	138	373	99	1746	10	217	88,000	113,624
19	Govindpura	Thana Gazi	125	257	-	90	34	133	34	238	1	175	10,000	30,000
20	Jaitpur Brahmanan	Thana Gazi	126	401	-	90	128	183	44	569	1	104	25,000	47,750
21	Seeli Baori	Thana Gazi	132	385	-	108	152	125	63	1115	6	145	57,000	97,075
22	Guwada Lala Bhaiya	Thana Gazi	139	13	-	2	1	10	7	180	1	200	116,000	42,680
23	Guwada Soti	Thana Gazi	148	42	-	8	1	33	19	210	5	140	143,000	95,105
24	Guwada Gugli	Thana Gazi	154	264	-	144	54	66	37	443	2	45	15,000	19,030
25	Rajor	Rajgarh	6	1968	499	1130	108	231	71	644	3	170	42,000	66,220
26	Rada Nadu	Rajgarh	9	1301	268	730	186	117	29	506	7	217	82,000	111,690
27	Ghewar	Rajgarh	11	698	104	228	200	166	58	757	5	448	158,000	147,150
28	Dubkan	Rajgarh	15	301	-	42	35	224	14	176	2	33	22,000	45,235
29	Tilwari	Rajgarh	19	316	-	110	21	185	8	108	6	360	118,000	136,290
30	Roop Bas	Rajgarh	29	257	-	99	-	158	34	387	2	12	4000	9,000
31	Chawa Ka Bas	Rajgarh	30	239	-	187	13	39	15	137	3	260	100,000	82,880
32	Khedli	Rajgarh	41	241	-	124	38	79	52	437	1	35	13,000	21,630
33	Kundroli	Rajgarh	97	288	-	108	33	147	49	651	1	75	54,000	99,000
34	Koondla	Rajgarh	100	1140	204	750	45	141	70	901	12	241	172,000	166,445
35	Beegota	Rajgarh	139	2507	-	1887	183	437	162	2269	4	78	36,000	67,025
36	Veerpur	Rajgarh	140	456	-	264	34	158	46	585	2	45	18,000	23,780

TABLE-2 - RISE IN GW TABLE Vs WATER CONSERVATION EFFORT

S No	Name of Village	Level of Conservation Effort				Level of GW Table Rise				Remarks
		Cultivated Area. Hect.	Storage Capacity Created M^3	Storage created Per Unit cult. area M^3/ Hect.	Rank Order of Effort	Annual Average Dept of GW. ft. Before Effort	After Effort	Rise in GW Table ft.	Rank Order of Impact	
1	Nangal Bani	210	62,000	300	22	50.0	30.5	19.5	10.0	
2	Raipur Bhal	71	27,000	380	19	66.5	52.0	14.5	28	
3	Jaisinghpura	101	73,000	720	12	60.0	40.0	20.0	7.5	
4	Bhooriyawas	238	91,000	378	20	45.0	26.0	19.0	12	
5	Bhaonta Kolyala	65	236,000	3,630	5	56.0	31.0	25.0	1	
6	Doomoli	69	43,000	620	15	74.0	58.0	16.0	23.5	
7	Kabligarh	172	105,000	610	16	61.5	41.5	20.0	7.5	
8	Kala Lanka	173	272,000	1,570	9	58.5	34.0	24.5	2	
9	Ban Chhari	85	212,000	2,500	6	59.0	35.5	23.5	3	
10	Gopalpura	80	616,000	7,700	2	45.0	22.0	23.0	4.5	
11	Ban Kala	101	41,000	410	18	66.0	52.6	13.4	29	
12	Kyara	205	25,000	120	31	61.0	44.0	17.0	21	
13	Lalpura	163	23,000	140	29	50.5	32.5	18.0	16	
14	Nagel	9	35,000	3,900	4	34.0	15.0	19.0	12	
15	Chaha Ka Was	74	24,000	325	21	30.0	18.0	12.0	33	
16	Hamirpur	411	65,000	165	27	41.0	23.0	18.0	16	
17	Jaitpur Gujran	67	112,000	1,670	8	61.0	41.0	20.0	7.5	
18	Piplai	373	88,000	240	24	51.0	34.0	17.0	21	
19	Govindpura	133	10,000	80	34	50.0	34.0	16.0	23.5	
20	Jaitpur Brahmanan	183	25,000	138	30	51.0	41.0	10.0	35.5	
21	Seeli Baori	125	57,000	460	17	45.0	30.0	15.0	25.5	
22	Guwada Lala Bhaiya	10	116,000	11,600	1	57.0	34.0	23.0	4.5	
23	Guwada Soti	33	143,000	4,330	3	32.0	12.0	20.0	7.5	
24	Guwada Gugli	66	15,000	230	25	48.0	33.4	14.6	27	
25	Rajor	231	42,000	180	26	51.0	34.0	17.0	21	
26	Rada Nadu	117	82,000	700	13	45.0	27.0	18.0	16	
27	Ghewar	166	158,000	940	11	42.0	23.0	19.0	12	
28	Dubkan	224	22,000	100	33	43.6	31.0	12.6	32	
29	Tilwari	185	118,000	640	14	43.0	25.6	17.4	19	
30	Roop Bas	158	4,000	25	36	45.0	35.0	10.0	35.5	
31	Chawa Ka Bas	39	100,000	2,500	7	40.0	22.0	18.0	16	
32	Khedli	79	13,000	160	28	38.0	25.0	13.0	30.5	
33	Kundroli	147	54,000	296	23	87.0	74.0	13.0	30.5	
34	Koondla	141	172,000	1,220	10	52.0	34.0	18.0	16	
35	Beegauta	437	36,000	78	35	37.5	27.0	10.5	34	
36	Veerpur	158	18,000	110	32	65.0	50.0	15.0	25.5	

