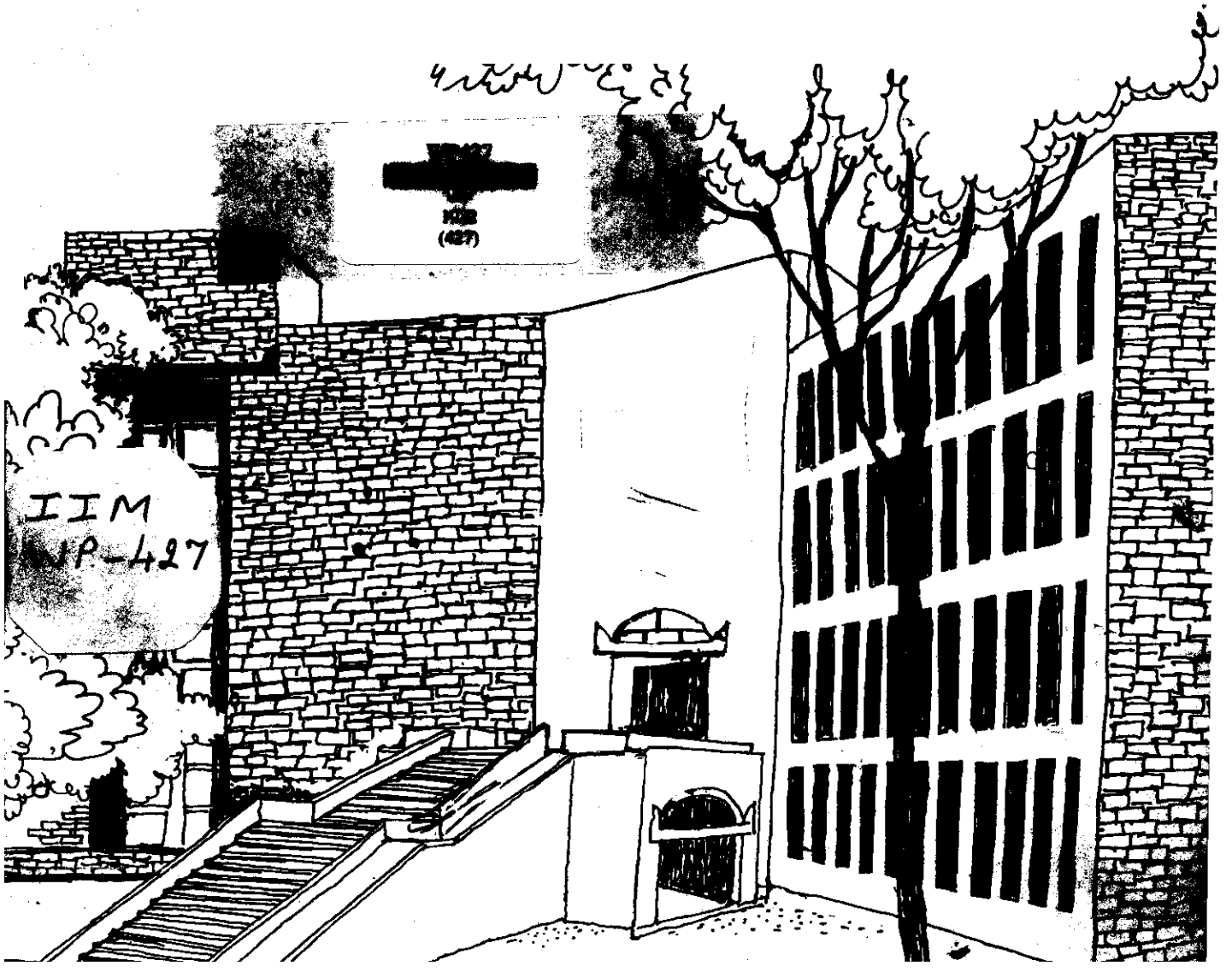
विद्याविनियोगाद्विकासः
IIM
AHMEDABAD

W. P.: 427

Working Paper



SUGARBEET CULTIVATI ON IN INDIA

by

Gurdev Singh

&

Amar Guleria

W P No. 427

June 1982

The main objective of the working paper series of the IIMA is to help faculty members to test out their research findings at the pre-publication stage.

INDIAN INSTITUTE OF MANAGEMENT
AHMEDABAD-380015
INDIA

Sugarbeet Cultivation in India

1. Introduction

The origin of commercial cultivation of sugarbeet for sugar goes back to the experiments of Andreas Sigismund Markgraf (a distinguished German Scientist) in the early 18th century. He recognised the presence of sugar in some temprate plants and found that sugar manufacture from these plants was feasible. White beet was found superior in this respect. Sugar was manufactured from sugarbeet for the first time towards the end of 18th century. In 1840 sugarbeet sugar contributed about five percent to the world sugar production. This contribution increased to about 50 per cent by 1880 and over 60 per cent by 1900. After some set-backs during the world wars sugarbeet sugar once again attained its status, and currently it accounted for over 50 per cent of the total world sugar production.

Sugarbeet (Beta-vulgaris) being a temprate crop is grown in temprate regions as a summer crop. But in the past couple of decades its cultivation was extended to sub-tropical regions where winter season approximately meets its climatic requirements. It thrives best in the loose fertile soil preferably loam or clay loam, deep enough for roots to grow. The soils should sufficiently retain moisture to encourage continuous growth. It grows well on neutral to slightly alkaline soils. The crop can tolerate fairly salt content and alkalinity in the soil. The crop can also be grown on acidic soils after amending it with lime. Overliming, however, affects the yield adversely.

In India, though sugarbeet crop was introduced as early as 1914 at Indore and subsequently in a few other places, systematic studies on different aspects of beet cultivation were started by the Indian Institute of Sugarcane Research, Lucknow only in 1959. Its cultivation was extended to certain sugarcane research stations and agriculture farms in various states in 1960-61. Cultivation of sugarbeet was initiated at G.B. Pant Agricultural University in 1964. On the basis of experiments till 1969 on cultivation at different places in the country, it has been established that sugarbeet could be successfully cultivated in the irrigated plains of Punjab, Haryana, Rajasthan and West UP. Encouraged by the results of these experiments, ICAR in 1970 launched an All India Coordinated Sugarbeet Project with Pantnagar, Lucknow, Kanpur in UP and Srinagar in J & K as main centres and Jullunder (Punjab) Hissar (Haryana) and Sri Ganganagar (Rajasthan) as sub-centres. Under a centrally sponsored scheme sugarbeet was introduced in one factory area in each of the states of Punjab, Haryana, UP, Rajasthan, Maharastra, Tamil Nadu in the V plan and a pilot plant size diffusion unit was installed at the selected sites.

