IMPACT OF MINOR
CANAL IRRIGATION PROJECTS OF AKRSP(I)
IN BHARUCH PROGRAMME AREA

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FORWARD

What is the best approach to overall development? Some would argue for education, while others would say health care.

AKRSP(I) does not intervene in either of these core sectors. Yet we believe that by focusing on our core competence of natural resource development, we can also have a significant impact on health and education, as well as on other less tangible aspects of quality of life.

This study demonstrates, through one kind of project, how this actually happens, but also raises questions about the long term sustainability of such interventions. It is one of a number of studies by our Research and Monitoring team that is intended for our own internal learning process but is also offered to a wider audience so that others may learn from our experience.

Barry Underwood
Chief Executive Officer

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ABSTRACT

AKRSP(I) has been working in the area of developing minor canal irrigation projects in the hilly regions of Gujarat. This study highlights the social, economic, and environmental impact of three of these projects. In the programme area the cropping pattern has changed from single season kharif crop to multi-season kharif, rabi, and summer crops. Many farmers have also started cultivating commercial crops like sugarcane and banana. Owing to an increase in agriculture production, average annual income has increased two to three times. As a result of an increase in income and employment, migration has also come down. Workload of women has increased owing to increase in the number of cropping seasons and adoption of animal husbandry. Nutrition levels have improved and locally produced food can fulfill the requirements of the entire population throughout the year. One can, however, foresee the social and environmental threat posed by excess use of water, chemical fertilizers, and pesticides, and cultivation of commercial crops like sugarcane and banana. There is an emerging need to start a campaign of careful use of water without damaging the social and physical environment.

INTRODUCTION

Since 1985, AKRSP(I) has been promoting small irrigation projects appropriate to local situations in three environmentally fragile areas: (1) soil erosion prone hilly area (Bharuch), (2) drought prone area (Surendranagar), and (3) salinity prone area (Junagadh). AKRSP(I) has been working mainly on: lift irrigation, canal irrigation, group wells, and check dams in Bharuch; percolation tanks and check dams in Surendranagar; and check dams, percolation wells, and percolation tanks in the Junagadh area. Bharuch has only 5 per cent of agriculture land under irrigation, with high rainfall and many natural streams. Thus this area has a larger scope of development of irrigation than other districts in Gujarat. Till now, in the Bharuch are AKRSP(I) has worked on six canal projects, 10 lift irrigation schemes, 10 check dams, and 24 group wells, and has created irrigation Potential for about 7500 acres of which about 5000 acres are irrigated through canals The availability of water has led to significant changes in the socio-economic and physical environment of the region. Canal water is available at low rate of farmers, and their net income has increased.

Much controversy has been raised against dams and canal irrigation. Many studies (Fahim 1981, Aronan 1981) show that they are environmentally unsuitable. The question arises why is then that an NGO like AKRSP(I) is involved in promoting canal irrigation? It is true that big canal irrigation projects have created social and environmental hazards, but minor dams with less than 1000 hectares command area can be a better substitute for big dams. At present AKRSP(I) is involved in six minor canal irrigation projects and all of them were constructed on small streams. According to the irrigation experts and environmentalists, minor canals are a cheaper and safer source of irrigation. Instead of one big dam, it is better to build many small dams. Bringing water from long distances is expensive owing to seepage on the way. A larger concentration of small dams can provide water to a larger area with less seepage on the way.

Several minor canal irrigation projects were initiated by the government in the tribal areas of the south-eastern part (Bharuch area) of Gujarat during the last twenty years; many of them lying unused or underused because of poor planning and execution, and indifferent management. Senior officers of irrigation Department of government of Gujarat suggested that AKRSP(I) should take interest in rehabilitating these projects where large funds bave been invested without commensurate benefits.

In 1990 the Chief Executive Officer and other senior staff of AKRSP(I) visited Pingut irrigation project, which was completed in 1982 with an investment of Rs. 30 million; but no land was irrigated. AKRSP(I), the irrigation department and the farmer's society promoted by AKRSP(I) got together to re-activate the project. The objectives of this exercise were as follows:

to increase the area under irrigation;

involve farmers in planning the irrigation programme;

Get the farmer's society to take full responsibility for recovery of water rates;

Get the society to become more active in providing services of its members.

Through their joint efforts 120 acres in 1990, 300 acres in 1991, and 500 acres in 1992 was brought under irrigation. By 1997, a total of 1120 areas (82 per cent of the potential land) was irrigated through this project, in 1997 it was decided that henceforth the farmers' society would deal directly with the government and AKRSP(I) will give only support on technical institutional issues.

Appreciating the cooperation of the farmers and the better utilization of the capacity of the Pingut project, AKRSP(I) was requested to prepare a similar participatory arrangement for the Baldeva project, which is very near to the Pingut project. The Baldeva project was supposed to have been completed in 1974, but no land was irrigated till 1992. joint irrigation development and management of the Baldeva project has led to the irrigation of about 500 acres in the summer of 1993, bringing in a net income of Rs. 40 lakh to the farmers. In 1998, the Registrar for Cooperative Society appointed an administrator to look after the activities of the society; AKRSP(I) will provide support from outside, whenever there is a demand from the people.