TABLE – 3 - RISE IN ANNUAL GROSS VILLAGE PRODUCT Vs ESTIMATED INVESTMENT ON WATER CONSERVATION

S No.	Name of Village	Population	Level of Investment on Water Conservation			Rise in Annual Gross Village product			Remarks
			Estimated Investment Rs.	Per Capita Invest. Rs.	Rank Order	Estimated Rise Rs.	Per Capita Rise. Rs.	Rank Order	
1	Nangal Bani	519	96,036	63	27	171,026	330	28	
2	Raipur Bhal	353	31,370	88	23.5	185,424	525	21	
3	Jaisinghpura	340	126,150	370	6	364,207	1071	8	
4	Bhooriyawas	1299	114,662	88	23.5	549,597	423	24	
5	Bhaonta Kolyala	288	432,715	1.500	1	969,985	3364	2	
6	Doomoli	387	44,553	115	18	146,334	378	26	
7	Kabligarh	664	120,410	180	14	730,996	1101	7	
8	Kala Lanka	635	61,960	100	20	385,900	608	19	
9	Ban Chhari	528	76,550	140	16	521,889	988	10	
10	Gopalpura	396	210,200	530	4	1,123,857	2860	3	
11	Ban Kala	416	39,128	94	21	255,024	613	18	
12	Kyara	822	16,320	20	36	340,311	426	23	
13	Lalpura	1049	21,840	21	35	237,689	225	31	
14	Nagel	171	36,389	210	11	114,660	670	17	
15	Chaha Ka Was	464	26,530	58	28	168,994	364	27	
16	Hamirpur	1651	49,160	30	32.5	473,705	287	30	
17	Jaitpur Gujran	401	99,480	250	8	488,339	1218	6	
18	Piplai	1746	113,624	65	26	386,704	221	32	
19	Govindpura	238	30,000	124	17	195,714	822	12	
20	Jaitpur Brahmanan	569	47,750	85	25	393,513	692	16	
21	Seeli Baori	1115	97,075	89	22	423,276	380	25	
22	Guwada Lala Bhaiya	180	42,680	237	9	136,386	758	13	
23	Guwada Soti	210	95,105	453	5	269,621	1284	5	
24	Guwada Gugli	443	19,030	43	30	78,403	177	34	
25	Rajor	644	66,220	103	19	354,370	550	20	
26	Rada Nadu	506	111,690	220	10	517,750	1023	9	
27	Ghewar	757	147,150	195	12	537,799	710	15	
28	Dubkan	176	45,235	260	7	129,935	738	14	
29	Tilwari	108	136,290	1,262	2	387,216	3585	1	
30	Roop Bas	387	9,000	23	34	61,262	158	35	
31	Chawa Ka Bas	137	82,880	605	3	255,864	1868	4	
32	Khedli	437	21,630	49	29	78,648	180	33	
33	Kundroli	651	99,000	152	15	293,053	450	22	
34	Koondla	901	166,445	185	13	855,167	949	11	
35	Beegauta	2269	67,025	30	32.5	285,409	126	36	
36	Veerpur	585	23,780	41	31	175,694	300	29	