The researches established that sugarbeet can successfully be grown as a winter crop in northern Indian states. Gujarat and Maharastra had shown a fairly good potential for the crop. The important advantages perceived of this crop were:

i) Sugarbeet is a 6 to 7 months crop yielding 30 to 50 tonnes of roots with a sugar content of 15 to 16 per cent. The

expected recovery was 10 to 12 per cent. Thus, it could produce as much sugar as 12 months sugarcane crop could, if not more, But due to shorter duration the yield of sugar per hectare per unit of time would be higher from sugarbeet than from sugarcane.

ii) After harvesting sugarbeet a kharif crop can be grown. In otherwords the productivity of land can be enhanced considerably.

iii) Sugarbeet and sugarcane could be grown as companion crops resulting maximum production of sugar per unit area.

iv) Sugarbeet has high tolerance to frost and cold which are prevalent in northern Indian States and which are not conducive to the growth of sugarcane.

v) Being tolerant to high pH sugarbeet has technical advantage over sugarcane or any other crop in alkaline areas of Punjab, Haryana and West UP.

vi) Beet being a root crop, it helps in improving the soil and less tillage was required for the following crop.

vii) Beet tops (foliage) are nutritive fodder for livestock at the times when no other green fodder was available.

viii) Beet pulp makes a good material for animals feed especially when mixed with adequate quentity of molasses.

ix) Molasses from beet is a rich source of vitamin B and is therefore a valuable raw material for pharmeceutical industry. These could be used in the manufacture of alcohal.

x) Processing of sugarbeet in a sugarcane processing unit would prolong the processing period and thereby would reduce the cost of manufacturing sugar. At the same time it would ensure increased employment of labour at the factory.

Encouraged by the results achieved in cultivation of sugarbeet and in manufacture of sugar from it, the Ganganagar sugar Mills Ltd., Sri Ganganagar (Rajasthan) installed in 1970-71 a sugarcane-cum-sugar-beet diffusion unit for processing 1200 tonnes of sugarcane and 600 tonnes of beet per day. The plant faced difficulties in the initial stages because of lack of irrigation and problems of matching capacity of different units in the factory. However, subsequently, the achivements were quite encouraging.

The recommendations of National Commission on Agriculture, various committees and workshops during seventies emphasised the need for development of sugarbeet and its introduction by the existing sugar factories particularly in Punjab, Haryana, Western UP, Bihar, Rajasthan, Tamil Nadu and Karnataka and in some other states that might be interested in the venture. Currently the Government of

India, Ministry of Agriculture, has expressed interest for the study to examine economic aspects of beet cultivation and processing. The present study taken up by the Indian Institute of Management, Ahmedabad aimed at analysing various aspects of sugar production through beet. This paper forms a part of the larger study. Its scope is restricted to the cultivation of sugarbeet in Sri Ganganagar.

2. Sugarbeet Cultivation and Processing at Sri Ganganagar

2.1 Suitability of the Area

Sugarbeet requires a fairly cool climate, good rainfall or irrigation and bright sunshine during its growth period. Climatic conditions approximating to its requirements are met with during winter season in Sri Ganganagar district of Rajasthan. The district has sandy loam to loam soils with almost neutral reaction which are best suited to sugarbeet. The only constraint was low rainfall and inadequate irrigation water. Moreover, wheat and cotton were equally remunerative crops in the area. It was realised that to make this new crop acceptable to the cultivators some incentives were essential. Accordingly the state government agreed to provide extra water for this crop. Also in the initial stages seed was provided at 100 per cent subsidy which was subsequently withdrawn by stages. The supply of fertiliser and pesticides for this crop

were also arranged through the mill on credit with the Rajasthan Bank Ltd.

2.2 Achievements

As pointed out earlier sugarbeet cultivation was introduced in Sri Ganganagar in 1970-71. The achievements till 1980-81 are shown in Table 1. The data in the table showed that targetted area increased till 1973-74. It remained stable between 1973-74 and 1977-78, reduced to about 2/3rds in 1978-79 and was unchanged since then. It was, in fact, the last years actual area and the yield which resulted in changes in the targetted area for the current year. In the earlier phases the targetted area was bound to increase to economically utilise the capacity. But due to improvements in yield and increase in area under beet, it was not possible for the mill to process the entire production in the normal processing period in 1976-77 and 1977-78. Therefor, from the subsequent year (1978-79), the targetted area was reduced and hence the actual sown area was also decreased.

Looking at the yield, which was more determined by irrigation water supply than any other input, it remained stagnant at very low levels till 1974-75. In the next three years it increased to about fourfolds. In 1979-80, however, it dived down to 60 per cent of the previous level but recovered to some extent in 1980-81 when it was recorded at 21.2 tonnes per hectare. One of the reasons for the

Table 1 : Targetted and Actual Area, Yield, Prices, and Sugar Recovery from Sugarbeet in Sri Ganganagar, Rajasthan (1970-71 to 1980-81)

Years	Area (ha)		Actual as % of target	Yield (tonnes/ha)	Price (Rs/tonne)	Sugar recovery (per cent)
	Target	Actual				
1970-71	200	100	50	8.8	92.1	3.55
1971-72	800	456	57	8.2	90.0	6.26
1972-73	1000	760	76	15.0	120.0	8.57
1973-74	1200	1125	94	8.4	120.0	10.20
1974-75	1200	714	60	7.9	150.0	9.78
1975-76	1200	1223	102	19.8	160.0	10.61
1976-77	1200	1200	100	27.4	160.0	9.78
1977-78	1200	1120	93	30.0	160.0	9.10
1978-79	800	650	81	29.4	130.0	11.32
1979-80	800	743	93	17.6	160.0	11.10
1980-81	800	675	84	21.2	250.0	10.15

Source: Office of the Chief Executive Officer, The Ganganagar Sugar Mills Ltd., Sri Ganganagar, Rajasthan.

low yield during 1979-80 was the drought conditions prevailed in the area. The canal water supply was not adequate. Another factor affected the yield during 1979-80 was the reduced procurement price paid in the previous year, which discouraged the farmers to use enough of other inputs such as fertilizer. The recovery reached to 10.61 per cent in 1975-76 but reduced to 9.10 per cent in 1977-78 because of excessive production. It reached to the ever high of 11.32 per cent in the subsequent year when the area under beet was reduced to suit the capacity of the mill and the processing was completed in the normal processing period. It went down marginally in the following year because of poor crop and in 1980-81 by about one percentage point because of scarcity of irrigation water in that year.

On the whole there were wide variations in the area sown, yields obtained, and recovery of sugar from sugarbeet. Apart from the explanations discussed in the preceeding pages for such variations one might want to understand what had happend at microlevel. For the purpose we have drawn a sample of growers, dropouts and non-growers for a cross-sectional analysis. In what follows, therefore, is the details of a micro study.

3. The Sample.

Since commercial cultivation and processing of sugarbeet were carried out at Sri Ganganagar only, the present study was located in that area. The study aimed at analysing various aspects of sugarbeet

cultivation by the sample farmers. The objectives of the study were:

i) to study awareness, adoption and diffusion of sugarbeet in Sri Ganganagar area;

ii) to examine the economics of sugarbeet cultivation in comparison with sugarcane and other competing crops in the area; and

iii) to discuss the policy implications of the analysis on the expansion of beet cultivation in the study area and in North India.

To carry out these objectives a sample of farmers from the selected villages was drawn as in the following manner. Sugarbeet was grown in 54 of the 255 villages of Ganganagar Tehsil in 1980-81. These villages were grouped into four groups on the basis of number of beet growers as given below:

Number of beet growers	No of villages
1 to 2	19
3 to 10	11
11 to 20	9
More than 20	15
Total =	54

Since there was limited choice in the selection of growers from villages with one or two growers, we did not consider this group of villagesfor our sample. From the remaining three groups three villages from each of the groups were selected representing distance and the direction from the mill. The selected villages are given as below:

Group 2 : 15ML, 2e and 13z

Group 3 : 3HH, 6a and 17z

Group 4 : 25ML, 27gg and 8y

Another village, 7a was selected to get an adequate number of non-adopters (discussed below).