In 1993 AKRSP(I) was asked to undertake canal construction and repair work of the Chopadavav and Lakhigam projects. In 1994 potential irrigation of 1554 hectares was created through these three projects. In 1996 major work on the Lakhigam canal was completed, and networking of the canal system was started. For all of these canal projects, irrigation societies were formed for proper water distribution, while AKRSP(I) provided technical and managerial support. In 1997 the Baldeva, Chopdavav, Lakhigam, and Isar canal irrigation societies entered into a contract with the government for undertaking the construction of canal structures, lining, and earth work. In 1998 the Lakhigam canal society executed brick lining work of three minor canals, and in the Isar canal project, strengthening and lining of field cannels on one minor was completed. In the same year in the Kakadiamba canal project, AKRSP(I) had entered into a contract with the irrigation department for brick lining work in two minors. In 1999 the Lakhigam canal society completed field canal lining work, the Isar society took up repair work of the damaged structure in the canals and the Chopadavav society carried out desilting work. In the Kakadiamba canal project, lining work for other minors was continuing at the time of writing. Earlier, the tail ends of canals were unlined, and either water was not reaching fields or was not enough for full irrigation. Now in many cases lining work has been completed, and water reaches the end of the canal. A total of 7932 acres of potential irrigation has been created through all the six projects, of which 4582 acres are actually irrigated (see Table 1).

Map.

Table 1: Potential and Actual Area under irrigation.

Canal	Potential Irrigation (in acres)	Kharif (in acres)	Rabi (in acres)	Summer (in acres)	Total (in acres)	Percentage of actual crop potential	No. of Farmers.
Pingut	1357.5	0	495	625	1120	82	449
Baldeva	2337.5	0	0	1087.5	1087.5	46	288
Lakhigam	1000	0	150	150	300	30	136
Chopadavav	1337.5	0	215	500	715	53	350
Kakadiamba	1015	0	235	437.5	672.5	66	337
Isar	885	0	277	410	687	77	335
Total	7932.5	0	1372	3210	4582	58	1895

Source: AKRSP(I) records.

Table 1 shows that there is a difference between potential and actual irrigated area. It is almost impossible to achieve 100 per cent potential, because many assumptions undergo changes between the planning and implementation stages. During the planning stage some assumptions are made but people do not behave as per the assumption. It is very difficult to predict the behaviour of farmers as their decisions on cropping patterns depend on many socio-economic factors. Another reason for low utilization of water is unlined (*kutchha*) canals and their faulty construction, which causes water seepage and water logging. Many field are not leveled and do not have field channels; therefore, canal water does not reach in uplands. However due to intervention by AKRSP(I), government and village irrigation societies' and their joint efforts, utilization of canal water has improved significantly.

It has been observed that availability of water from canals, has changed the socio-economic and environmental scenario in the area, and therefore, this study was taken up to realize the impact of this. This will help to determine the future course of action, and decide to precautions to be taken to avoid negative impact.

STUDY AREA

The study region comprises the western-most part of the Satpura Hills. The whole region is eroded by many streams. The area is predominantly (85%) tribal. The majority of tribals are living in poverty. They are either land less or small farmers (AKRSP(I) defines small farmers as those with land holdings totalling 2.5 acres or less). The area relies mainly on rainfall and often only one kharif (monsoom) crops can be grown, in a year. The main crops of the area are maize, jowar, paddy tur (pigeon pea), and cotton in Kharif; wheat and gram in rabi; and groundnut and mung (green gram) in summer. Wherever irrigation for the whole year is available, sugarcane and banana crops are also grown. The majority of farmers have no irrigation and can grow only maize, jowar, and paddy in kharif. For the rest of the year the tribals migrate to nearby towns, or sugarcane growing areas to work as daily wage workers. The average rainfall in 1200 mm, but the area under irrigation is only about 5 per cent of the net cultivated area.

OBJECTIVES

The present study attempts to examine the socio-economic and physical environmental changes due to increased irrigation, and their impact in the project area. The major objectives are to assess:

Changes in the economic status of the people in terms of increase in agriculture production and income;

Changes in social life in terms of availability of food and nutrition, reduction in migration and improvement in the quality of life of women;

Changes in the physical environment in terms of an increase in area under irrigation, changes in the cropping pattern, and changes in use of fertilizers and pesticides and their impact on health of soil, human, and animals.

METHODOLOGY

About 10 per cent of beneficiaries and 5 non-beneficiaries from each canal project were chosen. The sample include 219 beneficiaries and 30 non-beneficiaries. The stratified sampling method was used. Stratification of the sample was based on gender (male and female) and location of fields with reference to canal (head, medium and tail) (see Table 2).

Table 2: Distribution of Sample Farmers.

