ARID LAND MANAGEMENT

A progress Report

on

Operational Research Projects

Division of Extension & Training
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PREFACE

Adequate technological knowledge has been developed for reclamation and increasing production in the arid and semi-arid areas. Despite available technical knowhow there has been a rather slow diffusion of the 'newer scientific discoveries' among the farming communities. Since its inception in 1952 the Central Arid Zone Research Institute, Jodhpur is engaged in developing suitable technologies for reclamation and improvement of the desert. The need for large-scale application of these technologies was fully realised by the Institute in 1966 when a Division of Extension and Economics (now Division of Extension and Training) was created. Based on concepts like Intensive Agricultural Development Programme, National Demonstrations etc., Operational Research Project viz., Arid Land Management, including Drip and Sprinkler Irrigation systems was launched in 1974. Under this project the CAZRI'S Scientists them selves are demonstrating the technical know-how in arresting the intensifications of desertic conditions and in increasing productivity of the desertic land in a cluster of five villages near Jodhpur. The package of technologies and successful demonstrations in the selected villages, should find application in similar areas of the region.

One of the important objective of the project is to study and analyse the technological, economic and social constraints in the transfer of technology from the Research Institutes to the rural community. It is hoped that with this understanding not only the scientific programme of the Institute will be strengthened and improved the results of successful technology have a multiplier affect.

The project for its success needs fullest participation of the villagers including men, women and children. The active support and participation of the State development departments and the dedication of the scientists is essential. Let all concerned accept the challenge and the opportunity thrown up by the project.

The first publication of this project was compiled in 1977 by Shri S.P. Malhotra, Dr. Panjab Singh and Shri M. L. A. Sen. This bulletin has been up-dated by Dr. Panjab Singh formerly Head of Division of Extension and Training and his colleagues. I compliment the scientists of the institute for their dedication work in this project. Suggestions for improvement for subsequent bulletin are welcome.

H. S. MANN
Director

ACKNOWLEDGEMENT

The success of the project depended on an integrated effort put at all levels of programme planning and implementation. The Operational Research Project on 'Arid Land Management' and 'Drip and Sprinker Methods of Irrigation' operating in the villages around Jodhpur are indebted to Dr. H.S. Mann, Director, Central Arid Zone Research Institute, Jodhpur for his leadership in the formulation of the programme and a constant guidance during the implementation.

Special mention deserves to be made of Shri S.P. Malhotra, Head Division of Sociology, economics and statistics for actively coordinating the programme at each level.

Time to time guidance received from senior scientists of the Institute in executing the programme and active and keen interest shown by various subject matter specialists of various disciplines merit most sincere appreciation. An excellent job done by Shri B.L. Tak in taking spot photographs deserves praise.

During the course of operation these projects have been fortunate to receive utmost cooperation from the state agencies associated in state agricultural development.

Shri M.L.A. Sen, Shri P.L. Joshi and Shri Z.D. Kavia, have put very sincere efforts in compiling the information in an organised manner. Help rendered by the scientists in the division of extension and training in collecting information deserves appreciation.

The record of activities presented on the report owns for its authenticity and utility to the painstaking efforts put in by the team of O.R.P. led by Shri M.L.A. Sen, Shri P.L. Joshi and Shri Z.D. Kavia in their respective fields of activities.

25th September, 1979.

PANJAB SINGH

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INTRODUCTION

1.1 Genesis

The scientists engaged in agricultural research and education have evolved a number of suitable technologies to cater to different needs of the rural people. Some of these have established their merit on the research farms and also on the fields of the farmers. Whatever may be the constraints, the diffusion of such technologies into the rural masses is slow especially in drought prone areas. The impediments responsible for slow diffusion would be dealt in later. All out efforts have been made to transfer the relevant technologies developed at the Institute on to the lands of the farmers for gainful utilization. Entire farming system approach followed in place of piecemeal application of individual technology has played a key role in deriving quicker benefits. Introduction of National Demonstration Programme in 1965 with a view to minimise the time gap between the discoveries and their application on farmers field gave an opportunity to the scientists to demonstrate their experimental findings on farmers' fields and assess the economic viability and suitability of a new finding. This programme succeeded in creating interest among farmers and scientists in some parts of the country. But it failed to show the same result throughout the country due to various problems like insect and pest attack and inefficient water management on individual farms. It was then realised that the blanket recommendations regarding the choice of variety and package of practices for a particular area were not appropriate. Therefore, the concept of minikit demonstration has come into operation in 1972, to enable the farmers of a particular area to assess for themselves and select a suitable variety for his area.

It was, therefore, felt that there was need to extend the concept of National Demonstration on area or watershed basis. This could be well undertaken through Operational Research Projects, involving an integrated approach to rural community problems through the cooperation of local agencies, voluntary organizations, development department and socio-economic institutes. Keeping this in view, the ICAR formulated a few Operational Research Projects for implementation during the fifth plan. These projects are designed to identify the major operational problems in the transfer of technology from research stations to cultivators' field. Socio-economic, administrative and organisational problems or deficiencies will be studied in these

projects. The basic concepts of the projects are (i) acceptance of technology of production by masses, (ii) diversification of labour use resulting in enhanced purchasing power among the poorest section of village community, (iii) scientific land and water-use planning and upgrading of the ecological infrastructure in agricultural growth, and (iv) standardization of low-cost labour-intensive production techniques.

Through the Operational Research Project it is intended to introduce the new concept of land and water-use planning in our villages. The projects would also generate more opportunities for gainful employment. The path way chosen for development is the one which will involve an appropriate blend of monetary and non-monetary inputs. Through these projects we do not wish to create isolated showpieces but would like to assist in the development in such a way that the movement becomes self-generating. One of the important aids of these projects is to introduce the concept of social audit in rural transformation work. This principle has been identified as a conscious attempt to improve the economic well-being of families having low income. In other words, for planning of these projects there is a built-in-bias in favour of poor sections of the rural community.

1.2 Preamble

Arid Zone of Rajasthan presents one such example where the weaker wedding links between technology and production are not very hard to be located. This part of the state sprawled into 1.96 million sq km becomes all the more important in the light of production scarcity and varying magnitude of general welfare of its inhabitants. The land forms in arid areas are very heterogenous comprising barren rocky areas, shifting sand dunes, sandy plains, saline flats, alluvial flats, dead streams, barren gravelly stretches and undulating topography. The sand dune infested area in western Rajasthan alone accounts for about three-fifth of the total area and is mainly formed due to wind erosion. With the increasing intense human and livestock pressure and the low adoption of technologies, a reckless exploitation of land suggesting a corrosive effect and the continuation of desertification trend in arid zone of Rajasthan is an oft repeated fact. Having developed sufficient technological knowledge for increasing production and being aware of its low adoption by farming population, the CAZRI is actively engaged for development of arid region-via media Operational Research Projects undertaken in a cluster of five villages. To couple the social aspects of rural transformation effectively with the technological aspects of the operational problems in the transfer of technology, the programmes are being tackled from the social, organizational and technical angles concurrently. An

interdisciplinary team consisting of scientists from the Institute, workers from various state government departments, various local bodies and above all the farmers of the area are engaged in the programme to adopt an integrated approach to the use of available human, soil, water, plant, animal and solar-energy resources. To gain a further knowledge of the anatomy of the society inhabiting the area, a detailed socio-economic survey was conducted before initiating the various elements of the programme. The small and marginal farmers as well as the lineage heads and the opinion leaders were indentified. While operating the programmes at the farmers' fields principles of 'social audit' is given due place so that the weaker section of the society derives the maximum benefit of the programme.

For such conditions the immediate need becomes the rehabilitation of sand dunes and proper use of the natural resources available. Such a vast area is assetted with abundance of natural resources like sunshine, healthy climate, soil responsive to management practices, large underground water potential and round the year possibility of crop harvest. Among the resources available proper use of surface and ground water in production of crops, vegetables and plants need much greater emphasis.

1.3 Operational Research Project

The Institute, since its inception, has been active in delineating and finding solutions for the set of problems which are unique in nature as compared to other parts of the country. On the basis of proven findings of this Institute, important management aspects for development of arid region via-media Operational Research Projects have been undertaken in a cluster of five villages. Two such approved projects presently in operation are as under.

1.3.1 Operational Research Project on Arid Land Management

The project was sanctioned in the year 1974. It has the following objectives :

1. Sand dune stabilization.
2. Pasture, grasses and forage development.
3. Afforestation and shelterbelt plantation.
4. Demonstration of improved technology in cultivation of important vegetables and fruits for higher productivity.
5. Demonstration of improved technology in cultivation of kharif and rabi crops for higher productivity.
6. Demonstration of effective rodent control methods.

7. Community organization and programmes of technicracy.
8. Sheep development programme.

1.3.2 Operational Research Project on Drip and Sprinkler methods of irrigation

The project was sanctioned in 1976. It has the following objectives :

1. To evaluate sprinkler and drip methods of irrigation on land holdings in the villages of western Rajasthan.
2. To evaluate different type of sprinkler and drip systems and develop efficient system for indegenous manufacture and use.
3. Extension of these methods in the regions selected for Operational Research Project work.
4. Training of personnel for design, installation, operation and maintenance of two methods of irrigation.

The budgetary and staff positions of the two projects are given in Annexure I and II

2. ORGANIZATION

2.1 Area of Operation

Based on socio-economic survey a cluster of five villages namely Daijar, Manaklao, Palri-Khichiyan, Basani Karwar and Basni Lachha in panchayat samiti Mandore was considered suitable and thus selected for implementation of first phase of the Operational Research Programme. Among five contiguous villages of Mandore Panchayat Samiti, Daijar (2284 ha) in 1974, Basani Karwar (526 ha) in 1975 and Palri Khichayan (1440 ha), Basani Lachha (650 ha) and Manaklao (2912 ha) in 1976 were adopted. These together comprised 7812 ha (78.12km ^{2}) and are inhabited by 548 households.

The occupational distribution of working force in the O.R.P. area is given in Annexure III. The analysis of the occupational distribution of the population in these villages revealed that 64.4% of the workers have agriculture as their main occupation, 19.9% are agricultural labours, 1.2% are engaged in animal husbandary and 14.5% in other occupations. The average size of agricultural holding is 6.6 ha with 7.5% of it under irrigation. The social amenities available in this area are 3 primary schools, 2 railway stations and one co-operative society. All the five villages in this cluster are connected by kuchha and pucca roads. There are 105 active irrigated wells, out of which 38 are electrified. The land use of this cluster and other

socio-economic characteristics have also been given in Annexure IV and Fig 1. Out of the total area of 7812 ha about 55 ha is under sand dune creating a sand rift problem to nearby inhabitants. Similarly gravely waste area come to nearly 1383 ha and saline and other waste to 50 ha. Our emphasis besides intensively using the good land, has been to make use of such so called waste land which had never been used by the farmers.

3. APPROACH AND METHODOLOGY

3.1 Approach and selection of villages

The project is being implemented by the Division of Extension and Training with a very close collaboration of different subject matter specialists in the Institute. In addition, the various state government department, local bodies and above all the farmers of area, are the participants in the total programme. While selecting the villages, proximity to the Institute, villages not otherwise covered by other projects operated by government or private agencies but have enough scope for dry land agriculture, villages with larger number of weaker section including agricultural labourers, marginal and small farmers, those responsive and willing to extend physical facilities were some of the main considerations alloted priorities. A primary survey was conducted to help in making a comparative appraisal of potential villages for a final choice.

3.2 Bench Mark Survey

Soon after the selection of villages, a bench mark survey of the area was conducted on pretested and structured schedules. The data collected were fully utilized for planning the development programme in each village. The main objectives of this survey were to estimate the existing level of employment, per capita income, irrigation potential, the land use pattern and crop productivity, the status of dairy and other livestock, industry, roads and communication, education and training, health services, drinking water facilities, village co-operative organisations and the aspirations of the village people.

3.3 Project Direction Committees

The project direction committees, one at the Institute level and the other at district level have been constituted for constant guidance, smooth running and implementation of the project. The composition of these committees is as follows :

Co-ordination committee (Institute level)	
Director, C.A.Z.R.I.	Chairman
Head, Division of Extension & Training	Member
Head, Division of Sociology and Economics	Member
Jr. Extension Officer	Member
Subject matter specialists (4)	Member
Deputy Director of Agriculture, Jodhpur	Member
BDO, Panchayat Samiti, Mandore	Member
Co-ordination Committee (district level)	
District Collector	Chairman
Head, Division of Extension & Training	Member
Jr. Extension Officer	Member
Project Director DPAP	Member
Dy. Director, Agriculture	Member
Dy. Director, Soil conservation	Member
BDO, Panchayat Samiti, Mandore	Member
Urban Co-operative Bank, Jodhpur	Member
Farmers from ORP area (5)	Member

3.4 Principle of Social Audit

While operating the programme at individual farmers' field the principle of social audit is given due place. Small and marginal farmers, as identified in a bench mark survey are usually covered under kharif and rabi demonstrations so as to extend the maximum benefit to the weaker section of the society. For demonstrating certain technologies like stabilisation of sand dune, water harvesting techniques, drip and sprinkler systems of irrigation, which need comparatively higher initial investment, certain medium group farmers have also been selected.

3.5 Exhaustive Record Keeping

For continuous monitoring and evaluation, different records like socio-economic survey schedules covering all crops and livestock, input-output relationship and household information, input-output data, monthly progress report of activities, seeds, fertility and insect pest registers are maintained by the Operational Research Project staff stationed at Beriganga, an afforestation centre of the Institute located in the project area.

4. ARID LAND MANAGEMENT

Ever since the inception of the project in these villages, optimum utilization of available resources like land, labour, capital etc was given due priority. Existing useable land, not in use (cultivable waste) either for crop cultivation or plantation of grasses/trees, are utilized to full potential depending on land suitability, thus providing a better use of these existing resources. This practice not only made proper use of the land resources existing with farmer, but also of the other resources like labour and capital available with him. Similarly much emphasis has also been laid throughout on the intensive use of available labour and capital by increasing cropping intensity on the farmers holdings. The progress of work on different aspects covered under the project is summarised objective-wise in the following paras.