A list of sugarbeet growers in the selected villages was prepared in ascending order of the area under beet. In majority of the cases all the farmers of the village had grown beet in 1980-81. A sample of 30 growers (about 20 per cent of the total growers) from the selected villages was randomly drawn. To study the awareness, adoption and diffusion, by the farmers we have also selected 10 drop-outs from four of the nine selected beet growing villages. Similarly we decided to select 10 non-adopters also. We however, could not find the required number of non-adopters from these nine villages. Therefore, another village was selected to complete the sample. One non-adopter, however, did not provide adequate information and hence was not included in the analysis. The final sample is shown in

Table 2: Distribution of Selected Farmers Among the Selected Villages

Name of Village	Number of growers		Number of non-growers	
	Total	Selected	Dropouts	Non-adopters
3 HH	15	4	-	-
15 ML	6	1	4	5
25 ML	28	5	-	-
6 a	17	5	-	-
7 a	-	-	-	4
2 e	6	2	4	-
27 gg	22	4	-	-
8 y	43	5	1	-
13 z	3	1	-	-
17 z	17	3	1	-
Total	157	30	10	9

4. Awareness, Adoption and Diffussion of Beet Cultivation

Though sugarbeet was first introduced in 1970 in Ganganagar Sugar Mill area when small quantity of beet was produced and processed, all the cultivators in the area did not become aware of the crop immediately, not even the then cane suppliers to the mill. On the other hand two among the sample cultivators had known this crop prior to the trial run in 1970. By 1972, 45 of the 49 sample farmers became aware, where as the last unit in the sample reported 1977 as the year of his awareness of this crop (Table 3).

A majority of the sample farmers (39) got the first information on beet from the mill personnel. Another nine reported fellow farmers as their source of information on beet. The remaining one came in contact with the personnel of National Seeds Corporation and became aware about beet. It implied that the departmental extension service did not play any role in creating awareness among the farmers about this new crop enterprise even as late as 1977 when the last person in our sample reportedly became aware of beet cultivation. It was further observed that at least 50 per cent of the adoptors (growers and dropouts) became aware in the first two years of adoption of this crop in the area against only one of the nine non-adopters we selected for this study. It was further noticed that 24 of the 40 adopters had grown this crop for the first time within two years of their awareness. Another eight took two to five years and the remaining eight took more

Table 3 : Awareness of Sample Farmers About Sugarbeet

Year	Awareness			Source of information			
	Growers	Dropouts	Non-adopters	All farmers	Mill personnel	Fellow-farmers	Others
Upto 1971	4	1	-	5	4	-	1
1972	10	4	1	15	13	2	-
1973	13	5	7	25	18	7	-
1974	-	-	1	1	1	-	-
1975	1	-	-	1	1	-	-
1976	1	-	-	1	1	-	-
1977	1	-	-	1	-	1	-

than five years to decide the adoption of beet cultivation. Table 4 shows that as many as six of the growers of 1980-81 had cultivated beet for the first time. Why some of the farmers took such a long time for adoption, and why some of the adopters discontinued beet cultivation after one or more trials, could be due to many reasons. The policy of the mill about the adoption of villages for cultivation of sugarbeet could be one of the important reasons. In principle, all the cultivating households must grow sugarbeet on a minimum area proportionate to their operated area. Therefore, if some of the cultivators in a village did not agree to grow sugarbeet that village was dropped from the selection by the mill. Therefore, even the cultivators desirous of growing beet were not able to do so because of this policy. Though in practice the policy was not strictly followed and it was left to the cultivating households of the village to allocate the minimum required area under beet among themselves. The policy hastened the adoption in some cases and delayed in some other cases. Similarly, the dropouts may not be genuine dropouts as is evident from readoption for the second and even for the third time. Therefore, adoption and diffusion were constrained by such interversions and may not be considered as normal behaviour of the individuals.

As shown in Table 4, 10 of the 40 adopters were dropouts (by selection) till 1980-81. Even among the remaining 30 current growers, only 10 were continuing growers, i.e., those once adopted beet

Table 4 : Adoption of Beet Cultivation by Sample Farmers

Year	Fresh adopt-ers	2nd time adopters	3rd time adopters	All growers	1st time dropouts	2nd time dropouts	All dropouts
1971-72	9	-	-	9	-	-	-
1972-73	9	-	-	15	3	-	3
1973-74	3	1	-	17	2	-	4
1974-75	4	1	-	20	2	-	5
1975-76	5	2	-	21	4	2	9
1976-77	1	2	1	21	4	-	10
1977-78	1	1	-	17	5	1	15
1978-79	2	2	-	17	3	1	17
1979-80	-	1	-	17	-	1	17
1980-81	6	6	2	30	1	-	10
Total	40	16	3	-	24	5	-

cultivation had never discontinued. Among the remaining 20, six were fresh adopters of 1980-81 and 14 were readopters i.e., those who after the first adoption discontinued beet cultivation but readopted it again. Three of these 14 had discontinued beet cultivation twice i.e., they adopted it for the third time in less than 10 years of their first adoption. Table 5 gives the history of adoption of this crop by sample farmers. It shows that while each year (except 1979-80) there were fresh adopters, and 2nd and 3rd time adopters (since 1973-74), there were some dropouts also (since 1972-73). That was perhaps the reason that even among the 30 growers in 1980-81 only 10 were continuing growers and only seven had more than five years experience in beet cultivation. It was further observed that even among the discontinuing growers about 50 per cent had experience of more than four years in the cultivation of this crop. So and so two of the 10 dropouts fall in this category. There were only four dropouts (out of 10) who did not have adequate experience to rationally decide about discontinuing beet cultivation. If we look, into the adoption process it was relatively quicker. Even if for some reasons the farmers had to discontinue their subsequent readoption was not much delayed.

Unlike adoption, diffusion of beet cultivation was slow. On an average the per farm area under sugarbeet has increased (Table 6). The increments were rather small and towards the latter years there was a tendency to reduce area under beet perhaps because of large

Table 5 : Experience of Different Adopters in Beet Cultivation

Time in years	Adopters Groups			Time for adoption/dropout				
	continuing growers	Discontinuing growers	Drop-outs	1st adoption	2nd adoption	3rd adoption	1st drop out	2nd drop-out
1	-	-	1	17	6	2	5	1
2	-	-	3	7	5	-	7	3
3	2	3	2	5	2	-	6	1
4	1	4	2	1	-	-	4	-
5	-	1	-	2	1	1	-	-
Greater than 5	7	6	2	8	2	-	2	-
Total	10	14	10	40	17	3	24	5

Table 6: Diffusion of Beet and Its Yield on Sample Farms

(Area : hectares/farm
Yield: tonne/hectare)