APPENDIX 1

Indicative Examples of Compilation of Last 4 Columns of Table 1 for Village wise Summary of Works Implemented

Name of Village	Work No.	Identification of work	Catchment Area, Hect.	Storage Capacity, M^3	Estimated Cost Rs.
1. Nangal Bani	(i)	Shaitan Wala Bandh	35	24,000	22,036
	(ii)	Sadak Tale Ka Anicut	50	15,000	43,200
	(iii)	Raghuveer Wala Bandh	20	11,000	14,280
	(iv)	Meeno Wala Bandha	24	12,000	16,520
Total	4		129	62,000	96,036
2. Raipur Bhal	(i)	Rada ka Johad	12	7,000	7,000
	(ii)	Goau Ka Johad	15	8,000	8,400
	(iii)	Guna Wali Bandhi	25	8,000	11,900
	(iv)	-do- (Expansion)	7	4,000	4,070
Total	4		59	27,000	31,370
10. Gopal Pura	(i)	Mewalon Ka Bandh	200	1,84,000	90,000
	(ii)	Chotare Wala Johad	25	13,000	20,000
	(iii)	Kadakya Wala Johad	80	27,000	10,000
	(iv)	Bawadi Wala Johad	150	28,000	10,800
	(v)	Balai Wala Bandh	34	6,000	7,200
	(vi)	Naya Bandh	170	1,60,000	18,000
	(vii)	Gore Wala Bandh	150	1,80,000	34,000
	(viii)	Badari Wala Bandh	150	16,000	18,200
	(ix)	Amli Wali Med Bandhi	5	2,000	2,000
Total	9		964	6,16,000	2,10,200

APPENDIX 2

Indicative Examples of checking the appropriateness of Water – Storage Capacity Provided at Various Works Built with TBS Involvement

S.No.	Name of Village	Identification of Work	Catchment Area Hect.	Storage Provided M^3	Storage Provided M^3/Hect. Catchment Area	Remarks
1	Koondla	Gyarsa Wala Bandh	15	18,000	1200	OK
2	-do-	Ram Dhan Wala Bandh	20	20,000	1000	OK
3	-do-	Ram Dayal Wala Bandh	22	19,000	860	OK
4	-do-	Ram Chander Wala Bandh	34	28,000	820	OK
5	-do-	Kanha Wala Bandh	30	21,000	700	Less
6	-do-	Birbal Wala Bandh	28	19,000	680	- do -
7	-do-	Matadin Wala Bandh	25	11,000	440	Too Small
8	-do-	Bhag Wala Bandh	30	17,000	570	Less
9	-do-	Siaram Wala Bandh	15	9,000	600	Less
10	-do-	Ram Chander Ka Anicut	7	3,000	430	Too Small
11	-do-	Bhagwan Sahay Ka Bandh	5	2,000	400	Too Small
12	-do-	Ram Uday ka Bandh	10	5,000	500	Less
13	Kyara	Meena Wala Johad	20	13,000	650	Less
14	-do-	Goav Upper Wala Johad	8	12,000	1500	Super Fluous

APPENDIX 3

Indicative Examples of Computation of Rise in Ground Water Table in Various Villages through Water –Conservation Works with TBS involvement