4.1 Sand Dune Stabilization Programme

Out of total area covered under the programme, nearly 55 ha is under active sand dune and 1383 ha under gravelly and waste land. To begin with a medium sized sand dune of about 2 ha at village Daijar, about a kilometer from the Daijar railway station on the Jodhpur-Pokaran route, formed by the accumulation of fine sand particles on rocky surface, was taken up for stabilization (Fig 2). The lower portion of the area on the catchment side also represented gravelly and undulating land surface, largely found in these villages. The movement of such sand particles was posing hazards to the adjoining fertile cultivable lands of the farmers. This sand dune has been lying fallow for a number of years and hardly any vegetation was seen on it. The owner of the duney area was motivated to carry out the technologies evolved by this institute so as to put the barren land into productive use by raising tree plantations and grasses, which in turn would meet the fuel and fodder requirements of the farmers in about 5 years and also save the adjoining farm holdings from being engulfed by the moving sand particles. Since the sand dune and the hillocks around have a large potential for water harvest, it was thought that the land, down the slope could be used for producing *kharif* and *rabi* crops. Subsequently in 1974 before the onset of monsoon the duney portion was fenced with barbed wire and angle iron posts. After a few good showers, one year old seedlings of *Acacia tortilis* (Israeli babool) and *Prosopis juliflora* (Vilayati babool) were planted in pits of $60 \times 60 \times 60$ cm. In between the rows of trees, grass seeds of *Cenchrus ciliaris* (dhaman) and *Cenchrus setigerus* (sewan) species were sown. In all 750 tree seedlings have been planted so far at 5×5 m apart, with nearly 100% success. It has been estimated that the plantations on the dune will make it possible

for the farmer to obtain 5 tons of fuel wood from each ha after every 10 years and 1 ton grass per ha per year besides significant check in sand movement. The farmer has now developed profound attachment with his earlier neglected area and has been taking good deal of interest for its maintenance. To arrest sand and water movement, grass strip has also been planted on the down slope side of the dune. On rocky sides, 100 plants of *Acacia tortilis* and *Prosopis juliflora* were also planted to provide additional fuel beside adding to its scenic beauty. Ber plantation was also done in the rocky catchment available on the upper side of the area, rest being put under crops, thus making a potential use of the total area. Excess accumulation of water in the catchment caused a great deal of damage to the ber plantation in 1976. A view of the dune as it looks today can be seen in Fig 3.

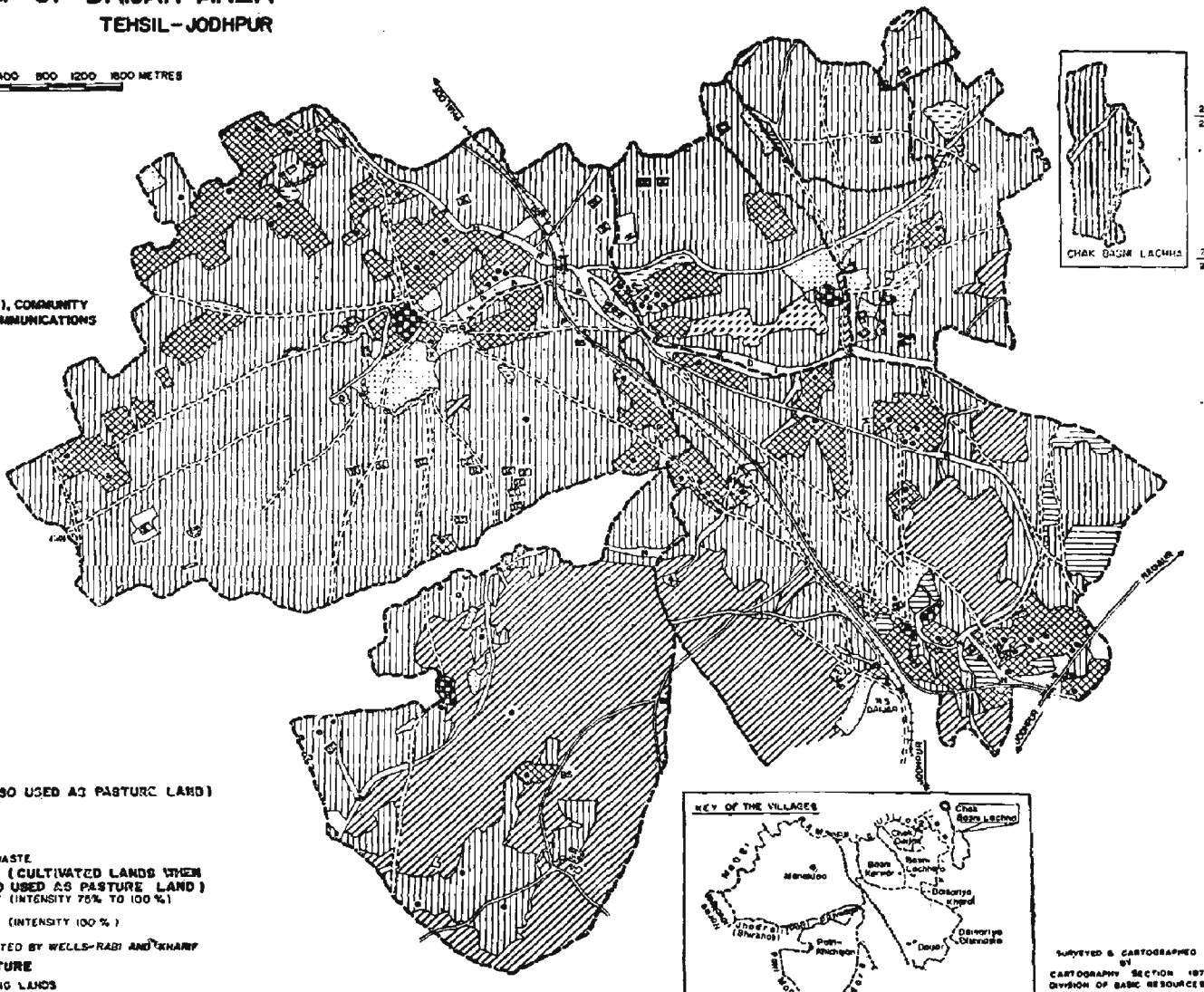
Similarly in Basani Karwar village, a sand dune of 16 ha area was selected under the stabilization programme with the co-operation of its owner. This sand dune was threatening the village holdings. In the first phase, the programme started on 8 ha area. It was fenced with barbed wire and angle iron posts before the onset of rains. Simultaneously, erection of micro-wind breaks against the wind direction was done by using the locally available brush weeds. On the commencement of rains, tree seedlings of *Acacia tortilis, Prosopis juliflora, Colophosphoremum mopane* and *Dichrostachys nutans* were planted following above mentioned techniques. Till 1971 a total number of 12694 plants of *Acacia tortilis*, 6210 of *Prosopis juliflora*, 165 of *Acacia senegal* (kumat), 112 of *Acacia nilotica*, 14 of *Dalbargia sissoo* (shishum) and 8 of *Azadirachta indica* (neem) were planted. Tree plantation has been done in strips of 10 rows for plantation of *Cenchrus* species of grass (Fig 4.) More than 90 percent survival of the tree seedlings planted during these years has been recorded along with a fairly good establishment of the grass. This area is expected to yield similar returns with 10 year rotational falling schedule. In all these, a total area of 37 ha is still under sand dunes and the farmers are being motivated to cover entire area under sand fixation. The farmers are fully aware of the technologies and there is a high acceptance for the programme.

On farmer's own initiative another sand dune of 2.7 ha area was selected for plantation of above tree species on top side and budded ber on the down slope side. Improved grass species were sown in between the plant rows. Along the periphery a wind strip was planted adjoining the boundaries of the field. Estimated cost for sand dune afforestation on 100 ha block and expeceted return is given in Annexure V.

LAND USE MAP OF DAIJAR AREA

DIST- JODHPUR TEHSIL- JODHPUR

400 0 400 800 1200 1600 METRES



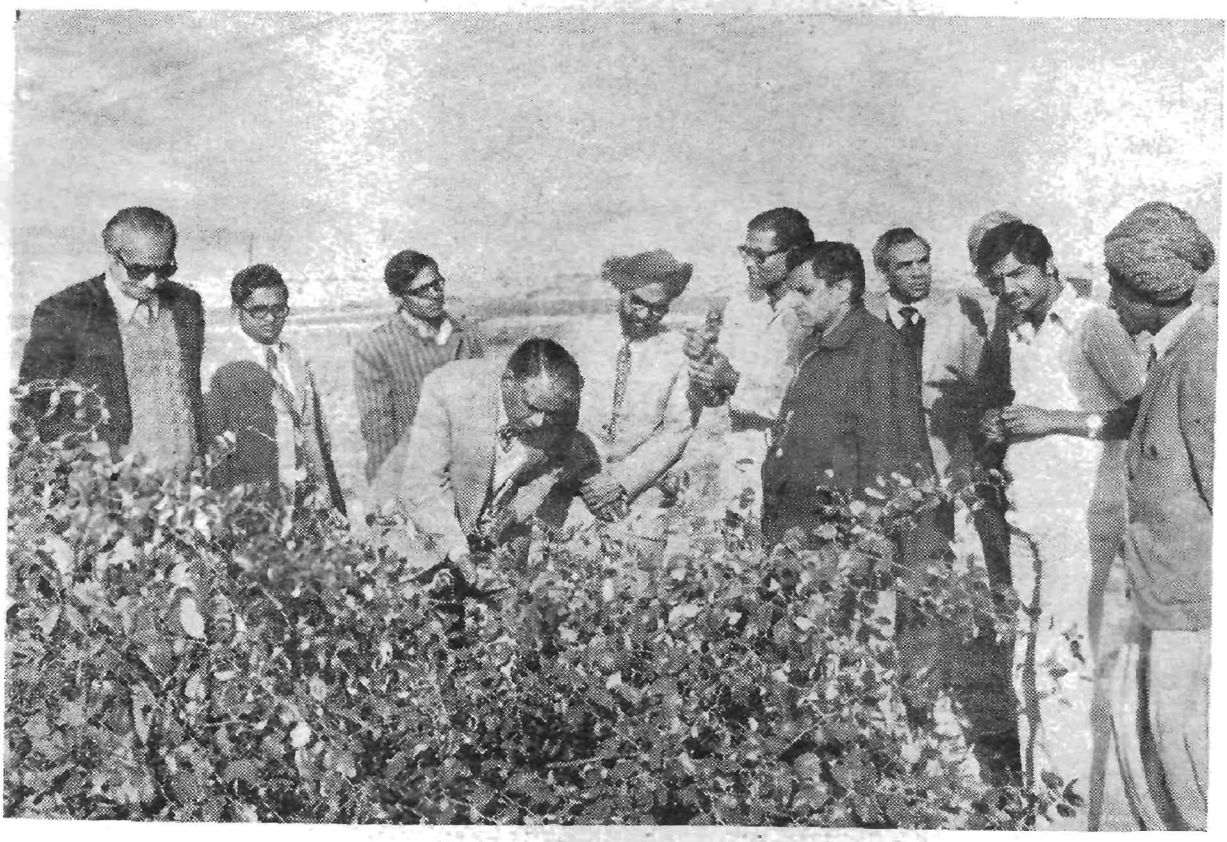
L E G E N D S

1. SETTLEMENT (ABADI), COMMUNITY INSTITUTION & COMMUNICATIONS
   - RURAL- COMPACT
   - RURAL- SCATTERD
   - Q QUARRY
   - G GRAVE-YARD
   - TEMPLE
   - TOMB
   - S SCHOOL
   - INN (DHARAMSHALA)
   - H HOSPITAL
   - RAILWAY LINE
   - BS BUS STOP
   - P PIAO
   - METALLED ROAD
   - UN-METTALLED ROAD
2. WATER FEATURES
   - RIVER (NADI)
   - CANAL
   - NALLA
   - WELL
   - TANK
3. WASTE LANDS (ALSO USED AS PASTURE LAND)
   - NO CROPPING
   - SANDY WASTE
   - ROCKY AND GRAVELLY WASTE
4. CULIVATED LANDS (CULTIVATED LANDS WHEN FALLOW ARE ALSO USED AS PASTURE LAND)
   - SINGLE CROPPED-KHARIF (INTENSITY 75% TO 100 %)
   - SINGLE CROPPED-KHARIF (INTENSITY 100 %)
   - DOUBLE CROPPED-IRRIGATED BY WELLS-RABI AND KHARIF
5. PERMANENT PASTURE
   - ORAN VILLAGE GRAZING LANDS

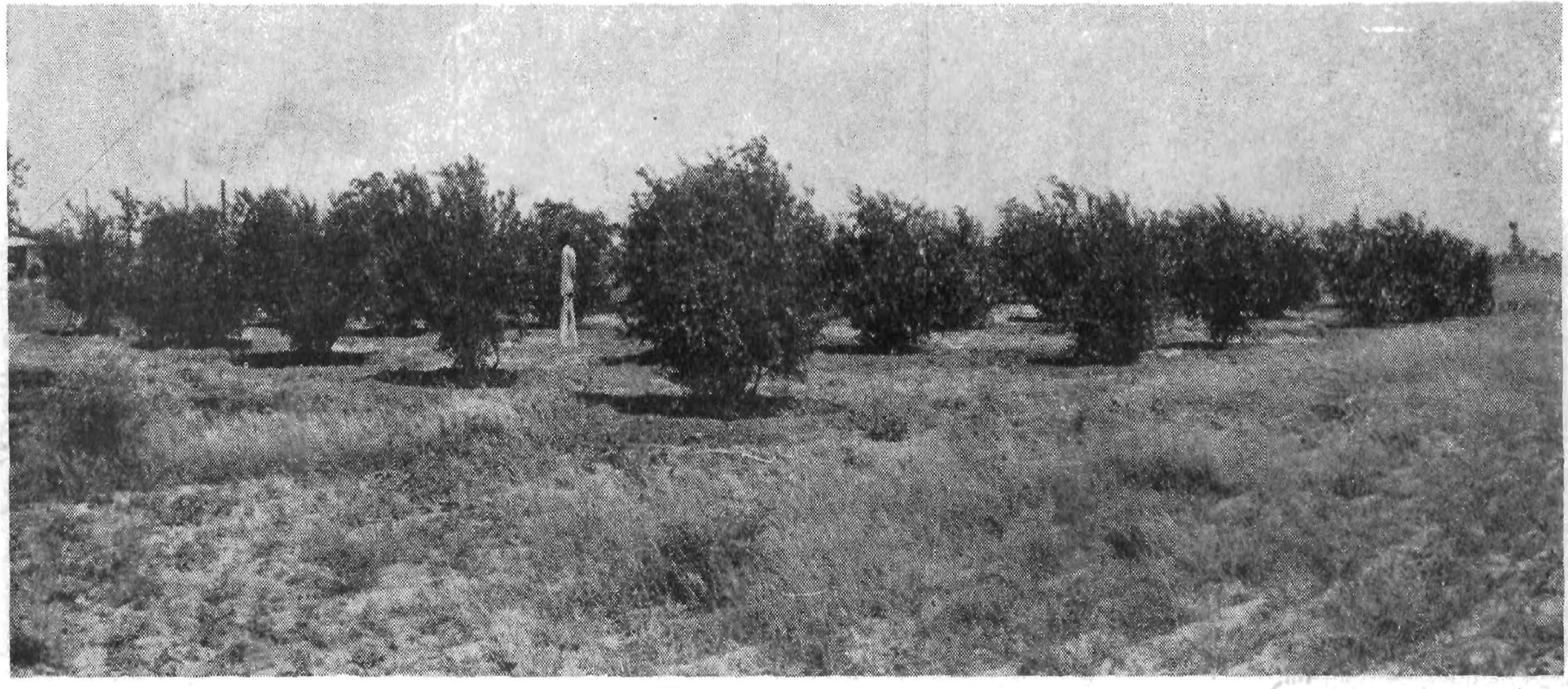
Surveyed & Cartographed by
CARTOGRAPHY SECTION 1979
DIVISION OF BASIC RESOURCES
SURVEY C. A. Z. R. I. JODHPUR

P. R. ASERI

Ocean of sand. Shifting of sand creates problem for cultivators, railway track and roadways in the desert. CAZRI has developed technologies for its stabilization which are highly cost effective.