Beet year	Fresh adopters		Continuing growers		Re-adopters		All growers	
	Area	Yield	Area	Yield	Area	Yield	Area	Yield
1971-72	1.51	400	-	-	-	-	1.57	40.0
1972-73	1.17	355	2.29	43.0	-	-	1.62	39.0
1973-74	1.83	291	1.74	41.2	0.25	44.0	1.67	38.8
1974-75	0.40	481	1.82	40.7	0.50	36.0	1.41	40.9
1975-76	2.62	294	1.69	37.0	2.75	42.9	2.02	35.4
1976-77	0.50	328	2.21	34.2	1.25	42.4	1.90	35.5
1977-78	0.50	368	2.73	35.9	1.45	45.0	2.20	37.7
1978-79	0.87	463	2.56	34.4	1.84	34.3	2.21	34.9
1979-80	-	-	2.50	35.4	1.58	39.3	2.18	36.4
1980-81	1.23	264	2.32	40.7	1.66	36.7	1.80	37.0

Table 6 (a): Attitude of Sample Cultivators Towards Sugarbeet Cultivation in Future

Category of cultivators	Continue growing/adopt beet cultivation				
	Only if price increases	Even at existing price	Even if price decrease	If additional water assured	Arrangements for disposal
	No. of cultivators				
Growers	-	9	21	30	24
Dropouts	3	2	-	9	8
Non-adopters	-	8	-	8	5
All cultivators	3	19	21	47	37

number of fresh adopters who put smaller area under beet. However, no specific trend in area allocation under beet was observed for any category of adopters. Surprisingly, even for the late adopters (fresh adopters) area under beet was not larger than the early adopters. The same was true for the 2nd and 3rd time adopters. The reason perhaps being the more or less stangnant productivity of beet as well as the village adoption policy of the mill. The yield experience was not exciting for either of the adopter groups. It showed a decreasing trend for the continuing growers and for readopters as well. For fresh adopters, however, no trend was observed, and variations over period were larger on these farms.

As shown in Table 6 (a) majority of the growers would continue growing beet even if the price of beet is marginally lowered, but assured irrigation and marketing were the important considerations in their decision about continuation of beet cultivation. Even nine and eight of the ten droupouts, respectively, asked for assured irrigation and easy disposal to readopt beet cultivation. Three of the ten, however, also demanded better price. Similarly eight and five of the nine non-adopters asked for assured irrigation and easy disposal as necessary conditions for their adoption of beet cultivation.

What we find about the adoption and diffusion of beet cultivation could be summed up as follows:

i) A large proportion of sample farmers took up beet cultivation immediately after the awareness.

ii) A large majority of adopters discontinued beet cultivation without adequate experience to rationally decide about the crop.

iii) Perhaps for the reason mentioned under (ii) above a large proportion of discontinuers took it up again without much waiting. This was true even for the third time adopters.

iv) Even the present dropouts were not averse to the crop. Many of them were willing to readopt it again if the conditions were favourable.

v) Even a majority of non-adopters were ready to adopt the crop if certain facilities were assured e.g. better price, extra irrigation, and assured and easy marketing.

5. Growing Sugarbeet in Sri Ganganagar - Recommended Practices.

Rotation:

Sugarbeet should be cultivated in long rotations with other crops so that it occupies the same field only after 4 to 5 years. This would avoid the chahces of infestation of pests and diseases. This was possible in Sri Ganganagar area to rotate sugarbeet on different plots but really no good combination of other crops with beet was feasible from better land use point of view.

Seedbed preparation

Sugarbeet requires good firm, well levelled seedbed free of clods, airpockets and undecomposed stabbles of previous crop but having sufficient moisture. It requires more moisture for germination compared to other winter crops. Three to four deep ploughings followed by planking each time were recommended. The desired quantity of well decomposed FYM/Compost should be throughly mixed with the soil well before sowing. Similarly basal dose of chemical fertilizer should be applied before sowing. In case of ridge sowing 15cm high ridges 45cm apart are recommended.

Sowing and seed rate

As mentioned above ridges at a distance of 45cms. are made for ridge sowing. In case of flat sowing also the distance between rows is kept the same. The seeds are dibble at 3 to 5 cm apart at a depth of 4 cm and 2.5 cm for early and late sowing respectively. Gamma BHC or Heptachlor are sprayed with water cans immediately after sowing followed by irrigation. In case of ridges, sowing ridges should not get submerged in water.

The normal sowing period spreads from End September to Mid-October. Late sowing reduces yield. Normally 10 Kg. per hectare of unpolished seed is required.

Thinning weeding and earthing up

Thinning is necessary because beet seeds are multi-germ seeds and more than one plant grows at each hill. Further because of mortality seed is sown at closer spacing. The recommended plant to plant distance after thinning is 20 cm. Thinning is recommended at 4 to 6 leaf stage when the soil comes into condition after irrigation. It must be done before the first top dressing. The unwanted plants are uprooted by hand leaving only one robust plant per hill and at plant to plant distance of 20 cm.

Weeding is done when necessary. Generally two to three weedings are required, one before thinning and one or two after thinning. Weeds are uprooted by hand or hand hoe to avoid injury to the roots. In case of ridge sowing earthing up is recommended at the time of last application of fertilizer.

Irrigations

Sugarbeet in Sri Ganganagar requires 8 to 10 irrigations. The first irrigation is given immediately after sowing and the last irrigation a few days before harvesting the crop. The remaining six to eight irrigations are spread over the growth period and are given when the need arises.

Chemical fertilizer

Sugarbeet requires 100 to 120 Kg. of nitrogen and 50 Kg. of phosphorus per hectare. It is considered desirable to provide

50 per cent of the nitrogen requirements in the form of FYM and the rest in two equal splits of chemical fertilizer. All the phosphorus must be applied as basal dose. In the absence of FYM, 1/3rd of the nitrogen and whole of the phosphorus should be used as basal application and the remaining nitrogen in two split top dressings within two months of sowing. The top dressings should accompany or immediately followed by irrigation.

Plant protection

The schedule of recommended plant protection practices for sugarbeet is given below:

a) Immediately after sowing one spraying of 5 litres of 20 per cent E.C. Gamma BHC or 20 per cent Heptachlor diluted in 3500 litres of water per hectare along with rows/on ridges with watering can followed by irrigation.

b) Repeat the above spraying after one month of sowing.

c) One spraying in March of 50 per cent EC Malathion diluted in 300-500 litres of water per hectare on foliage.

d) Repeat the above spraying in April.

The exact dates of (c) and (d) depend on the time of sowing of the crop.

Intercropping

Sugarbeet can be grown as a companion crop with sugarcane planted in autumn in Sri Ganganagar. Two rows of beet are sown between two

rows of sugarcane planted 90 cm. apart. Seed requirements of beet, therefore, are unchanged. The cultural practices and inputs requirements remain unchanged except the manurial requirements which are 240 Kg. of nitrogen and 100 Kg. of phosphorus per hectare. The yield of both the crops is reduced but the total production of sugar per unit area increases significantly.

Harvesting

Sugarbeet is ready for harvesting after 6 to 7 months of sowing. The drying up of lower leaves is considered the fair sign of ripening of the crop. At this stage roots attain a sugar content of 15 to 18 per cent and the accumulation continues to Mid-May. Therefore, the harvest time spreads from End March to End May depending upon the date of sowing. The roots can be lifted either with a digger or with a country plough run at an angle to the beet roots to loosen the roots from the soil. Thereafter the roots are hand picked, shaked to free the soil and detopped from the base of the lowest leaf of the crown with the help of a sharp blade (Gundasa).

Yield

A good crop of sugarbeet is capable of giving 30 to 50 tonnes of beetroots and 5 to 10 tonnes of tops per hectare. The yield of intercropped beet is reduced by about 20 to 30 per cent.