Canal	Type of Farmers			Farm Location of sample farmers			
	Male	Female	Total	Head	Middle	Tail	Total
Lakhigam	30	10	40	17	10	13	40
Baldeva	15	15	30	10	10	10	30
Pingut	25	20	45	10	15	20	45
Isar	16	18	34	12	12	10	34
Kakadiamba	25	20	34	10	10	15	35
Chopadavav	18	17	35	12	8	15	35
Total	129	100	219	71	65	83	219

DATA COLLECTION

Qualitative and quantitative information was collected for the purpose of the study. Quantitative information was collected through a framed questionnaire and from AKRSP(I) records. Qualitative information was collected through group interviews, observations, and discussions with knowledgeable persons like experienced farmers (women and men), officials of the irrigation department, teachers, and the *talati* (village level revenue official). Separate discussions were held with women in each project area to assess their perception and options about the canal project.

FINDINGS

Changes in cropping pattern

Table 3 shows that after the introduction of canal irrigation, cropping patterns have changed significantly. In the kharif season many farmers have shifted from cultivating jowar, maize and pigeon pea to paddy and cotton.

Slowly farmers are changing from growing traditional varieties of paddy to a high yielding variety of paddy. However, the preference is still for the traditional variety. According to the farmers, the traditional variety can be kept for 15 years, unlike the new variety which does not keep for more than three years. In the rabi season, farmers have started growing wheat and gram and groundnut and in summer green gram. It is important to note that not all crops are grown in the same year. If, in kharif cotton and pigeon pea are taken, which are six to eight month crops, in rabi no other crop cannot be grown. But in summer, in the same year groundnut and green gram are cultivated. Similarly if banana or sugarcane is grown which are 12 to 14 month crops, then during that year no other crop can be grown. Owing to availability of water in time, yield rates of almost all crops have increased.

Table 3: Changes in Cropping Pattern.

Crops	Before canal irrigation		After canal irrigation	
	Area in acre	Yield per acre (in quintals)	Area in acre	Yield per acre (in quintals)
Paddy	2240	5	2901	15
Maize	2895	4	1450	5
Jowar	1047	2	363	3
Cotton	40	3	814	7
Pigeon pea	275	2	275	6
Black gram (urad)	185	1	185	2
Vegetables	0	0	254	20
Wheat	0	0	600	5
Gram	0	0	151	4
Green gram(mung)	0	0	1100	5
Groundnut (summer)	0	0	1746	6
Banana	0	0	110	400
Sugarcane	0	0	300	300
Gross Cropped Area	6682	-	10249	-

Source: Field work 1999

Increase in Income

The income of farmers has increased after the introduction of canal irrigation. A survey of 30 sample farmers of Dadwana and Sarkui villages of the Lakhigam canal area (Table 4) showed that their income was 3.1 times that of the previous year. Annual income from all sources has increased from Rs. 12,376 to Rs. 38,498; annual income from agriculture has increased from Rs. 7,827 to Rs. 27683 and that from animal husbandry from Rs. 2,850 to Rs. 10,283. As availability of fodder has increased there has been an increase in the number of animals and production of milk. There was a corresponding 71 per cent decrease in annual income earned from labour work, indicating that people dependency on labour work has decreased remarkably.

Table 4: Average Annual Income of a Household Before and After Canal Irrigation in the Lakhigam Canal Area.

Source of income	Average Annual Income (in Rs.)		
	Before Canal Irrigation	After Canal Irrigation	Increase/Decrease
Agriculture	7827 (62%)	27683 (72%)	253%
Animal husbandry	2850 (23%)	10283 (27%)	260%
Labour	1900 (15%)	533 (1%)	-71%
Total	12376	38498	211%

Source : Field work 1999

After the introduction of canal irrigation, expenditure on agricultural inputs has increased, but, at the same time, net income has also increased. Many farmers have taken the advantage of irrigation and have started cultivating multiple crops. In part of their fields, they have begun growing vegetables, and on the boundaries they have planted fruit trees. This way they are getting additional income by selling vegetables and fruits.

An exercise was done in Surkui village with Sevabhai (a small farmer, and member of the canal irrigation society) of the Lakhigam canal area to calculate the net income based on input and output cost, before and after canal irrigation was introduced.

On unirrigated land only kharif (monsoon) crops can be grown. In Table 5, the per acre input cost and in Table 6, the per acre output cost are given for different crops. Often farmers grow three to four crops in one acre of land. Before canal irrigation was introduced, Sevabhai used to grow paddy, pigeon pea, and maize as mixed crops on his one acre of land. As can be seen in Table 6 the per acre net income from one acre of land prior to canal irrigation was Rs. 3,555. Before canal irrigation was introduced Sevabhai could grow only Kharif crop. During the remaining part of the year, he depended on labour work either within the village or in the sugarcane field of nearby areas or in nearby towns as a construction worker. On an average Sevabhai used to work as a labourer for 180 days in a year and earned Rs. 6,300 at the rate of Rs. 35 per day. Thus, before canal irrigation was introduced the total income of Sevabhai was Rs. 9,855. After canal irrigation was introduced Sevabhai started cultivating in all three seasons (kharif, rabi, and summer), and his income increased for two reasons: one because of increase in yield rates and, two, because of an increase in cultivation seasons, and therefore in the gross cropped area. Earlier Sevabhai could grow only kharif crop; now he can harvest rabi and summer crops also. As Sevabhai started getting assured water supply he started spending more on inputs in order to get higher yields. Table 7 indicates the cost of inputs and Table 8 indicates the per acre income on his one acre land after canal irrigation was introduced. The per acre net income, after canal irrigation was introduced, is Rs. 35,585 and the net increase in income is Rs. 25,730 (3.6 times).