Dr. O.P. Gautam, Director General I.C.A.R. at the Ber orchard established by a farmer in the O.R.P. with technical know-how of C.A.Z.R.I.



Desert apple, Grafted *Ber* blooming at farmer's field under O. R. P.

4.2 Grass land development

Two plots of one ha each at two different farmers fields at Basani Karwar and Manaklao villages were taken up in 1974 and 1975 for grass land development. At Basani Karwar the plot was sown with *Cenchrus ciliaris* (dhaman) and *Cenchrus setigerus* (sewan) grass seeds after clearing the plot of weeds and shrubs. Satisfactory establishment was recorded inspite of heavy rains after the sowing.

At Manaklao grass strips of these species have been planted at 50 cm spacings, and these have recorded more than 70% success. The practice created a wide impact in the community and now nearly 12 ha area at 5 locations in 4 different villages has been brought under improved grasses plantation. Institute contribution in such programme initially has been to provide with fence material and plants and grass seeds besides technical know-how. Now these facilities are being restricted to the technical advise only. A developed grass land plot in Basani Karwar village can be seen in Fig 5.

Besides suggesting techniques for maintenance of 12 ha area already brought under improved grass strains, an additional 4 ha area was brought under fresh plantation in 1978. Based on the impact of the programme, the farmers of Manaklao village have voluntarily agreed to develop their community land (approximately 100 acres) under improved grass land, if seeds and technical know-how can be made available. This is being given priority. Estimate of expenditure for 100 ha block of range land is given in Annexure VI.

4.3 Shelterbelt and Roadside plantations

The farmers have been educated about the importance of shelterbelt plantation in providing protection to the field crops and orchards. The Institute started this work in the year 1975 on one farmers field in Daijar with 50 plants of *Acacia tortilis* planted on road sides. The establishment has been very good. A shelterbelt of 3 rows of trees, each row 300 m in length, was established across the wind direction. The first row towards the windward side was planted with *Prosopis juliflora*, middle row with *Acacia tortilis* and the third row, nearest to the cropped area, with *Acacia nilotica*. A. *tortilis* and *P. juliflora* species have an advantage over *Acacia nilotica* (ssp. indica) in that the branches of this species always grow upwards and not horizantally. The planting of seedlings has been done at a staggered rate and at 5 m spacement from row to row and also from plant to plant. Road side plantations with *Acacia tortilis* sedlings, planted 5 m apart, have also been done in 1975 along

with the farmers fields to provide protection to their field crops from wind hazards and also to enhance the scenic beauty. Eucalyptus plantation along the contourbunds in water catchment were also done but due to very high intensity of rain and water flow in 1976 these have been washed off. Based on our demonstration work on shelter belt plantations a large group of farmers have approached for tree seedlings for plantation and as a result a strip measuring 3 km involving 16 farmers have been planted. In 1977 a wind strip of 6420 m long has been established. During 1978 another wind strip of 6923 m long has been established and 5360 seedlings of *Prosopis juliflora* and 7983 of *Acacia tortilis* were planted. Initial protection to the plants has been given by fencing with barbed wire lest the seedlings are damaged by brousing or trampling by stray cattle. The plants both in shelter belt and road-side plantation, have established very well and their survival has been more than 85%. To meet the growing demand of the farmers, the nursery was raised at Beri-ganga afforestation centre (near O.R.P. area). This alone of course could not meet the demand and, therefore, a progressive farmer in the O.R.P. area has taken up seedlings raising programme to meet the large growing demand.

4.4 Horticultural Programme

The horticultural demonstration programme carried out under the project has received good support of the local farmers. These farmers have become well aware of the various varieties of fruits and have specially liked the gola and seb ber (Zizyphus manritiana). About 5,000 ber seedlings have been planted so far at different farmers fields in five villages. The plantations have been done under unirrigated as well as irrigated conditions with sweet and brackish water and also at slopy, unlevelled and rocky areas. Two to six months old *ber* (Zizyphus nummularia) (Tharberi) plants were planted which would be budded with the improved varieties of *Gola, Seb* and *Mundia.* A heavily fruited plant of Gola variety is seen in Fig 6. These are quite new varieties for the area and would yield better than the present tikri type. Since the ber plantation requires well protected area and careful maintenance, preferably farmers who could spare such land and look after the plantations in the initial stage were selected. As and when these were ready for budding it was done. In all 2,000 plants have been budded so far. In 1978 about 300 new budded ber plants were planted and 400 local root stocks got budded. Further extension of ber plantation was held up because of lack of buds for grafting ber root or stock for budding. This programme is getting a wider popularity among the farmers. Spot trainings are also extended to the farmers who are anxious to know budding technique. There will be sufficient buds available

within the village and it is hoped to cover a large area in coming season. The details of expenditure and return from one ha ber orchard is given in Annexure VII. An established orchard in Manaklao village can be seen in Fig 7. To meet the high demand of grafted ber from the area, a progressive ber grower has developed nearly 30,000 budded plants at his farm under the technical guidance of the scientists from the Institute.

A view of the nursery is seen in Fig 8. After receiving proper training from the scientists at the Institute nursery and also from those working in the O.R.P. area, the family youth have taken up the total nursery programme. From preparation of nursery beds, plantation maintenance to removing buds from older orchards, and grafting them on the raised root stock is all being done by the farmer himself. The other fruit trees introduced in the area are pomegranate (anar), papaya and lemon. About 100 seedlings of pomegranate have been planted at two spots. So far two varieties i.e. Mandore and Shaharanpur have been introduced. Since seedless variety has a softer edible seed and has the same production potential as Mandore hence suggested for this area. The *anar* seedlings have also been planted under both irrigated and unirrigated conditions. The plants are growing satisfactory. Rocky catchment below sand dune and hillock were also planted with pomegranate but due to submergence in the catchments in 1976 the plants got damaged. An orchard of pomegranate in Daijar village can be seen in Fig 9. During 1978, 4 farmers were motivated to take up papaya plantation in 6 acres of land and further two farmers have come forward and raised the nursery to carryout the papaya plantation for 2 acres. In the same year one farmer from Daijar village has taken up the lemon plantation in one acre area. Efforts are being made to cater to the needs of seedlings of the farmers for lemon plantation. More recently dates have also been introduced in the area. On the edges of low lying saline patch of land, 40 suckers of improved date plants have been planted in 1978. The plants have established. Further extension of the area under date will be taken up in the following years depending on the availability of suckers.

Rejuvination of old orchard : To demonstrate the method by which old orchards could be rejuvinated to the farmers, a demonstration was undertaken at village Daijar on a farmers declining orchard. Besides selected spots demonstrations, many sporadic on-spot demonstrations were also arranged time to time to suggest proper pruning and other management operations. In 1977, 3 lemon orchards in the project area were taken up under this head. Budding operations of ber were carried

out at two farmers demonstration sites. Spraying operations for control of insects and disease were also carried out as a part of insect control programme. Regarding rejuvination of old orchard, institute contributions in these plantations have been to the extent of providing technical guidance and the seedlings earlier but now only technical guidance.

4.5 Crop and Vegetable Programme

Out of the total cultivated area of 3616.91 ha in the O. R. P. area, 286.14 ha is under irrigation and 3330.77 ha under dry cultivation providing good scope for dryland farming including use of simple water harvesting techniques for efficient utilization of limited water. An observational study on the cropping pattern for the Operational Research Project area would reveal that bajra, moth, guar, chillies, til are the important crops in *kharif* and wheat, mustard, zeera, in *rabi*. It is also observed that during 1974 to 1978 the total area under bajra alone decreased, but increased under mixed cropping of bajra and moth which is becoming popular in the area. In *rabi*, the major area is occupied by wheat followed by mustard, onion. Wheat + barley is an important mixed cropping in *rabi*, while gram is being cultivated on a limited area. The interesting feature is that the farmers in the area are increasingly realising the importance af mixed cropping. Pulses with cereals and pulses with fodders are being cultivated as mixed crops in the area.

Demonstration have proved to be most potent carrier for dissemination of new technology to the farmers. Usually demonstrations during kharif season are being conducted on the fields of marginal and small farmers. The year-wise number of demonstrations and minikit trials conducted in the area is given in the Annexure VIII. Among major crops and varieties demonstrated, hybrid Bajra (BJ 104, PHB-12), castor (Aruna), wheat (kalyan Sona, kharichiya-65) and potato (kufri chandra-mukhi) were sound remunarative over existing crop/varieties. The cost and return analysis summary of the demonstrations conducted on bajra, wheat, and potato is presented in Annexure IX-XI. With recommended cultivation practices and fertilizers (40-80 kg N/ha), based on soil test values, the yield of bajra ranged between 30-45 q/ha against 12-20 q/ha obtained with local varieties and conventional cultivation practices. Introduction of castor (var-aruna) increased the yield/ha (12q) and net profit/unit area (Rs. 2200/ha) over local castor. These are being rapidly adopted by the farmers of the area. Similar attainments were demonstrated with wheat (kalyan sona), potato (kufri chandramukhi), a completely new introduction, in the village yielded 200 q/ha with sprinkler irrigation system. Increasing emphasis was given on

economising the use of costly inputs like fertilizers and water. Integrated use of organic and inorganic manures, weedicides, intercrops and introduction of sprinkler system are some of the technologies being demonstrated to meet such objectives.

Our technologies and package of practices have got wider adoptability in the area and a large group of farmers have followed the recommended package of practices on bajra, castor, mung, moth in *kharif* and wheat, raya (mustard), zeera and potato in *rabi* seasion (Fig 10). Based on the analysis of soil samples, gypsum treatment to saline water was given in zeera and wheat. Emphasis was laid on convincing farmers on putting maximum area under improved varieties of crops. Bajra (BJ-104), guar (Durgapura safed) and others were in high demand. Salt tolerant bajra(var-babapuri) was also demonstrated in saline patches. Since this area is very close to the city market and has irrigation facilities, most of the farmers are regularly cultivating these crops and, our efforts were to motivate such farmers to go for sowing of improved seeds, timely use of fertilizers, insecticides etc.

In vegetable farming improved varieties of tomato (Pusa ruby), brinjal (pusa purple long), bhindi (pusa savani), cauliflower (snow-ball), peas (bonvella) and potato (kufri chandramukhi) were successfully introduced in the O.R.P. area. Besides crops and varieties use of fertilizeres, pesticides and weedicides, improved methods of crop cultivation practices were demonstrated which have fast multiplying effect now. Nearly all farmers in these areas are aware of the technologies and more than 70% have adopted improved management prcatices.

4.6 Efficient Water Use

4.6.1 Water harvesting in natural catchment

Since sand dunes and rocky areas constitute a major part of the total area in Rajasthan and limited availability of water is a large problem, extension efforts were made to demonstrate how to make use of these areas and catchments below, if any, based on its suitability for plantation and cultivation of crops. One such catchment area of 4.6 ha, with 2.4 ha sand dune upon one side and rocky hill of nearly 3 ha on the other, covered with wild grasses and plants for years, was selected for demonstrating the water harvesting technique in crop production. With proper use of simple terracing, contour furrowing and bunding techniques, permitting higher water retentation by arresting speed, harvest of a reasonable crop of bajra in catchment below and mung and moth on flat sandy area above was possible besides checking sand erosion. On stored water, a successful crop of raya was harvested in the rabi season. The ponded

expenditure of 0.22 paisa was incurred per rodent. The farmers in the O. R. P. area are now using this rodenticide for rat control. The control operation is repeated in the season with the active association of the farmers.