6. Sugarbeet Production by Sample Growers

Sugarbeet production system could conveniently be divided into three sub-system, namely, i) inputs procurement, ii) cultivation practices and input levels, and iii) disposal of output.

2.6.1 Inputs procurement

Inputs required for beet cultivation are not different from other crops. The inputs were either produced on the farm (partly/ wholly) or purchased. In case of beet the only farm produced input was FYM. Additional requirements of FYM were purchased from the co-villagers or even from other villages. But purchase of this input remained very low and insignificant for the selected cultivators.

The only source of irrigation water was distributory of Gang canal in the study area. The capacity of the distributory was reported at 2700 cusec. But due to silting and poor maintenance its actual capacity had been reduced to 2200 cusec. Even this supply was not assured especially during poor rainfall years which occured frequently in the area. The limited supply of irrigation water was rationed @ 6.25 hours per hectare per month. This much water was hardly sufficient for about 1/3rd of the irrigable area. Irrigation thus was a serious production constraint in the study area.

Since water requirements of sugarbeet are more than the other crops grown in the area, additional water supply was arranged. Though the canal capacity remained unchanged, additional water

supply was diverted to the beet growing villages from the existing level of water through installing additional water pipes for the beet growing villages. These pipes remained installed from the beginning of the beet season till it was harvested. The different sized pipes were installed on the bases of planned area under sugar-beet as given below:

Planned area under beet (bigas)	Size of pipe in inches	Water supply (Cusec per second)
Upto 56	2.0	0.10
56 - 65	2.5	0.14
65 - 75	3.0	0.20
75 - 96	3.5	0.28
96 -114	4.0	0.40

Note: 1 biga = 0.25 hectare

Source: Office of the Executive Engineer (Irrigation), North Zone, Sri Ganganagar, Rajasthan.

The practice followed for the distribution of such water was known as 'Baribandi'. Baribandi was fixed on weekly basis @ 3.24 hours per 'Murraba' (equivalent to 6.25 hectares). This could irrigate .25 to .30 hectares per hour per turn. Irrigation charges were fixed by the irrigation department on the basis of water requirements of each crop. The village level functionary kept the records of area under different crops and collected water charges at the end of each season. Sugarbeet despite its larger requirements

of water was charged lower price per unit of area compared to any other main crop . The reason was that beet was not a major crop in the area. In otherwords irrigation to this crop was subsidised.

The other capital inputs purchased for sugarbeat cultivation were seed, fertilizer, pesticides, and diesel and oil for tractors. While diesel was purchased by the individual tractor owners from the diesel pumps located at important points in the area at fixed rates, other inputs were supplied through sugar mill.

Sugar mill procure beet seed from National Seeds Corporation and supplied to the growers at a fixed price. The seed supply was restricted to selected growers (discussed elsewhere). The mill also arranged the supply of fertilizer and pesticides from cooperative supply units. Though the farmers had to procure seed from the mill, they were at liberty to arrange other inputs from any available source. The mill's supply was generally in the form of a crop loan arranged from Rajasthan Bank. In the beginning seed was supplied free of cost-100 per cent subsidised. This subsidy was subsequently brought down to 50 per cent in 1976-77, to 25 per cent in 1978-79, and to nil in 1979-80 onwards. The remaining part of the value of seed was considered as kind loan to the growers. Similarly the mill arranged the supply of fertilizer and pesticides as kind loan since the beginning. However, the pesticides use remained negligible over the years and its supply was stopped from 1979-80 onwards.

The supply of seed was made through extension staff of the cane department at the mill. Whereas fertilizer and pesticides were supplied through cooperatives or private trade at different places. For the services rendered by the mill in arranging these crop loans, it charged one per cent above the interest rate paid to the bank. In other words, farmers were charged for the services of the mill in arranging input supplies to them. The loan amount and service charges were deducted from the sale proceeds at the factory. The mill was responsible for repayment of loans to the bank.

Labour is another partly purchased input for sugarbeet. Partly the labour requirements were met from the family labour. The other sources of labour supply constituted permanent and casual hired labour. Just like family labour, permanent hired labour was partly used for beet crop. However, for specific jobs e.g., weeding, thinning, and harvesting, casual labour was hired exclusively for beet. The wages paid to labourers were the normal rates prevailed at different periods in the area. The wage rate went up at the time of harvesting of beet because wheat (the main crop) harvesting clashed with it.

Draft power was required for land prepartion, transportation of FYM to the farm and final produce to the market. Generally

farmers used their own draft power for such operations. Those operations were also carried out through hired draft power in some cases.

2.6.2 Cultural practices and level of inputs used

Preparation of seedbed and sowing

In our sample, 19 of the 30 growers used recommended number of ploughings and plankings. Twelve of them were old growers*. As shown in Table 7, 10 per cent of the growers did not use FYM/compost at all. All of them were new growers. About 44 per cent of the growers had used upto four tonnes and another 23 per cent used more than eight tonnes of FYM per hectare. The distribution of two groups of growers into level of FYM use groups pointed out no relationship between experience in cultivation and level of FYM use. On an average the use of FYM was recorded at 7.7 tonnes per hectare (Table 8). It was relatively higher for old growers than for new growers. All the growers had used basal application of fertilizer in the form of Diammonium phosphate.

All the growers used ridge sowing but the distance between two ridges varied from 30 to 45 cm. A majority of them (75 per cent) used the recommended distance of 45 cm. between rows and the remaining used 30 cm. The ridges were made with the help of a country plough. The plant to plant distance was kept at 3 to 5 cm. by majority of the farmers. Some of the old growers however used more than recommended distance.

*Old growers and new growers as defined under section 7 on page 38.

Table 7: Experience of the Sample Growers in Sugarbeet Cultivation in Sri Ganganagar, Rajasthan (1980-81).

Particulars	New growers	Old growers	All growers
1. No. of Cultivators	11	19	30
2. Area under sugarbeet		Per cent of 1 above	
Upto 1.0 hectare	45	37	40
1.1 to 2.0 hectare	36	26	30
More than 2.0 hectare	18	37	30
3. Productivity per hectare:			
Upto 29 tonnes	55	16	30
30 to 39 tonnes	36	26	30
More than 39 tonnes	9	58	40
4. Use of inputs per hectare:			
i) Nitrogen:			
Upto 75 Kg.	55	26	37
75 to 100 Kg.	-	37	23
More than 100 Kg.	45	37	40
ii) Phosphorus:			
Upto 40 Kg.	28	32	30
40 to 50 Kg.	45	42	43
More than 50 Kg.	27	26	27
iii) FYM: Nil	27	-	10
Upto 4 tonnes	28	53	44
4 to 8 tonnes	18	26	23
More than 8 tonnes	27	21	23
iv) Irrigation (No.):			
Upto 7	73	16	37
8 to 9	18	26	23
More than 9	9	58	40

8: Cultural Practices and Inputs Use on Sample Farms, 1980-81

Particulars	New growers	Old growers	All growers
No. of growers	11	19	30
Area per farm (ha)	1.3	2.1	1.8
Yield per hectare (tonne)	27.8	40.4	37.0
Seed per hectare (Kg)	12.8	8.4	9.4
FYM per hectare (tonne)	5.6	8.4	7.7
Nitrogen per hectare (Kg)	80.7	98.2	93.5
Phosphorus per hectare (Kg)	45.1	46.6	46.2
Irrigations (No.)	6	9	8
Labour use per hectare (mandays)			
i) Preparatory tillage & sowing	14	16	15
ii) Thinning, weeding & earthing up	19	22	21
iii) Harvesting & transportation	24	28	27
iv) Total labour	57	66	63

The sowing period in the area extended from End September to early December. Only about 62 per cent of the growers had sown this crop in the normal sowing period. The delay in sowing was caused because of the following:

a) The irrigation department announced shortage of irrigation water availability in the coming season and hence some of the growers watched for the policy on water availability.

b) The price of beet was Rs. 180 per tonne. The new price of Rs. 250 per tonne was announced only in October. This acted as an incentive and the growers decided to grow beet little late. Among our sample growers, none had delayed beet sowing. While 27 per cent had sown this crop in September, the remaining 73 per cent completed its sowing in the normal sowing period.