Table 5: Per Acre Input Cost of Major Crops on Unirrigated Land Before introduction of canal irrigation.

Components	Paddy	Pigeon Pea	Coarse grain (maize/jowar)	Total
Seeds	100	25	25	150
Fertilizer	100	50	0	150
Ploughing	60	60	60	180
Renting of Bullocks	50	50	20	120
Sowing	30	30	30	90
Weeding	200	50	50	300
Harvesting	250	100	100	450
Separating of seeds	50	50	50	150
Transportation	25	10	15	50
Total	865	425	350	1640

Source : Field Work 1999

Table 6: Per Acre Net Income from Unirrigated Land Before Introduction of the Canal irrigation

Crops	Per acre production of mix crops(quintals)	Total Value (Rs.)	Input cost 1/3 of one acre (Rs.)	Net Income (Rs.)
Paddy	3	1500	288	1212
Pigeon pea	1	1800	141	1659
Coarse grains	2	800	116	684
Total		4100	545	3555

Source: Field work 1999

Table 7: Per Acre Input Cost of Major Crops After Introduction of Canal Irrigation.

Components	Summer Groundnut	Paddy	Vegetables	Mango Grafts	Total
Seed/graft	110	452	200	500	1262
Fertilizer	300	415	500	500	1715
Ploughing	350	350	50	0	750
Sowing	160	240	300	200	900
Watering	150	150	600	300	1200
Diesel (for tractor)	150	150	0	0	300
Harvesting	280	600	800	500	2180
Separating seeds	390	240	0	0	630
Weeding	280	300	0	0	580
Transportation	50	100	5	100	750
Total	2220	2997	2950	2100	10267

Source: Field work 1999

Table 8: Per acre income from Major crops After introduction of Canal irrigation.

Crop	Per acre Production (quintals)	Total Value (Rs.)	Input Cost (Rs.)	Net Income (Rs.)
Paddy (monsoon)	15	7500	2997	4503
Vegetables(winter)	20	20000	2950	17050
Groundnut(summer)	7	8750	2220	6530
Mango(on the field boundary)	12	9600	2100	7500
Total		36350	10267	35583

Source: Field work 1999

After the introduction of canal irrigation many farmers shifted from paddy, maize, pigeon pea, wheat, groundnut, and green gram to mono cropping of sugarcane in the Pignut, Baldeva, and Lakhigam canal command areas, and banana in the Kakadiamba and Chopdavav canal command areas. Growing sugarcane yields a high rate of return on investment for farmers, as this crop does not require much care or investment, expenditure is mainly on fertilizers and pesticides, and farmers get cheap water from the canal at the rate of Rs. 80 per acre per watering. While for lifting water from stream or well, farmers have to spend about Rs. 630 (for 38 litres diesel) or the first watering, and about Rs. 270(for 15 litres diesel) on the following 13 to 15 watering. Farmers must pay Rs. 3,000 for use of 5 hrp. pump year round. Through electricity rates are subsidized for agriculture, supply is very uncertain, therefore, farmers prefer diesel pumps over electric pumps. There is less expenditure on labour, as only during harvesting time is there a labour requirement. With the introduction of sugarcane cooperatives, harvesting is done by machines at nominal charges, and farmers get an assured price for their crop. Therefore, with less labour and economic investment, farmers can earn an income of Rs. 39,600 from only one acre of sugarcane. Table 9 gives data on input, output, and net income from sugarcane cultivation.

Table 9: Per Acre Input Cost of Sugarcane Cultivation (in Rs.)

Components	Expentiture
Seeds (sugarcane stems)	1000
Sowing	4000
Fertilizer	4600
Pesticide	1000
Irrigation	1000
Weeding	1000
Watchman	1000
Harvesting, loading and unloading	2000
Total cost of inputs	**16,400**
Per acre production of sugarcane	700 quintals
Value @ Rs. 80 per quintal	56,000
Net Income	**39,600**

Source : Field work 1999

In the Kakadiamba and Chopdavav canal command area, farmers grow paddy, cotton, and pigeon pea in the kharif season. With the availability of canal irrigation they have shifted to a high yielding variety of cotton in kharif, and groundnut and mung in summer. Assured of availability of water throughout the year, some have shifted to mono cropping of banana. A one acre banana plantation provides a net income of 2,30,000 in one year. Table 10 indicates input, outputs, and net income derived from banana cultivation. Banana can be multiplied so that the farmer does not have to spend money or buying saplings each time. Seeing the economic benefits, many farmers are now shifting to banana plantation.

Table 10: Per Acre Input Cost of Banana Plantation in the Kakadiamba Canal Area.