Sl No.	Name of Village and Well-Owner	Depth of GW Before Works (feet)		Depth of GW After Works (feet)		Average Rise in ft
		Monsoon	Summer	Monsoon	Summer	
1	Bhaonta-Kolyala					
	(i) Shri Nanchu Ram	50	70	20	50	25
	(ii) Shri Sunder Babu	48	68	18	47	25
	(iii) Shri Jai Ram	44	65	17	46	22
	(iv) Shri Nathu Ram	42	66	15	47	23
	(v) Shri Ram Gopal	41	65	12	38	27
	Village Average	45	67	16.4	45.6	
	Annual Village Av.	56		31		25
2.	Ban Kala					
	(i) Shri Govind Ram	55	70	34	61	15
	(ii) Shri Mahadev	58	75	36	66	15.5
	(iii) Shri Prabhu Dayal	52	74	40	68	9
	(iv) Shri Budha Ram	60	78	42	70	13
	(v) Shri Bansi Patel	61	77	40	68	15
	Village Average	57.4	74.8	38.4	66.8	
	Annual Village Av.	66		52.6		13.4

APPENDIX 4

Indicative Example of Computation of Increase in Annual Gross Product of a Village

Name of Village : RADA –NADU

A. Increase in Value of Agricultural Product

Crop	Before Johads			After Johads			Change in Prod. Qtls	Value of Change Rs.
	Sown Hect.	Yield Qtl/Hect	Prodn. Qtl.	Sown Hect.	Yield Hect.	Prodn. Qtl.		
(i) Maize	24	15	.360	31	21	651	(+) 291	58,200
(ii) Millets	51	12	612	49	16	784	(+) 172	34,400
(iii) Mustard	12	8	96	16	11	176	(+) 80	48,000
(iv) Wheat	29	16	464	43	24	1032	(+) 568	1,70,400
(v) Barley	26	18	468	14	20	280	(-) 188	(-) 47,000
Total								(+) Rs 2,64,000

B Milk Production

Name of Milk cattle	Before Johads				After Johads				Change in yearly Milk Prodn. Ltrs.	Value of Annual Change Rs.
	Total No.	In Milk	Milk Yield Ltr/day	Total Annual Prodn. Ltrs.	Total No.	In Milk	Milk Yield Ltr/day	Total Annual Prodn Ltrs.		
Buffalo	460	75	3.5	52,000 (200days)	355	65	6	78,000 (200days)	25,500@ Rs. 7/-	1,78,500
Cow	150	35	1.5	9450 (180days)	125	30	2.5	13,500 (180days)	4050 @ Rs. 5/-	20,250
Total										(+)1,98,750

C Forest Produce, Services and others
before Johads Rs. 1,50,000
After Johads Rs. 2,05.000