On an average the seed rate used by sample growers was close to the recommended rate. It was, however, less than recommended for old growers than for new growers. The method of sowing followed by all the growers was dibbling on ridges at a distance 3 to 10 cm. from hill to hill. All the growers had given irrigation after sowing.

Irrigation

All the growers had given the first irrigation immediately after sowing and the last irrigation before harvesting. In addition

different growers had given 5 to 12 irrigations. As indicated in Table 7, about 37 per cent of the growers had given upto seven irrigations to their best crop. A majority of them were growers with negligible experience. Another 40 per cent had given more than nine irrigations, and a majority of them were old growers. In fact the number of irrigations and time of application were more determined by the availability of irrigation water rather than its necessity. For the sample as a whole the average number of irrigations was computed at eight. It was more for old growers than for new gorwers (Table 8).

Thinning, weeding and earthing up

All the growers in the sample carried out thinning, weeding, and earthing up at proper stages. The timings for these operations, however, varied for different growers because of difference in sowing dates. The growers also filled up the gaps with the first irrigation by dibbling extra seeds on proper spacing. No deep interculturing, however, was done. Weeding was carried out with a hand hoe or khurpi. Earthing up was done by majority of the growers.

Chemical fertilizer

In majority of the cases three doses of fertilizer were used. Basal application of phosphorus with FYM was given 10 to 15 days before sowing and the two dressings within two months after sowing. On an average 93.5 Kg. of nitrogen and 46.2 Kg. of phosphorus per hectare were provided from chemical fertilizer (Table 8). The rates

were more or less identical for two groups of growers for phosphorus but for nitrogen the average rate of application was higher for old growers than new growers. Since top dressings were applied alongwith irrigations and since irrigation was not under the farmers control, the timings of application of fertilizer were determined by the availability of irrigation water.

Intercropping

All the sample growers had grown sugarbeet as a pure crop. The practice of intercropping was not known to them.

Plant protection

Because no serious pest attack was identified in the area none of the growers had used any plant protection. In fact, the mill had stopped the distribution of insecticides for this crop since 1979-80.

Harvesting

The harvesting operations in the area began in April and terminated in May. Actual harvesting on individual farms depended upon the date of sowing. All the growers, however, had given the preharvest irrigation. The harvesting was carried out by a country plough. The roots were handpicked and the tops were cut. Generally harvesting was done by contract labour or casual hired labour. Only about 18 per cent of total labour employed for harvesting was family labour.

2.6.3 Disposal of output

Sugarbeet harvest has two components; namely, the roots and the tops. Because there was no alternative use of beet roots the only disposal outlet was the processing unit at Sri Ganganagar. As mentioned earlier the mill fixed the procurement price of beet on the basis of sugarcane price announced by the central government. This price was applicable to the net root weight at the factory site. Also pointed out earlier that the mill gave the sowing schedule to the individual beet growers (the mill kept the records). Accordingly the harvesting dates were issued. However, because of variations in inputs used and other cultural practices followed by individuals, many a time, the crop was not ready for harvest at the given dates and thus the growers could not stick to those harvesting schedules. Though there was a provision to issue new slips but again the new dates were generally not compatible with the optimum harvesting time because there were others in the queue. In practice therefore, the farmers did not get revised date slips before they brought the produce to the mill. Because there were other farmers [illegible] already lined up, the clearance got delayed. This had resulted in malpractices with slips issuing staff. Such delays however, resulted in deterioration in quality of produce and the farmers got lower price because of larger deductions. Also they had to incur extra costs on overstay at the site. Eight of the sample growers

reported such problems. Nine of the ten dropouts also pointed out this anamoly. As a result of deteriorated quality of produce, sugar recovery was adversely affected.

The transport to the factory, as mentioned earlier was the responsibility of the growers. Nearly 20 per cent of the growers had partly used hired transportation. About 53 per cent used their own tractors while the remaining 27 per cent used their own bullocks for transportation of beet to the mill. Unloading of produce at the mill site was also the responsibility of the growers. Generally it was carried out by casually hired labour on piece wage basis available at mill site. The normal rates of unloading were Rs.10 per trolley and Rs.25 per truck. The average transportation costs including unloading for the sample farmers were worked out at Rs. 30 per tonne of beetroots for the reference year 1980-81.

At the factory gate the individuals lined up their produce according to the serial number of slips for that day and got tokens for weighment. After weighment the produce was unloaded in the washing tanks. During unloading a sample of six pieces, three picked up by the grower and the other three by the mill personnel on duty was taken for laboratory tests. These sample pieces were weighted, cleaned with a knife and a brush and weighed again to arrive at the fraction for making deductions for dirt, stones, and other foreign material. For our sample growers this fraction was computed at

8.2 per cent. About 50 per cent of the growers were not satisfied with the method of ascertaining this fraction. The price was paid on the net weight of the produce, roots. The growers were issued a card containing the quantity and value of produce on which they got the payments from the cashier of the mill after about a week. The growers, however, wanted the payments to be made within three days.

The average yield of beetroots for our sample was computed at 37 tonnes per hectare. The maximum yield reported was 40.4 tonnes per hectare. These yields were subject to deductions at the mill.

Beet tops-a by product was used as green fodder during the green fodder scarcity period of April-May. However, since the crop was harvested in a short period, it was not possible for individual growers to use the entire quantity of fodder on his own farm. The common practice, therefore, was that the tops were given to the labour free of cost and it worked as an incentive. Another limitation of the tops as fodder was that these contain oxalic acid which is toxic. Therefore, either it was to be amended using 100 gms of lime per quintal of beet tops or the tops should be used with roughages in the ratio of 1:3. The average yield of tops was calculated at 6.2 tonnes per hectare.

7. Cultivators' Experience in Beet Cultivation

The cultivators experience in the cultivation of beet was examined with respect to the area, yield, and inputs used. In

addition to the factual details about these variables, the subjective responses of 30 growers were also examined.

On the basis of the length of experience in the cultivation of sugarbeet we have divided the beet growers of 1980-81 into two groups.

i) New Growers: They included the current year adopters and the readopters after a long break of five or more years. There were 11 such growers in our sample.

ii) Old Growers: They included the continuing growers and the discontinuing growers with long experience and very short break of a year or two. There were 19 such beet growers in our sample.