Input Components	Per acre expenditure (in Rs.)
Cost of saplings (Rs. 10 per plant for 2200 plants)	22000
Cost of planting saplings @ Rs. Per sapling	2200
Urea (100 kg)	4000
DAP (200 kg)	1660
Sulfate (300 kg)	1140
Organic Manure	6500
Watchman	7000
Harvesting	4400
Transportation to market	1100
Total Cost of input	**50000**
Per Acre Production of banana	400 quintals
Value @ Rs. 700 per quintal	2,80,000
Net income	**2,30,000**

Source : Field work 1999.

About 100 sample farmers (mainly women) said that, at present, different crops are grown in the area and they get a variety of food to eat, which meets their requirements of nutrients, vitamins, and minerals. Out of 219 sample farmers, 177 (180%) farmers expressed concern that the increase in area under sugarcane and banana will reduce the area under food crops, and ultimately, locally available nutritious food.

Increase In Nutrition Intake

An attempt has been made to calculate the total production of calories and protein, before and after canal irrigation was introduced in the command areas. A total of 6,682 acres of land (refer Table 3) is covered under canal irrigation. Before irrigation was introduced, these areas were producing low amounts of calories, protein, and other nutrients. After canal irrigation was introduced, production of nutrients (calories, protein, and other nutrients) has increased remarkably, and now there is a surplus. This surplus can meet the requirements of other people also. Tables 11 and 12 give data on production of calories and protein before and after the introduction of canal irrigation.

Table 11: Production of Calories and Protein in the Command Areas Before Introduction of Canal irrigation.

Crops	Area in acre	Yield/acre (quintals)	Production (quintals)	Calories (per 100 g)	Total Calories (in'000)	Protein (per 100 g)	Total protein (in'000)
Paddy	2240	5	11200	349	3908800	8.5	95200
Maize	2813	4	11252	342	3848184	11.1	124897
Jowar	1047	2	2094	349	730806	10.4	21778
Cotton	40	3	120	0	0	0	0
Pigeon pea	275	2	550	343	188650	25.5	14025
Black gram	185	1	185	350	64750	24.6	4551
Vegetables	82	5	410	38	15580	2.3	943
Wheat	0		0	0	0	0	0
Gram	0	0	0	0	0	0	0
Groundnut (summer)	0	0	0	0	0	0	0
Banana	0	0	0	0	0	0	0
Sugarcane	0	0	0	0	0	0	0
Total	6682				8756770		261394

Source: M. Swaminathan, Principles of Nutrition and Dietetics, 1986, Field work 1999, AKRSP(I) records 1999

Table 12: Total Production of Calories and Protein in the Command Areas After introduction of Canal Irrigation.

Crops	Area in acre	Yield/acre (quintals)	Production (quintals)	Calories (per 100 g)	Total Calories (in'000)	Protein (per 100 g)	Total protein (in'000)
Paddy	2901	15	43515	349	15186735	8.5	369878
Maize	1450	5	7250	342	2479500	11.1	80475
Jowar	363	3	1089	349	380061	10.4	11326
Cotton	814	7	5698	0	0	0	0
Pigeon pea	275	6	1650	343	565950	25.5	42075
Black gram	185	1	185	350	64750	24.6	4551
Vegetables	254	20	5080	38	193040	2.3	11684
Wheat	600	10	6000	348	2088000	11.5	69000
Gram	151	4	604	361	218044	17.1	10328
Green Gram(mung)	1100	5	5500	351	1930500	24.5	134750
Groundnut (summer)	1746	6	10476	549	5751324	26.1	273424
Banana	110	400	44000	66	2904000	1.4	61600
Sugarcane	300	700	210000	3.9	819000	0.01	2100
Total	10249		341047		32580904		1071191

Source: M. Swaminathan, Principles of Nutrition and Dietetics, 1986, Field work 1999, AKRSP(I) records 1999.

After the introduction of canal irrigation, production of calories has increased approximately 3.8 times from 87,56,770 thousands to 3,25,80,904 thousands. Production of protein has increased about four times, from 2,61,394 thousands to 10,71,191 thousands. On the basis of calories and protein requirements of agriculture workers for one year, the canal command areas were able to meet the calories requirements of 7,739 persons and the protein requirements of 14,322 persons before canal irrigation was introduced. After the introduction of canal irrigation, these areas could meet the calories requirements of 28,794 persons and protein requirements of 58,695 persons (see Table 13) (Average calories and protein requirements have been calculated on the basis of intake for heavy work (agriculture as recommended by the Indian Council of Medical Research (see Table 14). Thus the area moved from being calory deficient, to surplus in both calories and protein.

Table 13: Production of Calories and Protein, anf Fulfillment of Requirements, Before and After Introduction of Six Canals in Satpura Region.

Nutrients	Before canal irrigation	After canal irrigation	Increase
Calories (in '000 cal)	87,56,770	3,25,80,904	272%
Satisfies calories requirement of no. of persons for one year @3100 calories per day	7,739	28,794	272%
Protein (in '000 g)	2,61,394	10,71,191	311%
Satisfies Protein requirement of no. of persons for one year @50 g protein per day	14,322	58,695	311%

Table 14: Recommended Intake of Calories and Protein for Agriculture Workers.