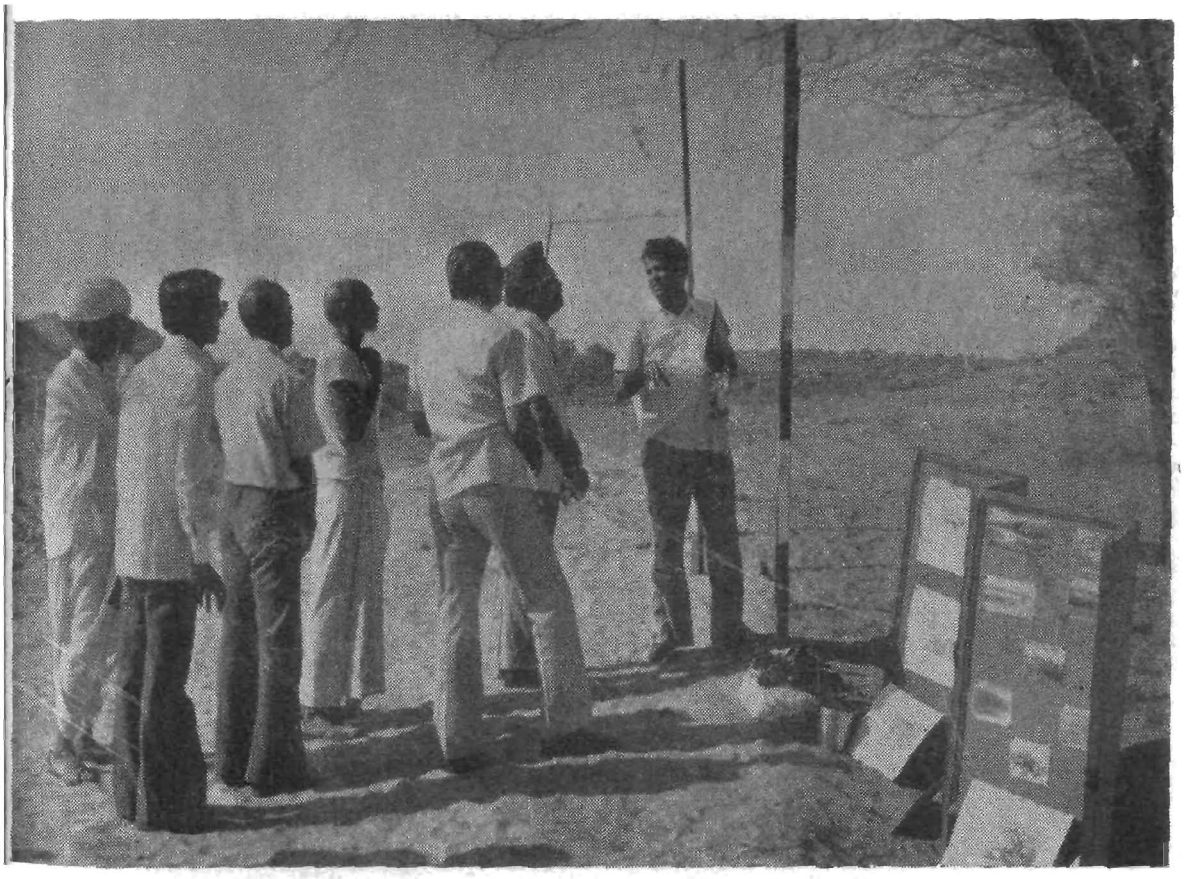
4.9 Installation of Solar Appliances and Gobar Gas Plant

A simple but most efficient low cost solar water heater where the flat-plate collector performs the dual function of absorbing the heat and storing the heated water is installed at Daijar village for demonstration cum trial purposes (Fig 13). This solar water heater costing only Rs. 350/- supplies 90 litres of hot water 80°C in the summer season. Similary, one solar oven as a demostration piece has been installed at farmers field in Daijar village (Fig 14) Farmers have realised that the main advantage of this solar oven are that there is no use of cook to stand in the sun, the oven does not require frequent 'adjustment' towards the sun, food remains warm for hours together even after sunset, efficiency is not effected by the wind speed and dust.

There is an acute shortage of fuel wood in the area and the cattle dung is often used for fuel purpose. A gobar gas plant has been installed in the village to demonstrate to the farmers the most efficient use of cattle dung for the purpose of fuel as well as organic manure. (Fig. 15). The aim is to exhibit the farmers as to how cattle dung can be converted into a good fertilizer (rich into nitrogen content) and to get the gobar gas as a bonus. This family sized gobar gas plant yields about 3 cubic metres of gas per day, which is sufficient to meet the cooking requirement of a family of about 6-8 persons and they can light a gas lamp also for about 2-3 hours per day. For this purpose 50-60 kgs of fresh dung per day is required. The details of the cost of installation of gobar gas plant is given in the Annexure XIII. The total cost of this complete gobar gas plant is about Rs. 2300/- including digestor, civil construction, gas holder, piping, stove, lamps etc. A very simple calculation has shown that this gobar gas plant is actually profitable, besides the incidental advantages of hygenic operation, absence of smoke and root, convencience in burning and richness of manure. More gobar gas plant has been installed at Manaklao village. Realising the importance of the plant many farmers have come forward for the installation of such gobar gas plants with and without subsidy.

4.10 Sheep and Cattle Development Programme

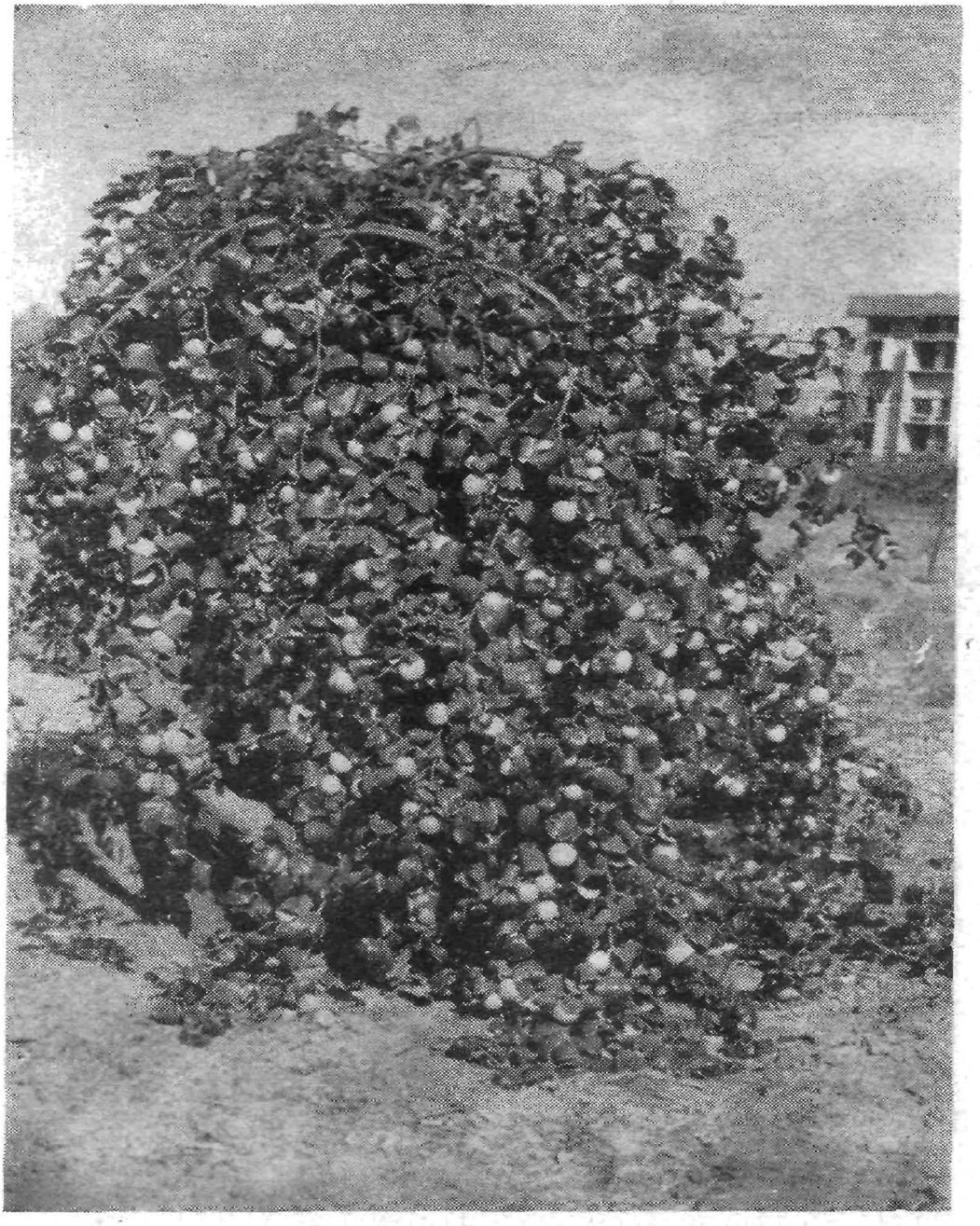
Besides crop improvement, cattle and sheep development programmes were also taken up in the Operational Research Project area. Some important observations regarding



Dr. M.S. Randhawa, Dy. Director Generai I.C.A.R. on a visit to sand dune stabilization area at O.R.P.

Moving sand dune was a problem at Dahijar village. The CAZRI developed technologies have stablised sand dune and have turned the arid land as a source of revenue.

Nuitritive grasses assure animal husbandary — Pasture development in O. R. P.



Desert apple (Grafted Ber) a successful fruit plant for the desert

sheep management practices in Operational Research Project area of the Institute were taken. The total land for grazing of sheep in these villages is insufficient and what so ever is there is not looked after properly. Generally the flock size is small to medium. Water is offered once daily at noon time. All sheeps are housed in open enclosures. Three peaks of cestrus are observed every year, first in march-april, second in june-july and third in september-october. The rams are allowed to mate with the ewes only during desired breeding seasons and for rest of the year a thread is tied around to avoid mating. No special care is taken for managing the pregnant and lactating ewes. Breeding are not usually agreeable for adopting cross-breeding, weaving is done at the age of 5-6 months. Migration practice is most common during the occurence of femine. They also migrate during rainy season tawards Jaisalmer and Barmer where rains are less and plenty of grazing land is available. Shearing is done twice yearly enterotoximia and scabies are the deseases which draw serious attention. Foot and Mouth disease and foot infection affects the income of the sheep raisers indirectly. During rainy season pneumonia is very common. They believe in control of contagious diseases by use of mantras and of common disease by use of local medicines. The preventive measures provided in the area cannot be considered satisfactory.

After a detailed survey of 5 villages in the Operational Research Project area of this Institute, the need for introducing sheep production in the area was keenly felt. Therefore, 10 crossbred rambouillet x chokla rams were distributed in these villages in early 1978. The results pertaining to their reproductive performance of these rams and their comparison with local Marwari rams indicated that cross-bred chokla x rambouillet can perform well, for improvement in the sheep industry in arid region of western Rajasthan and their performance can very well be compared with native Marwari rams. They were sexually more responsive and well adopted to dry hot conditions of this region. Incidences of abortion, still birth and dystocia in the ewes covered by them were nil and mortality rate among cross bred lams was negligible. This breed of sheep may recommended for all round development of sheep sector in Western Rajasthan. A first off spring of this breed in the village can be seen in Fig 16. Our major limitation however, is the mixed colour in these rams article needs to be improved.

5. DRIP AND SPRINKLER IRRIGATION SYSTEMS

This project came into operation in 1976. Since the ready made drip system is no

where available in the country, it was decided to design and produce suitable drippers in the Institute for demonstration purposes. The work done is reported as under.

5.1 Testing of Materials and Production of Drippers

Several kinds of materials viz; PVC, LDP, HDP, LDP+HDP—mix and other plastic materials of different grades were tried on a hand moulding machine purchased locally and installed in our workshop for making drippers so as to find out the cheap and suitable material to be used in the manufacturing drippers. Among the three different grades of PVC, drippers produced from the two did not have firm coupling while from the third the drippers could not be made at all. Plastic, LDP and LDP+ HDP mix produced drippers but with loose fittings and poor strength. Drippers made from HDP (high density polyethene) material were found best as far as the finish and the strength was concerned. There was no loss of material during the course of moulding and each dripper weighed 3-5 g less compared to those made from other materials. Thus the drippers produced from this material, besides being fine in finish, proved cheaper also. By this time we have produced nearly 80,000 drippers with this material in our own workshop. Availability of genuine material and suitable machine hand is a problem. The cost of drippers was coming to Rs. 300-350/1000 piece in 1976 compare to Rs. 1000-2000 in the market. Rates received from various firms, locally and outside Jodhpur, ranged between Rs. 1000 and 2000 p 1000 drippers. Drip manufacturing in the workshop is shown in Fig 17.

5.2 Design alteration

In the original three piece semi-self flushing type drippers sample available with us, the wall thickness of the cover portion and nipples were cut for excess size without reducing the efficiency. This has reduced the quantity of material needed per dripper by about 3-4 g and the pipe size from 15 mm (ID) to 12 mm (ID). We have now processed the purchase of 1,15,000 m PVC pipe (12-15 m size) at Rs. 1.20/m while that of 15-18 m costs nearly Rs. 1.60/m. Thus drip alteration brought a very significant saving in money through economy in use of raw material and also the pipe size. Sliding off of the three piece drippers from the laterals especially in may and june with high temperature was a problem in farmers field. Based on the feed-back mechanism a two piece dripper has been designed which is much more efficient and economical. New designed drip is costing only Rs. 100 per 1000 piece. Different kind of drippers as designed and developed in the workshop can be seen in Fig 18. All this has reduced the installation cost/ha in case of orchards. Two more moulding machines have been purchased and thus our dripper production

target would go to 20,000 drippers per month and thus expecting to meet our requirement. Annexure XIV would give a glance of stage-wise cost analysis of the total drip system as recorded in our Institute workshop. There exists a large scope for further cutting down the cost of the total system. This has to be done if the system is to survive with the farmers.

5.3 Installation

Drip system in total has been installed on 0.6 ha each of potato, tomatose and orchard of pomegranate and citrus. Filters have been made locally. The system has a good access into the village but the high cost of installation and non-availability of the ready made system are the major hurdles in wide adoptation. The cost structure as it stands now is Rs. 18,000-20,000/ha for vegetables and Rs. 4,000-5,000/ ha for orchards. Various firms dealing in plastics/PVC or irrigation systems are also being contacted to workout the commercial manufacturing so as to further reduce the cost of the system and also be able to supply to the farmers on demand. A potato crop grown with drip system at the farmers field in Daijar may be seen in Fig 19 and tomato crop grown in Manaklao in Fig 20. A comparative cost analysis of laying out drip system in vegetable and orchard plantation are given in Annexure XV.

Since the drip production techniques has been standardised and the laterals have been purchased, the system is expected to be installed on larger area in this season. Simultaneously, the work on testing of various kinds of drippers available in the country for their efficiency in crops/plant protection, pressure distribution relation for various kinds of drippers, lateral, emitter and plant distance relations with reference to cost structure of the system, and use of poor quality water through this system in various crops is being done on our research farm. Besides these operations, imparting training regarding installation and operation of the system on farm and in villages will also be given due emphasis. An experiment on such aspects on the farm can be see on Fig 21.

5.4 Sprinkler System

The system is in operation on 24 ha area in the villages covering 8 farmers since rabi 1976. It has been used successfully in producing bajra, wheat, pulses and almost all vegetable crops viz. tomato, potato, chillies, cabbage, cauliflower etc. In *kharif* season supplemental irrigation especially in recycling harvested water on undulating and duney lands are the major advantages expressed by the farmers. The

system has permitted to increase coverage under crops and to harvest oilseed crop in *rabi* season which otherwise was not possible. Many of the farmers are willing to purchase the sets of some sort of financial help through loans is provided through certain financing agencies. The system in use in the O.R.P. area has increased crop yields significantly and irrigation efficiency through increased productivity and irrigation command. In an study made on the farmers fields in the O.R.P. area it was found that the use of sprinkler system permitted 50% saving the water, 25% additional harvest of wheat on unit area basis and 150%on irrigation command basis. The details of the observations made are given in Annexure XVI. The detailed installation cost of sprinkler system on 6 ha area is given in Annexure XVII.