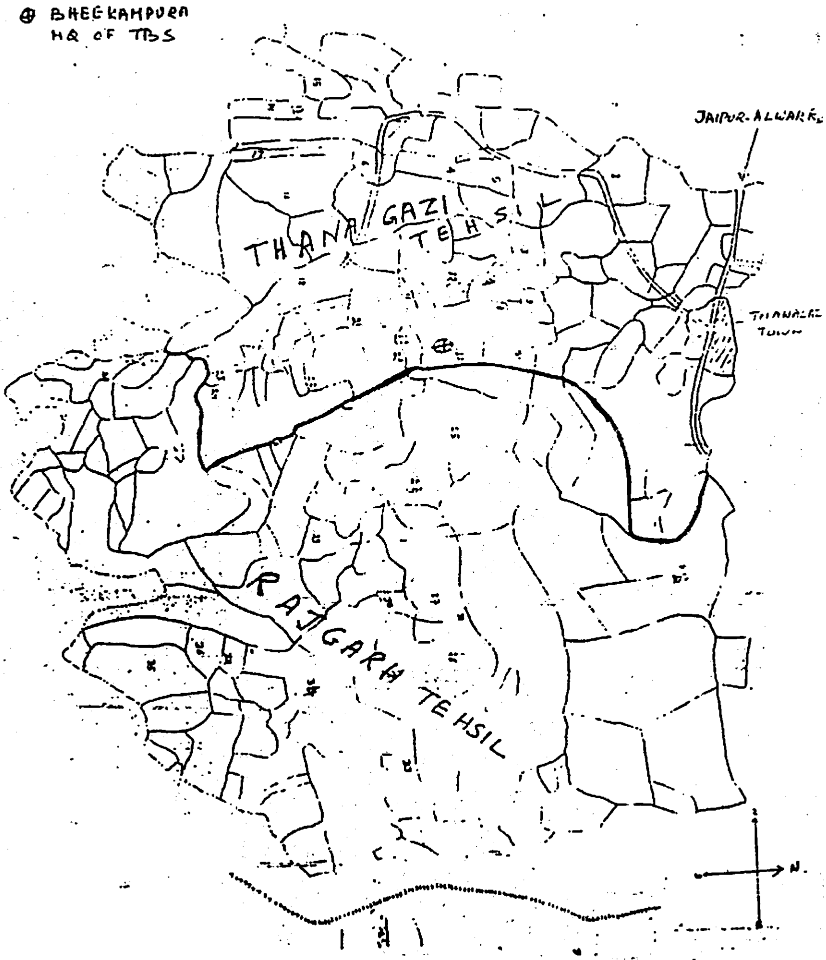
Change (+) Rs. 55,000

Total Increase in Annual Gross Product of Rada Nadu = 2,64,000 + 1,98,750+55,000 = Rs 5,17,750 which for a population of 506 works out to Rs. 1023 per capita.

FIGURE - I

TBS PROJECT AREA SUPPORTED BY ICCO
(THANAGAZI & RAJGARH TEHSILS OF ALWAR DIST OF RAJASTHAN)

NOTES — NUMBERS INDICATE VILLAGES COVERED IN REPORT.
NUMBERS 1-24 ARE VILLAGES IN THANAGAZI TEHSIL - 115 JOHADS
" 25-36 " " " RAJGARH " - 49 "



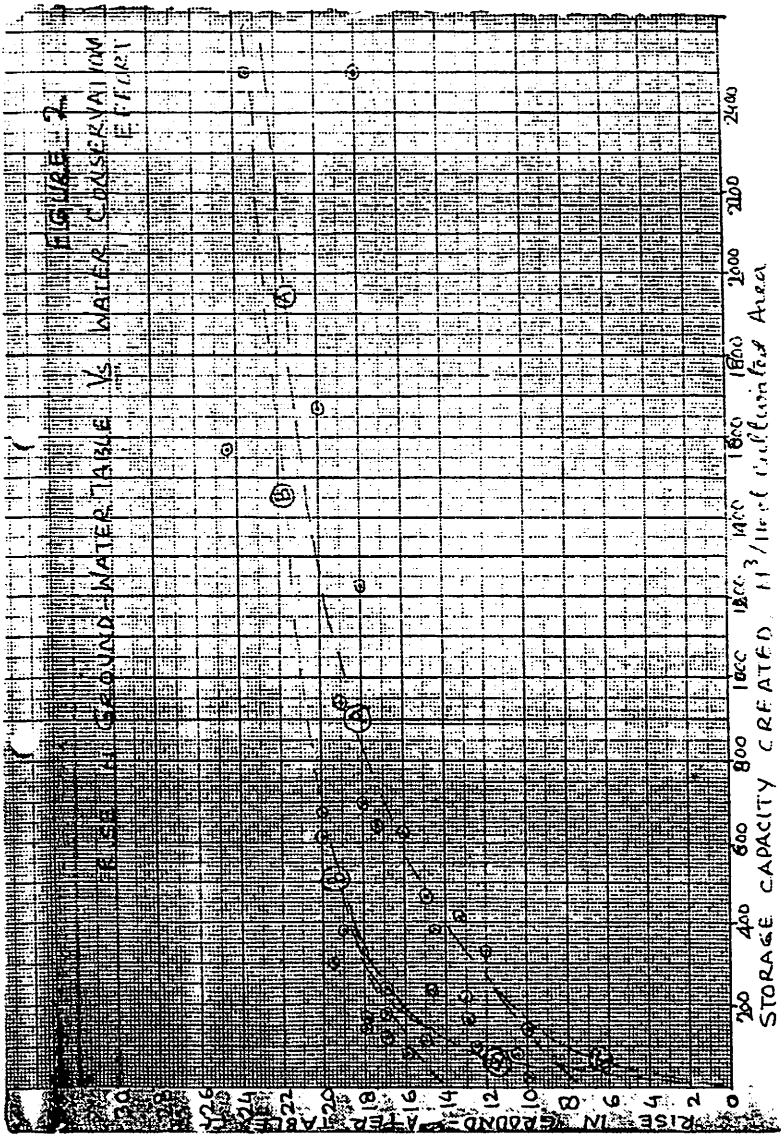


FIGURE 2
RISE IN GROUND WATER TABLE Vs WATER CONSERVATION EFFORT
STORAGE CAPACITY CREATED
RISE IN GROUND WATER TABLE
0
2
4
6
8
10
12
14
16
18
20
22
200
400
600
800
2000
2400