Particulars	Calories	Protein
Male	3900	55
Female	3000	45
Children	2420	51
Average	3100	50

Per person per year requirement of calories : 3,100 x 365 = 11,31,500
Per person per year requirement of protein : 50 x 365 = 18,250

(The number of beneficiary families in the command area is 1,895. The average size of a family in the Bharuch area is around 6. Therefore, the total number of beneficiaries in the canal-irrigated area is 1,895 x 6 = 11,370.)

The beneficiary farmers grow both food and commercial crops with canal irrigation. Extra Production of food crops provide extra calories, protein, and other nutrients like vitamins and minerals, and the increased production can meet the food requirements of about 2800 persons for the whole year. Non-beneficiary farmers also get work on beneficiaries' farms, as the crop intensity has increased and more labour is required. This way the purchasing power of non-beneficiaries has also increased and they can buy extra calories and protein in terms of extra food. Out of 30 sample non-beneficiaries 21 (70%) indicated that their purchasing power has increased for buying food items.

Table 15 shows that before canal irrigation arrived, one acre used to produce 1,31,0501 calories which could meet the calories requirement of one person for 422 days. The average family size in Bharuch is 6; therefore, one acre could provide food for only 70 days for a family. Families with less than 5 acres of land could not support their families solely from agricultural activity. After canal irrigation materialized one acre can now produce about 4,875,920 calories which can meet the calories requirements of one person for 1,573 days and of a family of six members for 262 days. Earlier per acre production of protein was 39119 grams which can meet the requirements of one person for 782 days and of a family of six members for 130 days. After canal irrigation was introduced the per acre production of protein has increased to 1,60,309 grams which can meet the requirement of one person for 3,206 days and of a family of six members for 534 days. It is important to note that if adequate calories are not provided by carbohydrates and fat, a part of the protein is used up as calories. This means if the diet is deficient in calories and rich in protein, protein gets converted into calories (energy) and enough protein is not available for body growth. Before canal irrigation arrived, enough calories were not available in the local diet, and protein, which is a rich and expensive nutrient, was being converted into calories. Therefore the diet remained protein deficient. After the arrival of canal irrigation enough calories/carbohydrates are available from other sources. Therefore, protein does not get converted into calories. Thus, after the introduction of canal irrigation, a farmer having 2-3 acres of land can easily meet the food requirements of his/her family. Earlier small farms were not sustainable and farmers had to depend on other sources of income.

Similarly, production of vegetables (cluster beans, cow pea, brinjals, ladies fingers, tomatoes, pumpkin, bittergourd, ashgourd) and fruits (mango, banana, guava, black berry) has increased refer Table 3). Fruits and vegetables are rich sources of minerals and vitamins, and help in maintaining the health of human beings. Since more fruits and vegetables are grown locally, people have easier access to them. Out of 100 sample women, 77 have expressed their satisfaction about the quantity and variety of food; the remaining 33 were partially satisfied, as they felt that although there was an ability of sufficient calories, protein, vitamins, and minerals in the diet, the general health of the people is improving. Out of 249 sample farmers (beneficiaries and non-beneficiaries) 161 farmers (65%) expressed that due to increase in availability of food they feel more energetic. Their number of days of sickness has also reduced.

Table 15: Per acre Nutrient Production Before and After Canal Irrigation.

Nutrients	Before	After
Calories (Kcal)	1310501	4875920
Protein (grams)	39119	160309

Source: Based on M. Swaminathan, Nutrition and Dietetics, 1986.

Impact on Migration

Migration in all the canal villages has reduced significantly in terms of the number of days of migration and number of persons migrating. The number of persons migrating for labour work has reduced by 60 to 75 per cent in all the canal areas. Of those who are still migrating, the number of days of migration has gone down from 150 days per year to 90 days per year. Farmers who were earlier cultivating only in kharif have started cultivating part of their land in rabi and summer also. Earlier after the kharif season, farmers used to migrate; now they stay

back. Landless labourers now migrate for a shorter period, as they get work within the villages. As availability of fodder has increased, the number of animals also has increased. Owing to availability of nutritious fodder from groundnut, maize and vegetable crops, the yield of milk has also gone up. Many landless farmers have now adopted animal husbandry as an occupation, and have stopped migrating. It also provides an extra income of about Rs. 2,500 per year per family. Many landless now get regular jobs as watchmen in sugarcane and banana fields. These are one year crops and need watchmen for protection and watering. Table 16 shows household wise migration pattern before and after canal irrigation in Pankhala village of the Chopadavav canal area.

Table 16: Migration Pattern Before and After Canal Irrigation in Chopadavav Canal Area.

Farmer Category	No. of Households	Migration before Canal Irrigation		Migration after Canal irrigation	
		Households	Percentage	Households	Percentage
Landless	75	70	93%	42	56%
Small and marginal	30	30	100%	0	0%
Medium	20	20	100%	10	50
Large	25	1	4%	0	0%
Total	150	121	80%	52	35%

Source: Reproduced from Niraj Joshi, Impact of AKRSP(I) Intervention On Migration In Bharuch Programme Area, Aga Khan Rural Support Programme (India), 1998.