6 EXTENSION ACTIVITIES

While organising various extension activities special attention was paid to involve maximum number of farmers in the programme. Very good rapport has already been created among the inhabitants of the area and a large number of farmers are coming forward to participate and contribute towards the successful implementation of these works. Constant efforts are being made from time to time to motivate and involve more number of farmers and other under this programme. Some of the formal gatherings organised for this purpose are as under.

6.1 Farmers Day

Time to time farmers days are organised at the Central Research Farm of the Institute at Jodhpur. Farmers of surrounding villages participate in the day-long activities. The highlights of the day includes demonstration of nursery techniques suitable for the arid lands, use of fertilizers, important desert grasses, cafetaria of dry farming crops, fodder, legumes, rodent and other pest control etc. Besides, stalls for exhibiting different types of improved agricultural implements, large scale use of seeds of improved varieties of crops and demonstration of use of pesticides etc. are also organised. Questions posed by the farmers on various problems faced by them in the cultivation of crops, grasses and trees, and in the utilization of water on problems of salinity, application of fertilizer, rodent control and choice of pesticides are answered by the scientists of the Institute. Small hand outs in hindi, providing information on different dry land agricultural techniques, and on forestry sand dune stabilization etc. are distributed to the farmers on this occasion. Participating farmer are also given seedlings of *Acacia tortilis* and *Pomegranate* and a small packet of improved grass seeds. This year division has extended the activities to the district of Pali. A kharif mela was organised at Pali central farm. Farmers from the adjoining were made

aware of the improved method of cultivation, ber orchard and date plam. Fig 22 shows the keen interest farmers are taken on 'Farmers Mela' day.

6.2 Field days

Number of field days has been organised from timo to time at the demonstration sites. On this occasion farmers from near by village participated. All the participating farmers were given a round to the different demonstration fields and the various aspects concerning different demonstration explained to them. Besides farmers, staff engaged in various village development programmes also attended these field days. Brief training of farmers for budding operations for ber was also organised. Biogas field cum night camp was organised at biogas plant site, techniques and use have been explained. Scientist farmers discussion taking place in the area is seen in Fig 23.

6.3 School children day

School children, teachers of Daijar, Manaklao, Basani Karwar, Basani Lachha and of Palari Khichiyan visited various demonstration and were explained about the importance and techniques used for different demonstrations organised in the area Fig 24. In addition, each visiting student was given two seedlings of *Acacia tortilis* and some seeds of Aruna castor for plantation in their home compounds. This is a regular activity conducted time to time.

6.4 Navyuwak and Mahila Mandal

Recognizing the importance these two agencies have been established in collaboration with the Block development officer of the area. The district level committee for the Operational Research Projects was helpful in the matter. With the help of the members of Navyuwak Mandal, rodent control operation could be successfully conducted in the area.

6.5 Leaflets in Hindi

Following are the Divisional publications which are distributed from time to time among the farmers for advocation of the recommendations of the Institute.

Village training : Time to time training is offered to the villagers in the area. Farmers were trained in controlling the losses occured in storing the farm production. At 3 different locations the use of celphos was demonstrated in wheat and bajra storage bins to 50 farmers. With the consultance of village panchayat and sarpanch it was planned to impart training to the villagers in different sectors of agriculture and animal husbandry. Such meetings were attended to impart knowledge about improved

cultivation and safe grain storage also. During the kharif 1978, the efficient use of sprinkler irrigation in guar and for supplement irrigation was demonstrated to 4000 farmers at a social gathering. Majority of the people were from the western zone and rural area. They were given understanding about the installation and maintenance of the system. Once in a month on Amawashya day the scientist-farmers gathering is organized in the village to discuss the problems and give training for improved agrl. practices.

Visits : The visitors from the country and abroad are taken around to the Institute. About 200 groups of VIP's, agricultural agencies from country and abroad have visited the area. Some important visitors who were taken to the area (Fig 25) are seen taking interest in the project work.

7 OPERATIONAL CONSTRAINTS

In an analysis of different constraints limiting technology transfer it is observed that cost, non-availability of inputs in time and lack of irrigation facilities minimising risk of crop failure are the major factors limiting use of hybrid seeds and commercial fertilisers. Besides "non-availability," ' wrong availability" of inputs had equally setback the transfer of technology in certain cases. To cite an example, supply of mixed seeds in place of hybrid bajra in one year followed by severe ergot Infection put behind the hybrid seed programme and thus needed much of efforts to re-establish farmers faith in the programme. A small fraction of the farmers still believe the use of fertilizers deteriorates soil fertility. Regarding use of pesticides, cost and poor knowledge about their use were the dominant ones, but few of them did not feel the need for pesticides use.

Farmers general belief that mixed cropping (bajra + mung + moth + til) covers the risk of crop failure, grains of local bajra and wheat are sweeter in taste, fertilizer spoils land and deteriorates grain quality, crop remains thirsty if irrigated by method other than flooding, pesticides poison the grain and use of fertilisers make land surface white (saline) etc. are slowly getting out of the farmers mind but are still a factor limiting faster technology transfer.

For planting of grafted ber *(Zizyphus nummularia)* the major impediments are water quality and shortage of water for initial establishment. Initial expenditure in planting (Rs. 3000/-ha) and fencing (Rs. 4000/- ha.) for protection against animal damage are other important factors limiting adoption.

Recently occurrence of frost in the last two consecutive years has shaken the faith of the farmers to some extent. Availability of grafted ber and lack of knowledge for budding among the farmers communities are also coming in way.

Lack of technical know-how in areas heavily infested with dunes (away from O.R.P. area), lack of finances for providing fence for initial protection and also non-availability of suitable plants types at the farmers door are the major factors limiting fast adoption of sand dune stabilisation programme in the area. All dunes available in the ORP area are covered under this programme and lack of such area in the vicinity of the project area limits further multiplication.

In case of irrigation systems (sprinkler and drip) high initial installation cost, limited water supply, saline water and lack of local skill to handle equipment are the dominant constraints. Many interested farmers are not convinced about the system for lack of these facilities. Our constant efforts in the direction of minimising cost of the drip system through altering planting pattern and improving system design has resulted in reducing the installation cost by Rs. 3000/- 4000/ha. An improved 2-piece dripper, designed and developed in the Institute is costing one-sixth, is more efficient in discharging water and has practically no operational problem compared to original 3 piece ones. These have been the result of built in feed back mechanism provided in the project. Similarly, biogas plant which is now known to most of the farmers in the area is not adopted mainly for non-availability of credit to meet initial installation cost. Many of the farmers do not have so many cattle to meet every day dung requirement and few feel that the system is not beneficial.

In case of rodent control, socio-religious feelings of the inhabitants of the area were observed to over ride prudence in the matter. For example some farmers has a strong feeling that we should not kill the rodents, the nature will check them. They are considering it as riding means for "Ganapati." Arranging frequent individual and group discussions, advocating the necessity of their control in the area the consenses was ultimately reached which shattered their strong belief resulting in an effective massive rodent control in operation in this area which have significant impact now.

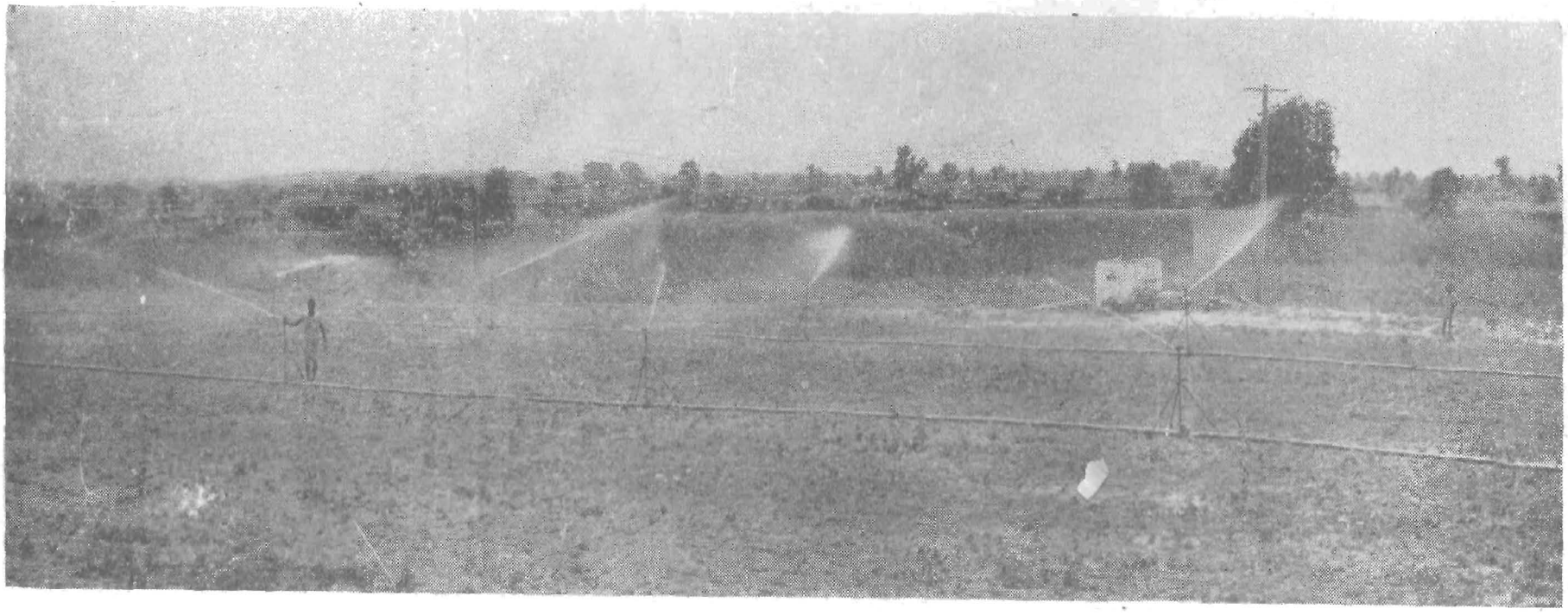
About solar water heater and solar cooker farmers feeling that the system is not beneficial and are not required by the farmers are important limiting factor besides cost. Majority of them go out for work in early morning and return only in evenings and as such are not able to make use of these appliances. Further, the

requirement to rotate solar cooker with direction of sun and farmers absence from the house for work limit practical use. House lady is reluctant to go close to the appliance because of high sun rays reflection to her eyes during operation.

In light of the several constraints mentioned above it is realised that diffusion of those innovations where farmer expects quicker return against investment is faster. For instance use of hybrid varieties, fertilizers and pesticides in crop management have been fastly adopted compared to other technologies listed. Plantations of trees on dunes and fruit trees like ber on duny and undulating marginal lands have higher acceptance if can be protected against animal damage by means other than wire fencing.

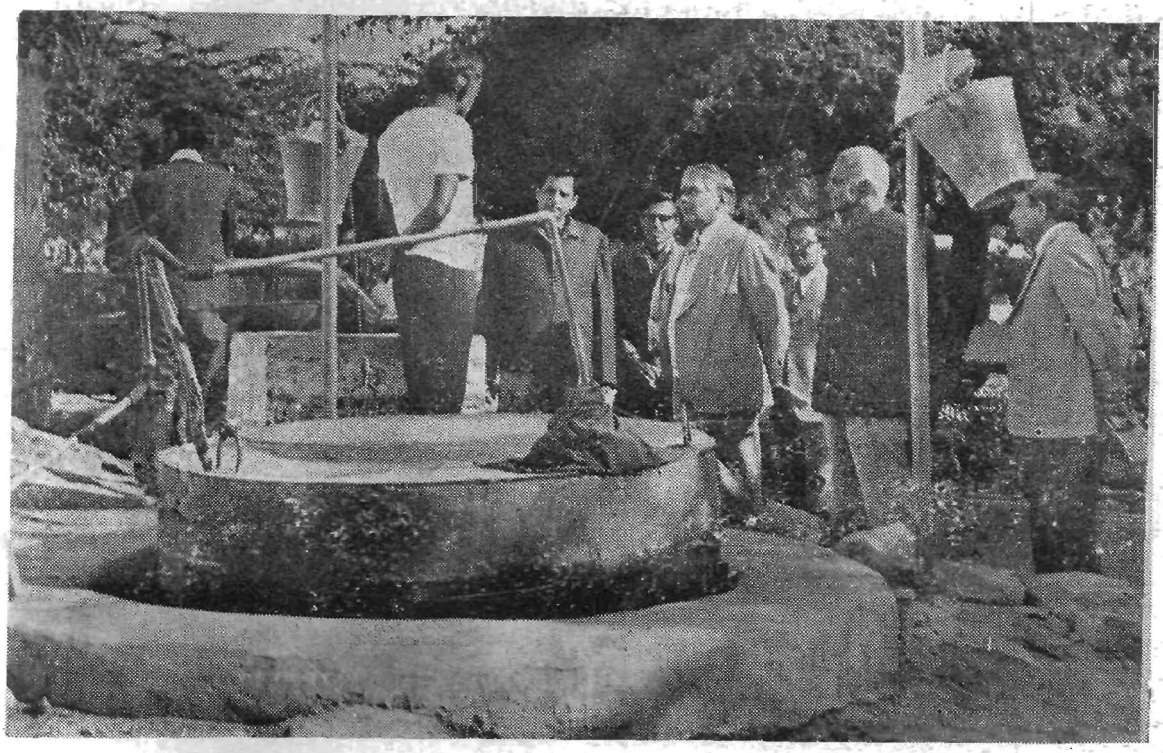
Exposure to media : Unawareness of these farmers to new technologies prior to the launching of this programme and their exposition to comparatively costly inputs like seeds (hybrids), fertilizers (commercial) and pesticides etc. which were partically not in use were responsible for slow adoption of our recommendations in the beginning of the Project. Subsidised use of such inputs and close extension workers farmers discussions were main tools to convince farmers. Our major mode of communication to the farmers is through day to day discussion, conducting of method and result demonstration, holding various field days and distribution of printed literature etc. No doubt the willing farmers are able to take the advantage of the innovation, but quite a large number of them is deprived off. Some of the effective communication modes like use of caste and village panchayat local leaders, writing of appropriate wall slogans, sticking of wall postors, taping their religious congregation, arranging regular film shows, showing documentary and feature films, offering extension lectures, providing daily news papers and community radio sets and keeping regular radio broad casts of our specialists through radio etc. could help in utilization of mass media and community activities in the O. R. P.