Table 7 gives the experience of these two categories of growers with respect to area under beet, productivity per hectare, use of inputs such as fertilizer, FYM and irrigation. Very weak relationship was found with the experience and the area under beet mainly because of the policy of allocation of beet area in proportion to size of holding irrespective of experience or no experience in beet cultivation. The productivity per hectare, however, showed a strong association with the experience in beet cultivation. In case of major inputs (e.g. nitrogen, phosphorus, FYM) no such

relationship was observed. However, number of irrigations and experience seemed highly correlated.

Coming to the relationship between productivity and various inputs use, as shown in Table 9, it was found that productivity was positively associated with the use of nitrogen, phosphorus, and irrigation. However, no specific relationship was found between productivity and FYM use.

Table 10 gives the sample farmers' responses on the changes in the use of inputs and reasons thereby, problems faced by the farmers in relation to the cultivation of sugarbeet, and their evaluation of its productivity. It shows that the majority of growers and dropouts have got normal or above normal yields, and 15 of the 40 adopters reported poor yield. Various problems faced by these 40 cultivators were related to irrigation availability and hot weather, disposal of produce, and labour scarcity. In case of disposal, the specific problems include under weighment and high deductions, transportation, delays at factory, difficulty in obtaining delivery slips, and wastage of farmers' precious time. Some of the farmers also reported problems of disease, and difficulties in procuring inputs. The major problems, however, seemed to be of disposal in time mainly because of hot weather.

Table 9: Relationship between Level of Inputs Use and Productivity of Sugarbeet on Growers Farms (1980-81).

Sl. No.	Inputs	Productivity (Tonnes/hectare)			
		Upto 29	30-39	40 & above	All levels
		No. of farmers			
1.	Fertilizers (Nutrients in kg/ha)				
	i) Nitrogen:				
	50-75	7	3	1	11
	76-100	1	3	3	7
	101 and above	1	3	8	12
	ii) Phosphorus:				
	Upto 25	1	-	-	1
	26-50	7	7	7	21
	51 and above	1	2	5	8
2.	Farm Yard Mannure (tonnes/ha)				
	Nil	2	1	-	3
	Upto 4	3	4	6	13
	4-8	1	2	4	7
	More than 8	3	2	2	7
3.	Irrigation (Number)				
	Upto 7	7	3	1	11
	8-9	2	1	4	7
	10 and above	-	5	7	12

Table 10: Responses of Beet Adopters

Sl. No.	Items	Number of cultivators		
		Growers	Dropouts	Total
1.	Yield:			
	i) Good	13	3	16
	ii) Normal	6	3	9
	iii) Poor	11	4	15
2.	Change over time in:			
	i) Seed rate	6	-	6
	ii) Timings of sowing, thinning, harvesting, etc.	5	-	5
	iii) Methods of input applications	17	-	17
	iv) Others	7	-	7
	v) No. change	8	-	8
3.	Reasons for changes:			
	i) Self realisation	12	-	12
	ii) Demonstrations	5	-	5
	iii) Fellow Cultivators	5	-	5
4.	Problems faced regarding:			
	i) Disease	4	-	4
	ii) Water	13	6	19
	iii) Input procurements	2	3	5
	iv) Labour	19	7	26
	v) Hot weather	22	10	32
	vi) Disposal of Beet	24	10	34
	a) Means of transportation, loading/unloading	12	-	12
	b) Delay of sowing other crops	2	5	7
	c) Obtaining delivery slip from factory	8	3	11
	d) High rate of deducation at factory	13	5	18
	e) Inadequate Price	-	-	-
	f) Delay for disposal at the factory	8	9	17

When asked about the changes affected in the input use over time only 22 growers (mainly old growers) responded. While majority of them indicated changes in the methods of inputs application, six indicated changes in seed rate and five changed timings of sowing, harvesting, etc. Majority of them realised the need for these changes on their own, whereas five learnt from demonstrations and the remaining five from fellow farmers.

8. Economics of Sugarbeet Cultivation

Economics of beet cultivation on sample farms was worked out by deducting total costs of cultivation from the gross value of produce. Since beet was grown for market, its production process ended with the disposal of output at the sugar mill at Sri Ganganagar. Therefore, the production costs included transportation, unloading and other costs borne by the growers at the point of disposal. The beet tops- a by-product was given free to the harvesting labour. Since it did not contribute to the returns, we have not priced it and hence not included in the value of output.

The production costs, consisted of costs on land preparation and sowing; application of FYM and chemical fertilizer; irrigation; thinning, weeding and earthing up; harvesting; transportation including unloading; etc. Actual prices paid for purchased inputs and hired service were used. In case of home produced inputs such as FYM and services of own resources such as labour, draft-power, machinery etc.

were priced at the existing prices/wage/custom rates in the selected villages. An interest rate of 12 per cent was used as an opportunity cost of farmers capital. In case of crop loan arranged by the mill from Rajasthan Bank, the interest rate charged was 16 per cent. However due to paucity of relevant data, this adjustment for crop loan for beet could not be made. Since all the inputs were not used in the beginning of the crop season, the interest was computed for half the production period i.e. 4 months for sugarbeet. Because we have included the imputed costs of own resources, seperate depreciation on durable assets was not included.

In working out value of output, actual payments received by the growers were not considered. As mentioned under 2.6.3 that the green tops did not have any market/major use and the harvesting labour was allowed to carry it free of cost, it was not included in the value of output. Further the price at the mill was paid for the net weight of roots free of soil, stones, and green tops. A deduction in gross weight of roots received at factory gate was applied to compute the net weight of roots on which the price was paid. In 1980-81 the price of sugarbeet was fixed at Rs. 250 per tonne of net weight of roots. On an average the deductions were made at 7.1, 8.8 and 8.2 per cent of the gross weight of roots brought by new growers, old growers and all growers respectively.

The difference between gross receipts and total costs was net profit. Its positive sign indicated the economics of this crop. On the whole, the net profit per hectare was worked out at Rs. 3730. The composition of costs indicated that transportation was the major component of cultivation costs followed by costs on fertilizer and FYM (Table 11)

Among the new and old growers though the total costs were higher for old growers, costs on preparatory tillage and seeds were higher for new growers and costs on irrigation; thinning; weeding and earthing up; and harvesting were more or less identical for all growers. On the other hand old growers spent more on manuring- a yield increasing input. As a result they got higher yield and hence higher costs on transportation. Both the gross value of output and cost of cultivation were higher for old growers. Also the net profit for these growers was about double the net profit for new growers.

The comparative economics of sugarbeet vis-a-vis other crops grown on sample farms is given in Table 12. The table shows that there was not significant difference in the allocation of area under Kharif crop, wheat was the major rabi crop. Sugarbeet was one of the minor crop which occupied only 8.7 per cent of the gross cropped area on sample farms in 1980-81. The reason for low area under this crop could be the policy for allocation of beet area

Table 11 : Economics of Sugarbeet Cultivation on Different Farms, 1980-81.