Farmers have started growing two to three crops, and as production has increased they need more labourers to work in their fields. This way the landless get work within the village, for 100 to 120 days in a year. Out of 219 farmers', 158 farmers informed that as availability of fodder has increased from crop residue, there is an increase in the number of animals. Increase in the availability of fodder from crop residue, conversely decreases the frequency of days spent in collecting fodder. Out of 100 sample women, 42 women said that now they rarely have to go for collection of fodder. According to 138 (63%) sample farmers, there is an increase in the yield of milk, as animals now get better quality fodder to eat.

Impact on Women

Owing to a reduction in migration, women can now stay back in their village, and can work according to their convenience. About 55 percent sample women said that reduction in migration has reduced their stress and strain. During the period of migration they lived in unhealthy conditions, which used to affect their mental and physical health. When women stay back in their village, children can have a settled life and can attend school regularly. Out of 219 farmers, 166 (75%) farmers said that the average number of school going days of their children has increased from 75 to 140. owing to improved economic conditions, people can buy books and children can study seriously. Now the children do not have to go for work to support their families. During their free time, children can play and enjoy their childhood.

Owing to increased availability of crop residue as fodder, the number of milch animals is increasing. Usually, women take care of animals and the extra income earned through animal husbandry goes to them. In general the economic condition of women has improved, but their workload also has increased. All the 100 sample women said that there is no reduction in the drudgery. Women still have to get up early in the morning for collection of firewood. As the number of animals is increasing, women spend more time on taking care of them. The workload of women has also increased because of increase in the intensity of irrigation and therefore, the number of cropping seasons. Earlier women used to work about four hours in a day, whereas now they have to work seven hours in a day for agriculture operations alone.

Inspite of the increased workload, women do not complain, because their family income has increased five to six times. Out of 100 sample women, 74 sample women said that they get enough food to eat, which keeps them healthy. Overall canal irrigation has helped in improving the quality of life of women.

Impact On Environment

At present the impact is very positive. Farmers grow a combination of crops like grains, pulses, cotton, groundnut, vegetables and fruits. But if precautions are not taken, farmers will slowly shift to mono cropping of sugarcane and banana. At present out of 219 sample farmers 47 (21%) farmers grow sugarcane or banana and another 53 farmers are planning to shift. During the discussion, farmers expressed the fear that while commercialization of agriculture might make them earn more money, they will not get nutritive food. Their dependency on outside food will increase. Everybody may not have access to enough food. Out of 219 sample farmers 82 farmers indicated that if food is grown locally, farmers do not mind sharing it with their neighbours, friends, and relatives. But if they have to purchase food they rarely share it with others. Even if they have money, they will not buy food for others. Banana is nutritious, but it cannot be a substitute for other food items like grains, pulses, and vegetables. Five women from banana growing farmers' households and 12 women from sugarcane growing farmers' households indicated that earlier when they used to grow grains, pulses, and vegetables, they had easy access to food items. But now they have to depend on male members of the household, and therefore many times they may not get the required items in time. According to 21 banana and sugarcane growing farmers, the economic benefits are very high from sugarcane and banana cultivation therefore, chances of other farmers shifting from multi-cropping to mono cropping are also very high. When this happens farmers, will also suffer from long term social and environmental loss in terms of deterioration in land fertility and nutrient deficiency. The farmers have started realizing the problems with mono cropping, but they do not see any better alternative. Therefore, they are sticking to this cropping pattern. A total of 25 sample farmers informed that sugarcane required 14-16 waterings of 16 inches depth during the cropping period. Once sugarcane is planted it remains in the field for two years. After the first harvest there is no need to uproot the plant; from the same plant, a second harvesting can be done. If water stands in the field continuously for two years it will certainly harm the soil. After the second harvest of sugarcane, farmers take a short duration crop of two to three months, and then plant sugarcane again. In the case of banana, the crop stands one year in the field and in the second year offshoots of the same plants are replanted. This way land is not kept fallow for regenerating its fertility.

If we look at the economic benefits, sugarcane and banana crops are beneficial, but from the environmental point of view continuous cultivation of sugarcane and banana can prove hazardous. Based on the author's study in the Ukai command area in Surat district, and the studies done by others, it can be said that excess use of water will result in water logging and salinity, which will decrease land fertility. During the study 16 sugarcane farmers admitted that they were using lots of water, and their fields remained wet throughout the cropping season. They are also experiencing more pest attacks than before. At the head of the canal plenty of water is available, and therefore farmers use chemical fertilizers very liberally as they respond positively to water. The average use of fertilizer has increased by two to four times. Since the area is largely tribal, traditional farming was practiced. As farmers got exposed to other agricultural inputs, they started using chemical fertilizers. After the introduction of canal irrigation, farmers increased the doses of chemical fertilizer. In the Kakadiamba and Pingut canal areas use of chemical fertilizers has increased from 50 kg per acre to 200 kg per acre. In sugarcane and banana fields, use of chemical fertilizers has increased phenomenally from 100 kg per acre to 700 to 800 kgs per acre. Now farmers have started realizing the problems associated with chemical fertilizers. Prolonged and continuous use of chemical fertilizers results in land becoming hard and losing its porosity. Out of 219 farmers, 52 (23%) farmers said that in order to maintain the yield, they have to increase the dosage (2% to 5%) of chemical fertilizer every year. Harshadbhai of Sim Amali village in the Kakadiamba canal command area said that he had been using chemical fertilizer since 1990. When he realized that constant use of chemical fertilizers led to reduction in land fertility, he switched over to organic manure in 1997. In his three acres of land, Harshadbhai applies 20 tractors load of organic manure (One tractor load contains 4-5 tones of organic manure.)