Educational Level : The root of the cause being the low level of literacy (13.4%) in the area. Need not say that literacy provides confidence, broadens the mental horizons, and also prepares the individuals to go for new innovations and their social participation also increases. Our observations are that extension literature distributed to the farmers are not fully utilized because of their illiteracy. Adults education programme should go in long way so that maximum number of farmers irrespective of sex and caste one have equal opportunity in the total development work of the community.

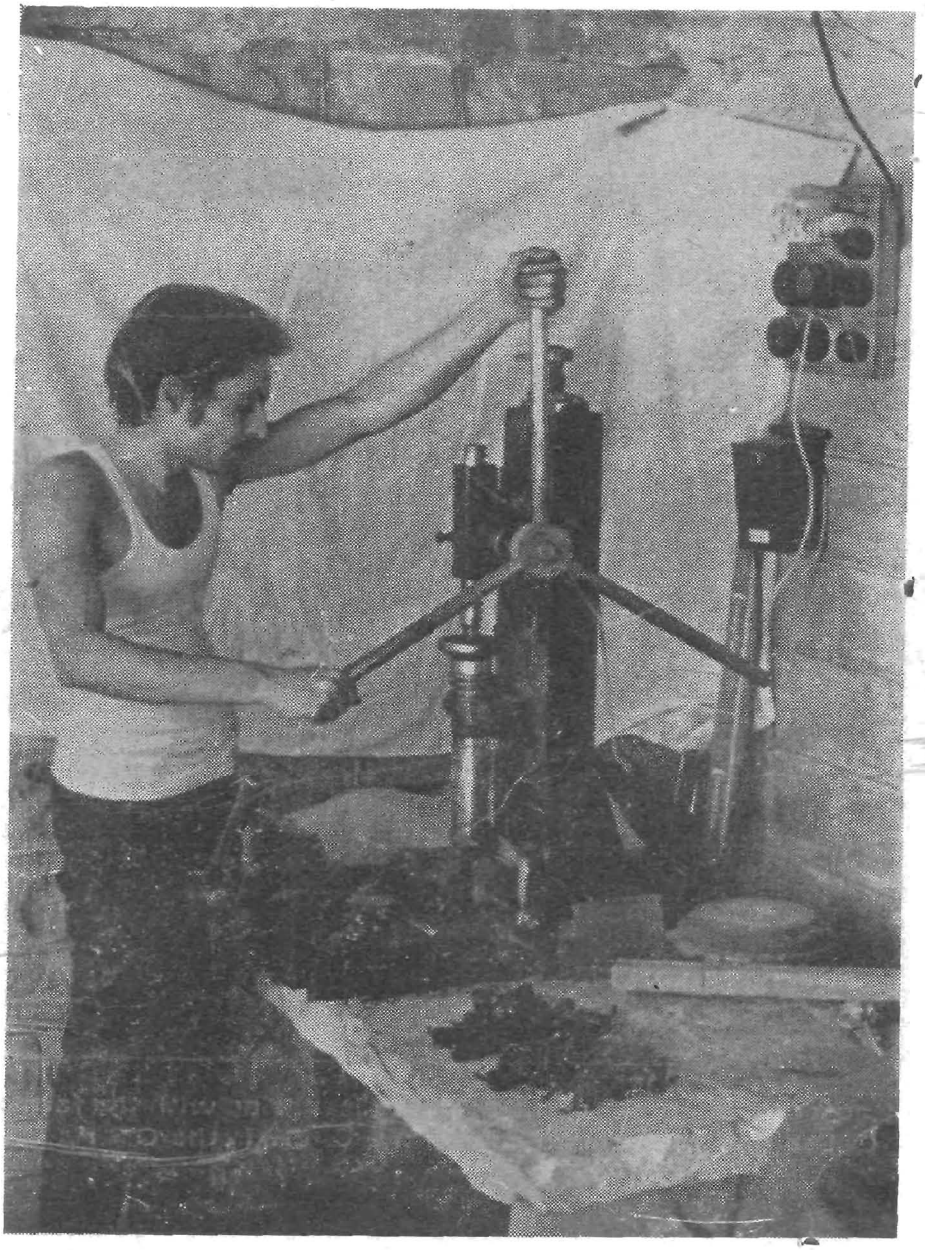


Sprinkler Irrigation — Conserves water and maximises crop production

Dr. N.S. Randhawa, Dy. Director General, I.C.A.R. inspecting Drip irrigation system at farmer's field under O.R.P.



Dr. O.P. Gautam, Director General, I.C.A.R. discussing with the farmer using Gober gas plant installed by the CAZRI in the O.R.P.



Dripper production in the work shop at C.A.Z.R.I.

Farmers dependence on adding agencies : For solution of many community problems, the farming community to a great extent depends on Govt. help and this attitude hampers the progress of work in the area to a considerable extent. This "help me approach" dominated "self help" approach in farming community. This attitude many a times comes in the way of their progress. Our observation on spread of rust in wheat crop, rodent damage and recently locust attack in the area made us to realise that the farmers were waiting for action to be taken by the Government agencies. A good deal of damage was already done before the action is initiated at Government level. Contrary to this there are large number of evidences where farmers are not willing to accept subsidy or free supplies for being afraid of Government action to recover. Our efforts in the area over years in this direction brought successful results and farmers acceptability to the scientific extension programme has gone high. Their participation in each of the extension activities has been much higher compared to previous years.

Natural : Frost damage to ber, papaya and potatose unfortunately experienced in first two years of our programme gave a set back to the programme. Improved technologies should provide measures to overcome these expected natural constraints hampering acceptability. Use of solar water heater or cooker is not synchronised with farmers cooking or bathing time. Majority of them go out for work early morning to their fields and come back only late in the evening thus they are deprived off their actual benefits. In this case probably system needs a change in a way that these appliances could be used in early morning and late evenings. Need not say that these should be cheaper as well.

In light of several constraints mentioned above it is realised that diffusion of those innovations is faster in cases where farmer expects quicker return against investment. For instance use of hybrid varieties, fertilizers and pesticides in crop management have been fastly adopted compared to other technologies listed. Plantations of trees on dunes and fruit trees like ber on duny and undulating marginal lands have higher acceptance, if can be protected against animal damage by means other than wire fencing.

8 OVERALL IMPACT

Our problem oriented efforts in extension, since the inception of the Operational Research Projects, have been to demonstrate the impact of the use of improved crops and varieties on the existing locals that of the use of economical doses of fertilizers

on the prevalent fertilizer-use practices, that of the use of efficient irrigation system on the conventional channel irrigation system and many other crop management practices e.g. timely use of pesticides, maintenance of plant population etc. which directly boost agricultural production.

A detailed schedule-based study conducted in the O.R.P. area revealed that among different crop management factors use of high yielding varieties, commercial fertilizers and insecticides and pesticides reached and multiplied quickly to the farmers fields. As a result of the programmes in the area, local varieties of crops in use earlier have been replaced with hybrids especially in case of pearl millet and wheat; inorganic fertilizers especially urea and diammonium phosphate are also being used where only organics were used. Pesticides and insecticides, not known to the farmers earlier, are being used against control of disease and pest problems in crop production. The awareness and the extent of adoption of various technologies are given in table.

Table : 1 Extent of awareness and adoption of different technologies in percentage in the ORP area.

Response	HYV	Fertili-zer	Insect-icide	Drip	Sprin-kler.	Horti-culture	Biogas	Solarheater/ cooker
Awareness	84	91	67	62	82	73	82	69
Adoption	56	46	53	7	18	60	2	2

With the recommended cultivation practices and the use of fertilizers based on soil-test values (40-80 kg N/ha) the yield of pearl millet in such demonstrations ranged from 30 to 45 q/ha against 12 to 20 q/ha obtained from local varieties and with conventional cultivation practices. The introduction of castor variety Aruna not only increased the yield/ha (12 q/ha) and the net profit per unit area (Rs. 2200/ha) over the local castor variety but also the variety matured early and cleared and land for the rabi crops. This variety is being rapidly adopted by the farmers. Similar attainments were demonstrated with wheat (Kalyansona). Potato (Kufri Chandra-mukhi), a completely new introduction in the village, yielded 200 q/ha with the sprinkler irrigation system. All possible crop-saving measures have also been demonstrated from time to time. Increasing emphasis is also being laid on econo-mising the use of costly inputs, such as fertilizers, and water.

The integrated use of organic and inorganic manures, weedicides, inter-crops (legumes) and the introduction of drip and sprinkler irrigation system are some of the technologies which are being demonstrated to meet such objectives.

About 58% of the area in western Rajasthan is under sand dune. Techniques for stabilisation of such sandy areas and growing grasses, shrubs and trees on these dunes which are now unproductive have been adopted by the farmers. Majority of the farmers have full knowledge about the programme as indicated by accelerated demand for seedlings, seeds, etc. More than 50000 seedlings of different species of plants are planted in the last season alone and much more could have been planted and there been plants available. Most of these plants have been use in strip plantation as wind breaks and shelter belts.

On marginal and sub-marginal lands where crop yeilds are low and soil conservation hazards high, farmers were motivated to use such lands as pastures and rangelands for animal production. Grass species like *Cenchrus ciliaris* and *Cenchrus setigerus* have been found to perform very well. Farmers have realised the importance of growing improved grasses and a small portion of the land of their farm and all community grazing lands are set aside for pasture development programme.

One of the important aspects of the programme had been the most efficient use of rain water and also of the limited well water available. Simple water harvesting techniques e. g. contour bunding, terracing, farrowing and ridging, minor levelling and ponding excess runoff water have resulted stabilizing crop production. Some such areas which otherwise were not under cultivation since long have been brought under cultivation and are giving economic results. Large number of farmers have come forward on community basis to adopt this technique in rainfed cropping. For efficient use of available well water, sprinkler and drip systems, though still in a very early stage of adoptions, have aroused the interest of farmers considerably. A socio-economic study conducted on sprinkler system at farmers land has revealed that the use of system alone brought 100% saving in water and thus doubled the irrigation command, economised in use of labour for irrigation ; resulted in 25% additional harvest on unit area basis and 150% on irrigation command basis. These advantages permitted the farmers to recover the total installation cost in 1-2 seasons of cropping. Many of the farmers are willing to own the system but for certain constraints, mentioned in the succeeding paras, the adoption has not been upto the level expected.

The introduction of alternative source of energy in view of the desertification being caused by the overexploitation of the vegetable resources by the fast increasing population and severe shortage of fuel resources and misuse of organic sources of fertilizer was considered necessary. The installation of biogas plants, solar heaters and cookers was, therefore, taken up. Majority of the farmers who had no knowledge of the systems are fully aware and a high demand for installation of biogas plant is an indication of the acceptability of the system by the community. ${}^{A}_{a}3_{M}{}^{2}$ size biogas plant installed is saving fuel and oil consumption worth Rs. 113/- month in a family of 8-9 members.

Rodent and other crop pests cause a considerable damage to the crop in the arid areas. Any piece meal effort on a small area basis is likely to fail, as rodent would surely over run territories. The situaion, therefore, warranted a necessity for the community to take up the work as its own programme. Consequently the programme was taken on a large scale involving all the five villages of a cluster. A drastic kill of the rodent pests was achieved by mixing 2% zinc phosphide alongwith 1% oil with bajra whole grains.

This programme has become a regular programme of the farmers and most of them come forward for participating in large scale control.

SUGGESTED REMEDIES

For effective transfer of the innovation some suggested steps which are in operation in the area need further strengthening. Among these : (1) Cummunity action approach involving entire society including farm women, school children and teachers should be involved to make the programme more effective especially for their roles to convince farmers about the improved systems. Children and teachers sooner or later turn as propogandist for our village programme and accelerate adoption (2) Entire farming system approach involving entire farm and all its development aspects in an integrated way should be adopted over single components (3) Supporting agencies like development agencies and banks etc. should be directly involved in multiplication of those programmes which are properly demonstrated and are accepted by the farmers. (4) The root of the cause being the low level of literacy (13.14%) in the area. Needless to say that literacy provides confidence, broadens the mental horizons, and also prepares the individuals to go for new innovations and their social participation also increase. (4) Adults education programme should go in a big way so that maximum number of farmers irrespective of sex and caste can have equal opportunity of participating

in the total development work of the community. (5) Some of the effective communication modes like use of castes and village panchayat local leaders, lineage heads writing of appropriate wall slogans, sticking of wall posters, taping their religious congregation arranging regular film documentary and feature film shows, offering extension lectures, providing daily news papers and community radio sets, and keeping regular radio broadcastes of our specialists etc. could help in widening the mental horizons of the farmers. A net work needs to be developed and strengthened. (6) Besides routine farming operations job oriented programmes like establishment of milk producers cooperative societies, breeders association, garden association etc. would make the programme more interesting and will raise the level of acceptability of the farmers. Total farming system approach and intensive cropping system may generate employment potential (7) Unawareness of the farmers to the advanced technologies and their direct exposer in absence of enough base leaves the farmers in a state of confusion. There is need to teach the objectives of the schemes by arranging discussions with the farmers. A proper briefing of the programme before actually implemented is important. This is such essential for certain high level technologies. A strong net work of training programme and arranged group discussions will not only provide enough base for the farmers to adopt recommended technologies, but would also develop a strong feed back machanism for future improving the technologies.

9. Report of the ICAR Review Committees : Review report of the first review committee constituted by the ICAR for Operational Research Projects on Arid Land Management is reported here. The Committee visited the Projects work in December 1976.