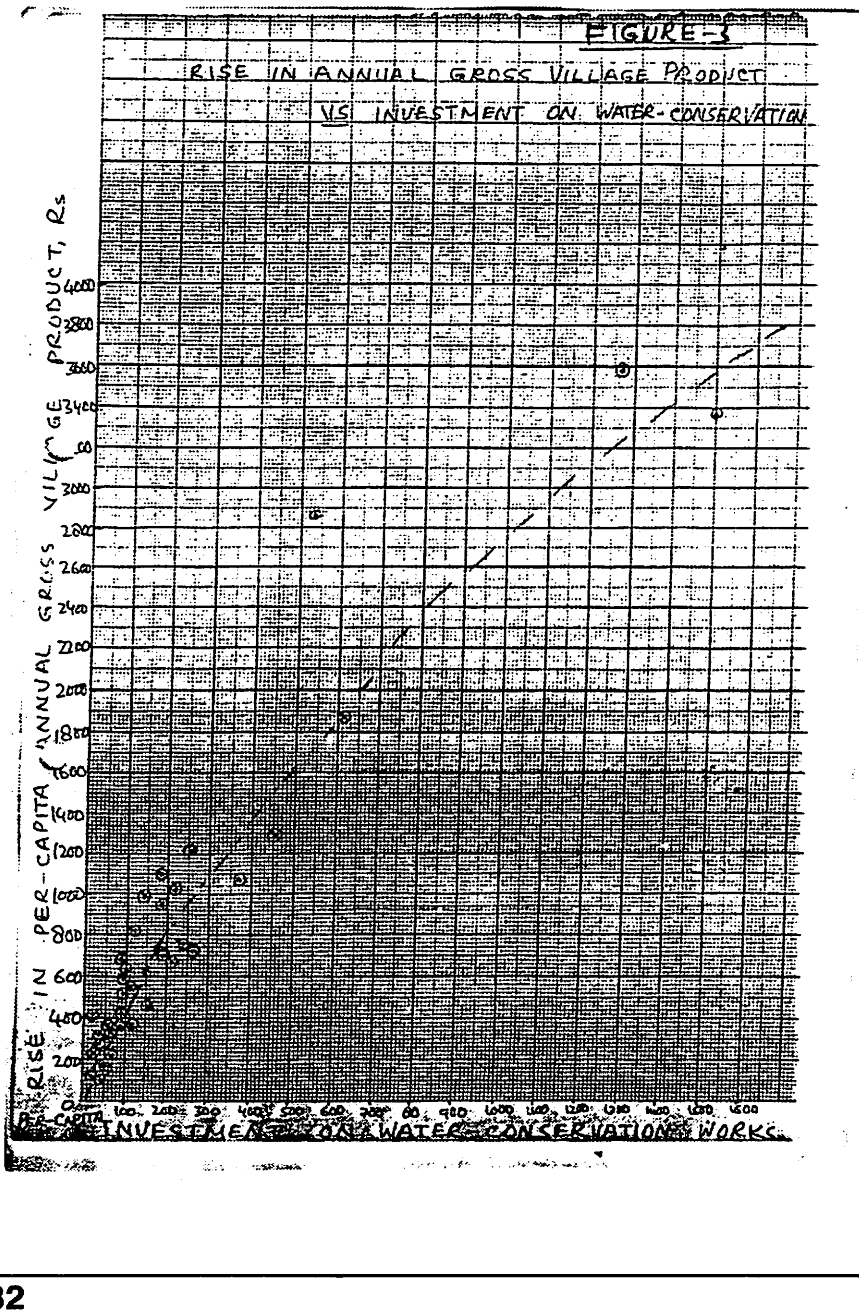
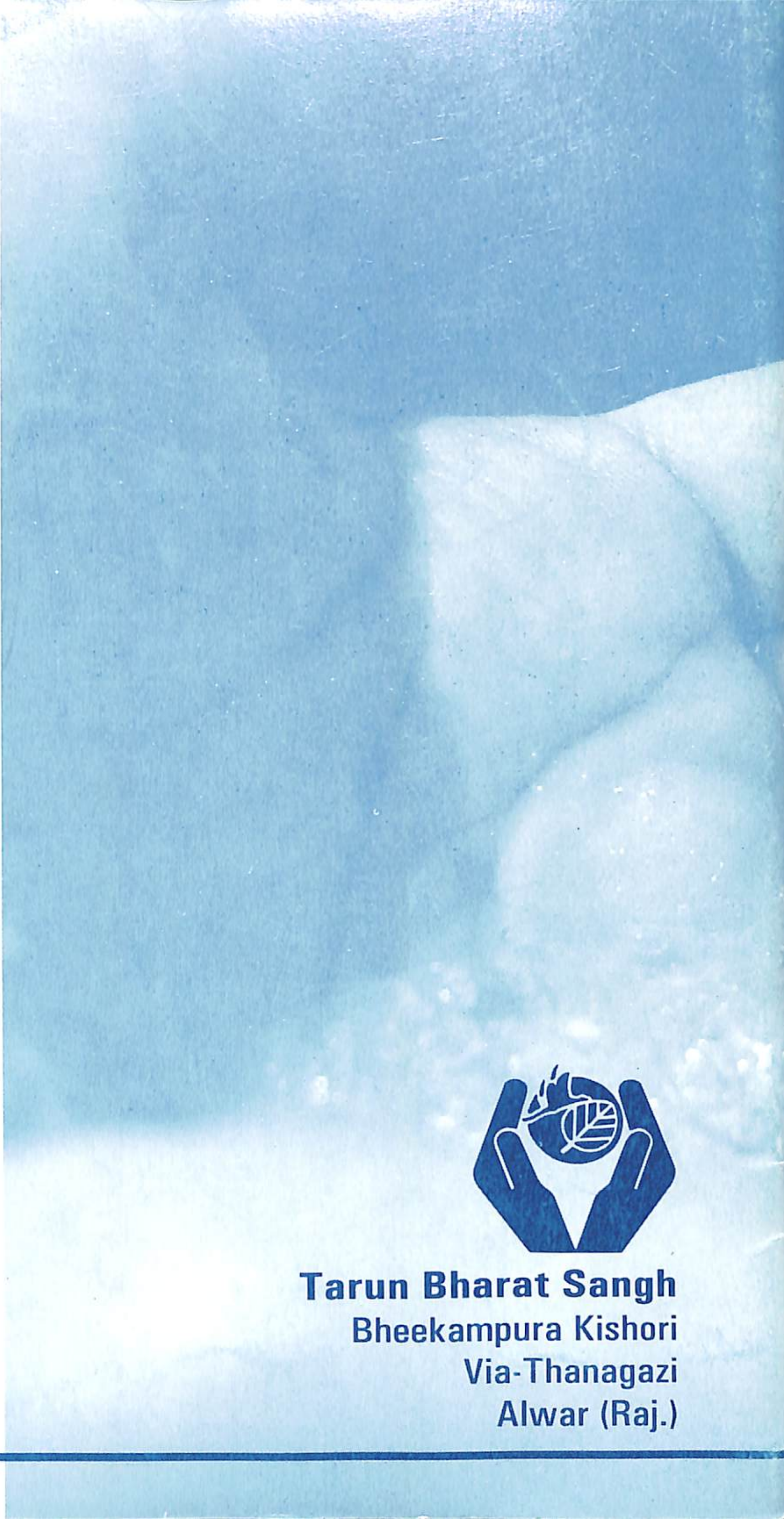


FIGURE-3
RISE IN ANNUAL GROSS VILLAGE PRODUCT
VS INVESTMENT ON WATER-CONSERVATION
RISE IN PER-CAPITA ANNUAL GROSS VILLAGE PRODUCT, Rs
PER-CAPITA INVESTMENT ON WATER-CONSERVATION WORKS



Tarun Bharat Sangh
Bheekampura Kishori
Via-Thanagazi
Alwar (Raj.)