There is another aspect worth noting. Sugarcane farmers are located on the head side of the canal, and they use the maximum amount of water, leaving less water for tail enders. In Hathakundi village in the Pingut canal command area, tailenders received only four waterings in 1999, instead of eight, for their summer crops of green gram and groundnut. In Ghodmung village in the Kakadiamba canal command area, tail end farmers suffered because they did not get the last watering in time for their mung crop.

Availability of water has led to farmers taking as many crops as possible. Earlier they used to cultivate one or two crops, and for the remaining periods their land was kept fallow, particularly in summer. Owing to heat, pests were destroyed, and farmers rarely faced any pest attack. After the introduction of canal irrigation, farmers in the command area started taking two to three crops, and land is rarely kept fallow. Continuous irrigation generates a favourable environment for different pests. According to 60%of the sample farmers, over a period of time, the frequency of pest attacks has increased. In the last seven ears, use of pesticides has increased by three times, from 300 ml to 1 litre for groundnut and paddy, eight times, from 500 ml per acre to 4 litres per acre, for cotton, and 10 times, from 800 ml per acre to 8 litres, in sugarcane and banana in all the six command areas. Out of 219 sample farmers, 153 (70%) farmers reported that their consumption of pesticides has increased from two to ten times depending on the type of pests. Other farmers reported that they used very little pesticide and that too only when necessary. About 60 percent of the sample farmers indicated that with excessive use of pesticides, many predators of pests were also killed. Many farmers reported a decrease in the number of useful birds along with the increased use of chemical pesticides and cutting down of tree for acquiring more land for cultivation. Some farmers narrated the case of bagala (egrets). During the rainy season egrets used to come to fields and eat termites and other pests which are harmful to the crops. Usually egrets live on banyan trees. Now not many egrets are seen, owing to a decrease in the number of banyan trees. As a result, pest attacks have also increased. According to the older generation farmers, there is a need to grow shady trees like banyan in which birds can build their nests. They suggested that with increasing irrigation, the number of trees should also increase. This will attract species of birds, which live on different pests.

Farmers earlier used traditional methods of pest control depended on nature for dealing with pests. During the field visit an interesting experience was narrated by a couple (Shantubhai and Urmilaben) from Punpunjia village in the Lakhigam canal area. Their mung crop was attacked by pests. While other farmers used pesticides, Shantubhai and Urmilaben decided neither to use pesticide nor to water the crop. After 15 days they noticed that all pests had disappeared. They then watered the crop and, to their surprise, the mung plants sprouted once again. This farmer couple could harvest a normal crop this year without expense. On the contrary, farmers who used pesticides spent a lot of money to save their crop.

Though plenty of dung is available, farmers are not using it as manure. One tractor of 20 bullock carts (40 quintals) of manure costs only Rs. 70; still people use chemical fertilizers which cost more (price of DAP is Rs. 450 for 50 kg and of urea is Rs. 193 for 50 kg). For one acre, farmers use one bag of chemical fertilizer, while one tractor of manure is enough for two acres. Interestingly an increase in the number of animals, and therefore manure did not result in an increase in the use of organic manure.

According to the local village leaders, and many experienced farmers, there is a need to make farmers aware of the environmental aspects of irrigation. While a few farmers are careful about using canal irrigation and adopt a balanced cropping pattern, many are ruining the land by using excess water and adopting mono cropping. Excessive use of chemical fertilizers might extract nutrients from neighbouring fields and deteriorate those soils also. If a few farmers use extra water for commercial crops like sugarcane and banana, many other farmers may be deprived of water for their foodgrain crops. Only if each farmer adopts a balanced cropping pattern, the equity in water use can be maintained.

CONCLUSION

Minor canal irrigation projects with a command area below 1000 acres can be socially beneficial, economically viable and environmentally friendly, provided planning is done very carefully. Minor canal projects can be built with less technical skills; even villagers with rudimentary training can construct minor canals. Through minor dams, river water can be used in an optimum way. Through AKRSP(I) supported canal projects, cropping patterns have changed and agriculture production has increased. The number of days of migration has come down from 150 days to 90 days. The quality of life of women and children has improved, along with a general improvement in the life style of the people. While the present situation is good, excessive use of water by sugarcane and banana farmers will ultimately lead to inequality in distribution of water and deterioration of soil because of waterlogging. Looking at the significant economic benefits, many farmers are likely to shift to commercial crops. This may weaken the biodiversity of the area. There is an urgent need to make villagers aware of the social and environmental dangers of non-judicious use of canal water. A serious campaign should be started for balanced use and equal distribution of water. Like other natural resources, water must be with care. In the words of Gandhiji – “There is enough for everyone’s need, but not everyone’s greed”.

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