Progress of the Operational Research Project

(a) Optimum resource utilization

The team interpreted word "resource" to cover the resources of the Central Arid Zone Research Institute as well as the resources of the farmer/farmers with which Operational Research Project is concerned. The team was happy to note that the resources of the Central Arid Zone Research Institute were fully utilized to support and execute the Operational Research Project.

i) In the programmes of sand dune stabilisation which included watershed management and shelter belts the basic resources of the farmers were fully utilized. The sand dune stabilization programme was a complete and integrated programme consisting

of growing tree and grass species to stabilise the sand dune and management of crop lands to collect and recycle the run-off from the rocky and sand dune catchments. Mortality of trees was low, grass growth was good and in the crop land wheat and raya were raised with supplemental irrigation.

ii) Water is scarce in the arid zones. The objective of drip and sprinkler irrigation programmes was to optimize the productivity per unit water. Although both are high level technologies the team was happy to note the keen interest evinced by the farmers. In fact a couple of farmers brought their own sets as a result of an earlier demonstration on the two irrigation systems. The agronomist in the project cut down the cost of installation by using PVC tubes instead of metal and by cutting down the quantity of plastics needed for making the drippers. By using the water saving systems of irrigation, farmers were able to cut down irrigation requirements by one-half and have brought an additional area of 2 to 3 ha under irrigation. Some of the farmers were willing to share water with their neighbouring farmers for supplemental irrigation to dryland crops like *raya.*

Potatoes were introduced by the Operational Research Project. The farmers have accepted the crop. Management, particularly in the double row drip irrigation system, was excellent. After potatoes off season vegetables were proposed to be grown.

Agronomic management of wheat, the traditional irrigated crop, needed improvement. The population density was not optimum. The crop growth was not uniform, possibly due to deeper sowing and uneven fertilizer distribution. Berseem crop was poor, possibly due to phosphorus deficiency.

It is suggested that whole farm plans be developed listing the needed inputs and their allocation to the crops selected. Secondly, water in the wells was plenty because of the good season. Alternative crop plans need be developed for use of well water in years of subnormal rainfall.

At the time of the visit of the team, all the kharif crops were harvested and there was thus no opportunity to look into the resource utilization in the drylands. The results of demonstrations on dryland crops were encouraging. It is suggested that scientists may study the causes for variations in the crop yield in the demonstrations with a view to identify remediable constraints such as time of sowing, plant stand, weed control, etc. The scientists in the Operational Research Project were aware that tillage, seedling, plant stand and weed control are the constraints to increased

production in the drylands. It is suggested that they should work out practical solutions to identified problems using as far as possible farmers resources. Both the scientists and the farmers agreed that the hybrid bajra programme suffered a severe setback due to (a) poor quality of the seed and (b) ergot disease. Solution to these two problems is beyond the Operational Research Project.

Aruna castor was introduced as a dryland crop in the Operational Research Project and was accepted by the farmers who not only grew it in the drylands but also in the irrigated chillies, 500 kg of seed was distributed. The next step is to educate the farmers on the maintenance of purity of Aruna castor which can be done only if they voluntarily not to grow local variety of castor and adopt the concept of a seed village.

iii) Under fruits, programmes with ber (Zizyphus) in drylands and pomegranates with protective irrigation were taken up. Budded ber programme was confined to farmers holdings near the villages. Some of the more enthusiastic farmers have taken it up in the irrigated lands. It appears that the quality varieties of ber now budded require protection against fruit flies which though simple, can be expected to be taken up only in a plantation system. When ber is included in afforestation programmes, it may be necessary to use "Theekri" bud wood so that plant protection is eliminated.

iv) Rodent control is one of the successful programmes. It was heartening to note that even "Bishnoi" farmers, who are averse to hurting any animal, have themselves contributed grains for preparing baits. In order to be successful, the campaign should be repeated periodically.

v) Because of the scattered dwellings, individual farmer contacts were difficult and conventional communications were ineffective. The Central Arid Zone Research Institute discovered that communication through lineage heads was the most appropriate approach. In addition, farmers' days, field days, result and method demonstrations were held. Leaflets in Hindi were distributed among farming communities.

(b) Operational constraints in the transfer of new technology

i) Sand dune stabilization

The technology recommended by Central Arid Zone Research Institute was proven in the farmers' fields. The constraint is one of magnitude and it is beyond the resources of an individual or a few farmers to undertake this type work like the soil

conservation, sand dune stabilisation should be considered as a national programme. The main bottlenecks seem to be the cost of fencing and the non-availability in large numbers of the seedlings of suitable species.

ii) Afforestation and Shelter belts

The farmers are prepared to plant and take care of the seedlings. The major constraint is the availability of seedlings in sufficiently large numbers. The Central Arid Zone Research Institute has produced last year nearly 35,000 seedlings but the need is much more.

iii) Improved crop productivity

In the case of drip and sprinkler systems of irrigation, the major constraint appears to be the availability of easy credit. The Central Arid Zone Research Institute has the proven know-how and is exploring the possibilities of getting some of the local enterpreneurs interested in fabricating the sets and providing services.

The dryland technology relies heavily on cash inputs like fertilizers which many farmers may not accept because of risk due to uncertain weather. As mentioned earlier, solutions to the bajra problems have to be sought elsewhere.

iv) Dryland fruits

The operational constrains in the case of ber has been the transport of bud wood from Central Arid Zone Research Institute which was over come by raising plantations of budded ber at selected locations within the Operational Research Project. The team felt that budded ber may be included in the sand dune stabilisation programme along with grasses, on lands which are not suitable for cultivated crops.

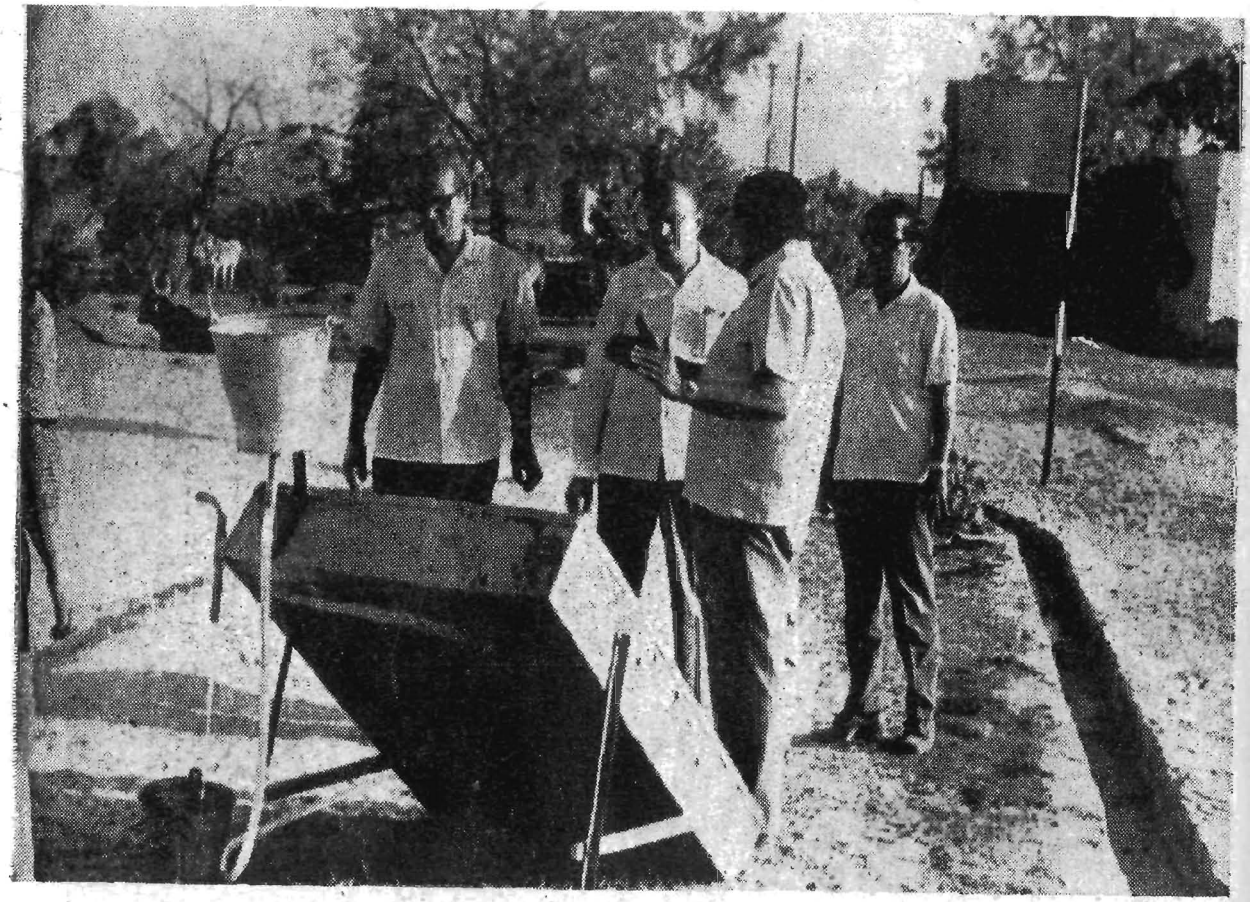
v) Communication strategy

In spite of the "Lineage method of communication," it is difficult to have periodical contacts unless quick transportation is provided.

2. Inter-disciplinary scientific approach

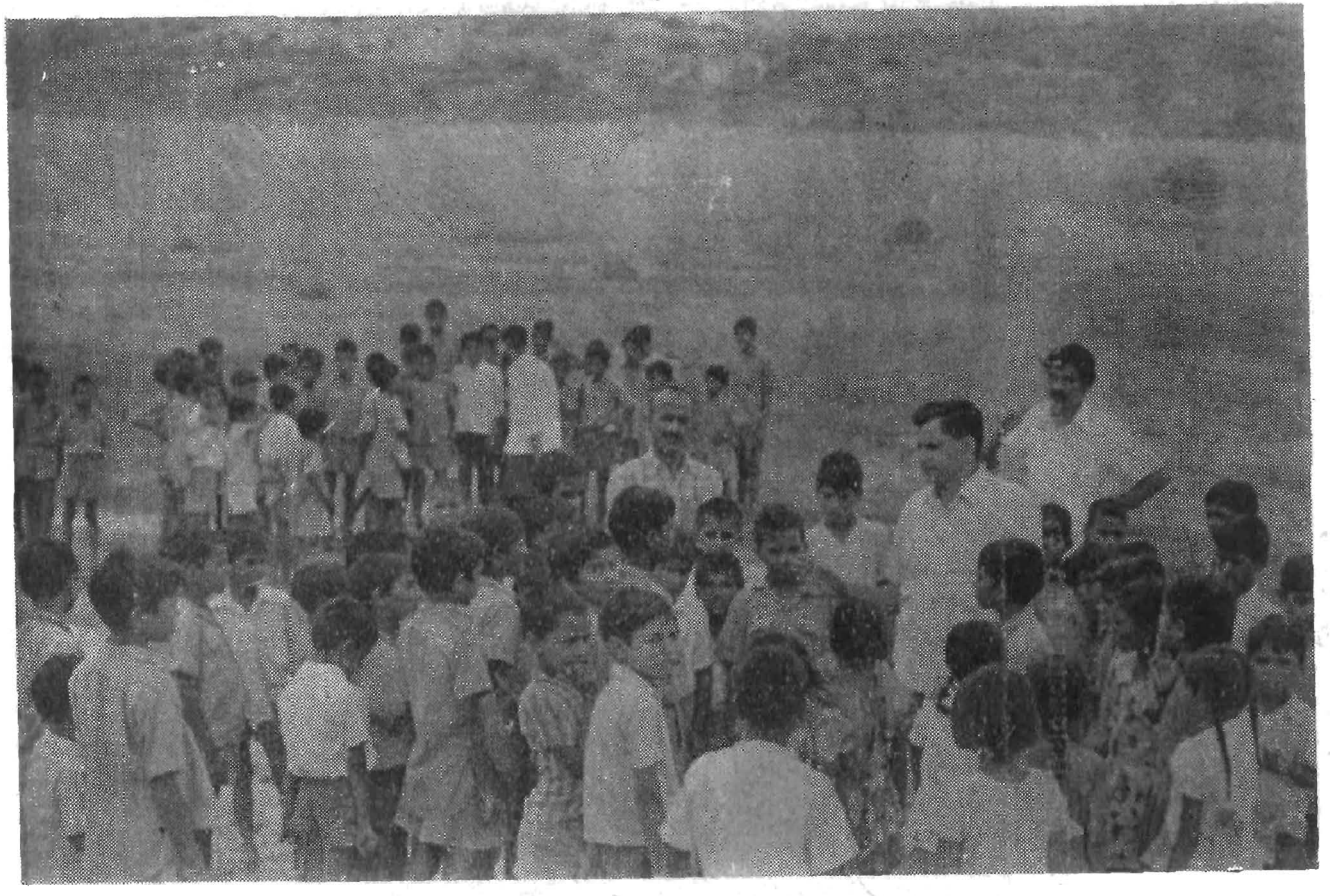
Presently, the departments of economics and sociology horticulture, agronomy and silviculture are jointly implementing the Operational Research Project. This association has resulted in developing a fine and understanding team. The necessary backstop to this team of field workers was provided by all the departments of the Central Arid Zone Research Institute. It is felt that involvement of the dryland

Dr. O. P. Gautam, Director General, I. C. A. R. on a visit to O. R. P., being welcomed by the farmers.



Dr. M.S. Swaminathan, Director General, I.C.A.R. inspecting solar water heater installed at farmer's house under O.R.P.

Members of Desertification Panel visiting to Operational Research Project area.



Children'sday celebration in O. R. P. area

team of the Central Arid Zone Research Institute will further strengthen the Operational Research Project.

3. Social audit

Based on the basic resources survey and socio-economic bench-mark survey conducted before the initiation of the Operational Research Project, small and marginal farmers have been selected for laying out demonstrations. Data have been collected for assessing the impact of the Operational Research Project on the farming community as a whole and, in particular, on the small and marginal farmers. Data analysis was in progress.

4. Scientific and Administrative consertia in PROJECT Monitoring

The team was of the view that monitoring of the project should imporve, particularly in terms of assessing the impact of the programmes. For example, although the tree and grass growth in the sand dune stabilisation programmes was excellent, no data were available on the yield of grass or growth of the trees.

As mentioned earlier, the sheep development programme was planned as a collaborative programme with the Sheep and Wool Research Institute, Malpura. This project was not initiated due to lack of response from Malpura Institute in spite of repeated requests from the Central Arid Zone Research Institute.

The Central Arid Zone Research Institute was aware of the need to associate the district administration in planning execution and monitoring the project and was working towards this end.

Because of the success achieved in several programmes of the Operational Research Project, it is time that the financial institutions are intimately involved in the project. For this purpose, detaild feasibility and profitability studies with supporting data are necessary.