Particulars	New growers	Old growers	All growers
		Rs. per hectare	
A. Costs			
i) Ploughings, planking and ridge making	176	166	169
ii) FYM application	476	949	822
iii) Sowing and seed	405	270	306
iv) Fertilizer	830	975	936
v) Irrigation	25	26	26
vi) Thinning and weeding	285	286	286
vii) Harvesting	182	185	184
viii) Transportion	994	1189	1136
ix) Interest on (i) to (vii) @ Rs. 12 per cent per year for four months	135	162	155
x) Land rent	750	750	750
xi) Total costs	4257	4958	4770
B. Returns			
i) Root yield (tonnes)	27.8	40.4	37.0
ii) Net root yield (tonnes)	25.8	36.8	34.0
iii) Gross receipts	6450	9200	8500
C. Net profit			
i) Absolute	2193	4242	3730
ii) Per rupee of costs	0.51	0.85	0.80

Table 12 : Comparative Economics of Sugarbeet and Other Important Crops Cultivated by Sample Beet Growers (1980-81)

Season and Crop	Area	Gross value of output	Total expenses	Net Profits	Turnover per rupee
		Rs. per hectare			
I Rabi					
1. Sugarbeet	53.9 (8.7)[a]	8500	4770	3730	1.80
2. Wheat: i) HYV	147.3 (23.7)	6114	3196	2918	1.91
ii) Local	12.1 (1.9)	3899	2884	1015	1.35
3. Mustard	47.7 (7.7)	3423	1913	1510	1.79
4. Gram	59.1 (9.5)	2852	1641	1211	1.74
5. Barley	0.8 (0.1)	2195	1822	373	1.20
II. Kharif					
6. Cotton: i) HYV	165.0 (26.6)	5433	2826	2607	1.92
ii) Local	24.5 (3.9)	3147	2070	1077	1.52
7. Sugarcane: i) Plant	32.0 (5.2)	9832	6279	3553	1.56
ii) Ratoon	9.0 (1.4)	7547	5105	2442	1.48
8. Gowar	19.3 (3.1)	1700	1471	229	1.15
9. Jowar	11.2 (1.8)	2400	2192	208	1.11

[a] Figures in parentheses are per cent of gross cropped area. These do not add upto 100 because unirrigated crop are not included here.

among the farmers of the selected villages. This has been already discussed elsewhere. Wheat and mustard were the competing crops of the season. Sugarcane, being perennial crop, competes with sugarbeet for land. Similarly cotton and sugarbeet overlaps with each other for their land requirements and hence could be considered competitive crops. Their comparative economics is given in Table 12.

The table shows that per hectare gross as well as net returns from the major crop enterprises on sample farms. It shows that sugarbeet was the superiormost crop followed by sugarcane planted, wheat, cotton and sugarcane ratoon in order. Mustard fell far behind. The net profit per rupee of costs, on the other hand, was marginally higher for cotton and wheat than for sugarbeet. In this regard even mustard was very close to sugarbeet. Sugarcane has another disadvantage in its duration on the field. Against 6 to 7 months duration of beet, sugarcane takes 12 to 14 months for ratoon and planted crops. Inspite of the comparative advantage of sugarbeet over other competing crops (for resources) as well as sugarcane (sugar producing crop), its area remained low. The major reason as mentioned earlier is of the control of the factory on area under this crop.

9. Some Implications

The implications of expansion of beet cultivation in North India emerging from the preceding analysis/discussion are manyfold. As we know, sugarbeet was introduced with the hope that it will attain the status of a source of sugar especially in North India, where sugar recovery from sugarcane was relatively low and the crushing season is relatively shorter. Inspite of encouraging reports on the success of sugarbeet cultivation in Sri Ganganagar, its cultivation on commercial scale was not taken up elsewhere. Even in Sri Ganganagar area, the mill was confronted with problems in convincing farmers to take up beet cultivation. Because of frequent dropouts, the mill had to drop some villages and include some other villages for beet cultivation every year. This had to be done even after relaxing the condition for cent per cent adoption in the selected villages. It was left for the cultivators to divide the minimum area to be put under beet among themselves to get the facility of additional irrigation.

The adoption of sugarbeet in Sri Ganganagar district, like any other new commercial crop of proven superiority, was very quick. In case of dropouts, they too did not lose much time to readopt sugarbeet. The diffusion of this crop, however, was halted because of fixed requirements of the mill. The incentive of additional water acted as stimulous in the adoption of this crop. Free supply of seed

in beginning years (subsequently withdrawn completly) and crop loan facilities arranged by the mill were other imcentives. Because of the difficulties in rationing limited supply of additional water among the growers, it was decided that all the cultivators in all the selected villages chosen for beet cultivation must allocate a certain proportion of their land under sugarbeet. This condition has helped the adoption process in the selected villages, but in other villages it denied the opportunity of beet adoption to some of the willing farmers because the others were not in favour of this crop. On the whole, however, the farmers were willing to grow sugarbeet on small areas if the additional water is available

It was, therefore, very likely that in the areas of comfortable water supply such as the plains of Punjab, Haryana and U.P., assuming the superiority of the crop, its adoption and diffusion would be easy and fast.

The cost of cultivation of sugarbeet in Sri Ganganagar established its economic viability and its comparison with other competing crops of the area indicated the comparative advantage of this crop in terms of absolute net profits per unit of land. However, the turnover per rupee of expenditure was marginally higher for wheat and cotton in the study area. Surprisingly, its irrigation costs were low because of canal irrigation. In the areas with underground irrigation sources, the cost structure would defenitly change.

Another important aspect one must consider for expansion of sugarbeet cultivation is that sugarbeet was a minor crop in Sri Ganganagar. Its expansion to larger areas would result in reduction in yield and hence wheat and cotton might become equally superior alternatives. Therefore, this crop could survive only through package of incentives.

In Sri Ganganagar area the land was not scarce and hence sugarbeet in real terms did not compete with any other crop for land. Also the crop did not compete for irrigation water because additional water was provided for this crop. Therefore, sugarbeet competed with wheat only for harvesting labour. However, in other areas where land is a real constraint, wheat and other rabi crops would be real competitors. On the other hand, some kharif crops could fit in an annual rotation with beet and this rotation could be rotated on different plots which was not feasible in Sri Ganganagar. The economics of such a rotation against other rotations without beet need to be established.

Another important implication of beet cultivation was that it was not desirable to grow this crop on the same field year after year. In fact this crop could be grown in the same field only after four to five years. In other words, it required a long rotation. That is unlike sugarcane or other crops its cultivation could not be concentrated in compact areas. This would be a handicap in the areas of very scarce land resource.

The disposal of sugarbeet was another aspect of sugarbeet production which has definite implications. Because of the perishable nature of the main product (beet roots) sugarbeet needed quick disposal and processing. The delay in harvesting also deteriorates its quality. The Ganganagar Sugar Mill gives the sowing and harvesting schedules to the producers. Since actual production was different than expected, the scheduled daily arrivals did not always match the processing capacity. Also since harvesting was advanced or delayed by a couple of days due to early or late maturity (because of variation in inputs use and other practices), availability of last irrigation and labour for harvesting the flow of beet to the mill again did not match exactly with the daily requirements. Both these have resulted in more waiting time for producers at the mill, deterioration of produce and loss in its weight, and hence low recoveries. The point we highlight here is that crop being sensitive to hot wheather, it needed timely harvesting and disposal. In the absence of well organized disposal arrangements, farmers would be reluctant to grew this crop on larger areas.

In brief, though the crop has established its superiority in the study area, the continuation of its cultivation would depend on the availability of additional irrigation and timely disposal arrangements. Its adoption in other areas assuming its economic

superiority would depend on the nature of incentives available to the farmers. The incentives would, however, be important only if the processing of this crop would be economically feasible. This aspect has been analysed in an other paper.