5. Recommendations

a) For the consideration of the Council

i) By its every nature, Operational Research Project is a difficult one. This is perhaps first time that the scientists are asked to take up and implement such projects. It is, therefore, necessary that the sanctioned staff is in position before taking up the project. The Council may consider ways and means for hastening recruitment of the personnel for the Operational Research Project.

ii) The operating staff will have to live in villages and this usually means running two establishments. The project staff should, therefore, be sanctioned a suitable allowance to meat the additional expenditure.

iii) The areas like Rajasthan where farmers' dwellings are scattered, there is need for quick transportation for the operating staff.

iv) The Operational Research Project poses a very important question on personnel policy. There is an apprehension amongst scientists that working in an Operational Research Project places them in a disadvantageous position because their work does not lend itself to publication of scientific paper and the usual norms developed for assessment of scientists working on a research station are inappropriate.

v) To achieve uniformity in reviewing the project at least one member should participate in the review of all the Operational Research Projects.

b) For the consideration of the Director of CAZRI, Jodhpur

i) The team of Operational Research Project scientists could be further strengthend by the involvement of the dryland team of the Central Arid Zone Research Institute.

ii) A small internal committee may be set up to visit the operational research project during the crop season, review the progress and suggest refinement and shifts in emphasis.

For the consideration of Operational Research Project scientists

i) It is recommended to list the farmers' existing practices, recommended practices, farmers' response, alternatives suggested and the agreed practices for implementation. This is necessary to place the field problems in their proper perspective.

ii) In an operational Research Project the focus should be on how to implement the agreed practices without sacrificing the scientific principles but compromising on the practices, using primarily the farmers' resources and implements.

iii) More emphasis should be placed on improving productivity of the drylands, minimising risks and stabilising the production.

iv) Changes in the attitude of the farmers and the impact within and immediately outside the Operational Research Project should be monitered.

v) One of the distinctive feature of the Operational Research Project is that is enables a direct feed-back to research. It should, therefore, be the endeavour of the

operating scientists to influence the research programmes at the Institute in a direction to solve the problems encountered in the field. There should be conscious effort in this direction.

Conclusion

The team would like to place on record the fact that the Central Arid Zone Research Institute initiated, as early as in 1972 village programmes using its own resources, which served as a precursor to the Operational Research Project sanctioned in 1974. Though only a few of the staff positions sanctioned have been filled the Institute has taken up Operational Research Project utilizing the Institute staff.

The team would like to acknowledge the co-operation of the Director, Central Arid Zone Research Institute and the assistance of the operating team headed by Shri S. P. Malhotra in reviewing the project.

ANNEXURE I

BUDGETARY AND STAFF POSITION OF O.R.P. ON ARID LAND MANAGEMENT

S. No	Name of Posts	No. of posts	Filled	Unfilled	Remarks
1.	Operational Research Officer	1	Nil	1	One SI (Botany) joined in January,
2.	**Subject matter specialists**				
	1. Agronomy	1	Nil	1	1979 against the
	2. Animal husbandry (Sheep)	1	Nil	1	post of pasture/
	3. Pasture/Forestry	1	1	Nil	Forestry.
	4. Production Economist	1	Nil	1	
3.	Research Assistant	2	Nil	2	
4.	Fieldman	1	1	–	
5.	Driver	1	1	–	
Budget (for 5 years ending 1978-79)					
6.	Allowances and Honoraria	: 3,52,181			
7.	Travelling allowances	: 22,500			
8.	Contingencies (Furniture, equipment etc.)	: 65,000			
9.	Petrol, Repairs of Jeep etc.	: 45,000			
10.	Contribution in the form of subsidies	: 50,000			
		5,34,681 or say 5.35 Lakhs.			

ANNEXURE II

BUDGETARY AND STAFF POSITION OF O.R.P. ON DRIP AND SPRINKLER METHODS

Sl. No.	Name of Posts	No. of Posts	Filled	Unfilled	Dete of Joining
I.	1. Project Officer	1	Vacant	1	S2 (Engg. & soil
	2, Senior Research Assistants	2	,,	2	Conservation)
	3. Machanics	1	,,	1	Joined in April,
	4. Operators	2	,,	2	1979.)
	5. Field-cum-Watchman	3	3	Nil	S-1(Agr. Engg.) Joined in Dec. 1978.
	Budget (for 5 years ending 1978–79)				
II.	Allowances and Honoraria	: 2,70,156			
III.	Travelling allowance	: 8,000			
IV.	Contingencies (Non-Recurring)	: 4,60,000			
V.	Contingencies (Recurring)	: 8,000			
		7,46,156 or say 7.46 Lakhs			

ANNEXURE III

OCCUPATIONAL DISTRIBUTION OF WORKING FORCE IN O.R.P. AREA

S. No. *Occupation*	Number	Percentage	Remarks
1. Total workers	976	29.08	of total population.
2. Cultivators	629	64.44	of total workers.
3. Agricultural labourers	194	19.88	of total workers.
4. Livestock forestry, plantation etc.	12	1.23	of total workers.
5. Mining and quarrying	5	0.51	of total workers.
6. Manufacturing of household	7	0.72	of total workers.
7. Other than household	1	0.10	of total workers.
8. Construction	7	0.72	of total workers.
9. Trade and commerce	12	1.23	of total workers.
10. Transport, Storage and communication	28	2.87	of total workers.
11. Other services	81	8.30	of total workers.

ANNEXURE - IV

Socio-economic characters of O.R.P. area

1.	Area	7812 ha or 78.12 Sq.km
2.	Population	3356 [Male : 1806 [Female : 1550
	Workers	*: 976*
	Non-workers	: 2380
3.	Density	: 45/58 km
4.	Religious Distribution	: Hindus, Jains, Muslims
5.	No. of house holds	: 548
6.	Literacy	: 14.30 per each
		(Total literates - 480 - Female 52 - Male 428
7.	Size of holding	: 6.53
8.	Occupational structure	(Earners)
	a) Agriculture	: 629 persons
	b) Casual labour	: 194 persons
	c) Animal husbandry	: 12 persons
	d) Others	: 141 persons
9.	Average size of holding	: per house hold 6.59 ha. irrigated 0.52 ha. unirrigated 6.07 ha.
10.	Community facilities available	
	a) Primary school	: 3
	b) Railway station	: Daijar & Manaklao
	c) Road Transport	: Connected by Katcha/pacca roads
	d) Electricity available	: Only in Daijar Manaklao and Palri-Khichyan
	e) Co-operative society	: One.
11.	Irrigation	
	Well-active	: 105
	Pumping sets	*: 38 (also electrified)*

12. LAND use category	Area in ha.	Percentage
(a) Uncultivable		
a) Hills and mountains	1404.79	17.99
b) Barren & Uncultivable land	133.77	1.71
c) Land used to other than than agri.	340.83	4.37
d) Permanent pasture & other grazing lands	153.35	1.96
TOTAL	2032.74	26.03
(b) Cultivable		
a) Current fallow or one year fallow	1014.12	12.99
b) Two year fallow land	976.75	12.51
c) Old fallow	206.21	2.64
d) Banjar	8.49	0.11
Total	2205.57	28.25
(c) Cultivated		
a) Irrigated	286.14	3.66
b) Unirrigated	3330.77	42.66
c) Total cropped area	3616.91	46.32
Double cropped area	47.49	0.61
Net area sown	3569.42	45.72

ANNEXURE-V

Benefit : Estimate for Sand Dune Afforestation of 100 ha. Block

A.	Afforestation :	
	Planting distance 5m x 5m	40.00
	No. Of plants	
1.	Fencing with barbed wire and angle iron posts	26,000.00
2.	Digging pits 60 x 60 cm refilling with fresh soil, mulching etc. 40,000 pits at 8 pits per rupee+mulching.	10,000.00
3.	Cost of raising seedlings 50,000	5,000.00
4.	Cost of transporting the planting materials over a distance of 5 kg on tractor trolley 2 trolley loads @ Rs. 10/- per trip	2,000.00
5.	Cost of weeding-2 weeding	2,000.00
6.	Cost of planting and replacement at 100 plants per man days @ Rs. 4.00 p.d.	2,000.00
7.	Watch and ward 2 watch men @ Rs. 150/- per man for 8 months	24,000.00
8.	One watch man for 9 years @ Rs. 1,200/- per year	10,800.00
9.	2 hutments for watch men, 1 pucca & 1 kutcha	6,000.00
10.	Unforeseen expenditure	800.00
11.	Interest on fixed capital at 11%	7,370.00
12.	Depreciation on fixed capital @ 5%	1,900.00
		76,270.00

B.	Returns from 10th year onwards by adopting 10 years rotation on a 100 ha. block	
1.	Fuel yield by adopting felling blocks of 3,000.00 qts. 10 ha. a year at 300 ats./ha	
2.	Rate of fuel sold at site Rs. 3/- qt.	
3.	Value of fuel from 10 ha. block	9,000.00
4.	Fodder value from lopping at 4/- ha for 10 ha.	40.00
5.	Value of thorny twings sold at site @ Re. 1/- ha for 10 ha.	10.00
6.	Grand total (3+4+5)	9,050.00
7.	Total expenditure on the afforestation work 100 ha block excluding fencing cost. (Rs. 76,270-26,000) = 50,270	50,270.00
8.	Expenditure for 10 ha block (say Rs. 5030)	5,027.00
9.	Net profit after 10th year 9,050-5,030	4,020.00
10.	Net profit per ha. after 10th year Rs. 402/- p. year Say Rs. 400/- per year/per ha.	

ANNEXURE VI

ESTIMATES OF EXPENDITURE FOR 100 HECTARE OF BLOCK OF RANGELANDS IN SEMI ARID REGIONS

S. No.	Particulars of cost item	Annual rainfall above 300 mm	Remarks
1.	Fencing	Rs. 37,000.00	This includes the expenditure on external and internal fencing.
2.	Soil conservation measure	Rs. 20,000.00	If necessa ry
3.	Reseeding	Rs. 35,000.00	If necessary
4.	Water points	Rs. 20,000.00	
5.	Housing for animals and stores, etc.	Rs. 12,000.00	
6.	Housing for watch and ward	Rs. 8,000.00	
7.	Field equipments	Rs. 4,000.00	
8.	Fire line and roads	Rs. 6,000.00	
	Total	Rs. 142,000.00	
		Recurring (per year)	
1.	Watch and ward	Rs. 4,000.00	
2.	Miscellaneous	Rs. 4,000.00	
	Total	Rs. 8,000.00	

ANNEXURE—VII

Estimates of Expenditure on 1 ha ber plantation in semi-arid regions.

Outlay per hectare

		Rs. P.
A.	First year	
1.	Field preparation (lay out, digging and filling o. pits)	
	Labour (16 man days)	80.00
	Manure	250.00
	Aldrex dust	10.00
		340.00
2.	Cost of grafts @ Rs. 3/- each (gap filling	750.00
	of mortality) 750.00+75.00) = 825.00	75.00
		825.00
3.	Planting	
	Labour (one man day)	5.00
	Two watering (one cartman@ Rs. 15/- with one man day)	40.00
		45.00
4.	Training, one man day (Mali)	10.00
5.	Miscellaneous	100.00
		1100.00
	First year total	1320.00
B.	Second to fourth year	
1.	Insect control @ Rs. 1 per tree	250.00
2.	Irrigation if necessary	50.00
3.	Bird scaring (Dec. to Jan.)	120.00
4.	Miscellaneous	180.00
		600.00

C.	Fifth year onwards (per year)	
1.	Manuring	2000.00
2.	Insect control of @ 3/tree	750.00
3.	Bird scaring	250.00
4.	Miscellaneous	200.00
		3200.00

Total Expenditure from 1 to iv year 1320 + 3 (600)	=	3120/ha
Expected income from II to IV year	=	10000/ha
Expected income V year onwards	=	8000/ha

ANNEXURE VIII

YEAR - WISE CROP DEMONSTRATIONS CONDUCTED IN O.R.P. AREA SINCE KHARIF 1974
(Since Kharif 1974 to Rabi 1978)

S.No.	Year	Bajra	Moong	Moth	Kharif Guar	Castor	Minikit trials on bajra	Wheat	Potato	Rabi Raya	Tomato	Bhendi	Gypsum tret Wheat	Zeera
1	1974	4	—	—	—	—	—	3	—	1	—	—	—	—
2	1975	9	1	1	—	—	—	7	1	—	—	1	—	—
3	1976	5 (BJ1 04)	1 (s-8)	1	—	—	-	1	2	1	1	—	—	—
4	1977	5	2		1	4	2	2	—	1	—	—	1	2
5	1978	4 (salinity)	3		3	1 Salinity-1	5	4	—	1	—	—	—	—
	TOTAL	27	7	2	4	5	7	17	3	4	1	1	1	2

ANNEXURE—IX

Cost and Return Analysis of Demonstrations on Bajra in the O.R.P. Area

(Per Acre)

S. No.	Item	1975 Rs.	1976 Rs.	1977 Rs.	1978 Rs.
1.	Seed	22.00	20.00	20.00	20.00
2.	Fym	160.00	Nil	60.00	100.00
3.	Fertilizer	302.00	256.00	87.02	75.00
4.	Field preparation and Sowing	60.00	42.00	35.01	40.00
5.	Interculture	75.00	5.00	20.00	35.00
6.	Irrigation	—	—	—	—
7.	Harvesting and threshing	130.00	20.00	20.00	30.00
8.	Total Cost	750.00	343.00	247.00	300.00
9.	Yield Qunt/acre	18	3	2.5 Qt	4.85
	grain fooder	40	8	7 Qt	10
10.	Returns gross (Rs.)	1910.00	350.00	305.00	455
11.	Return Net (Rs.)	1160.00	7.00 *	58.00 **	155

* Severe incidence of engot disease resulted in very poor yield.

** Failure of rains at maturity time resulted in very poor yield.

ANNEXURE X

Cost and return Analysis of Demonstrations on Wheat in the O.R.P. Area (does not include the fixed costs like depreciation and interest on fixed capital.)

STATEMENT I

(per Acre)

S.No.	Item	1974 Rs	1975 Rs	1976 Rs	1977 Rs	1978 Rs
1.	Seed	121.00	143.00	150.00	96.00	96.00
2.	Fym	50.00	80.00	75.00	160.00	200.00
3.	Fertilizer	177.00	342.00	341.00	223.00	150.00
4.	Field preparation and sowing	80.00	170.00	100.00	92.50	95.00
5.	Interculture	98.00	50.00	60.00	20.00	15.00
6.	Irrigation	250.00	250.00	175.00	166.00	150.00
7.	Harvest threshing	90.00	125.00	60.00	186.00	170.00
8.	Total cost per acre	616.00	1205.00	961.00	843.60	876.00
9.	Yield q/acre	14 35	18 40	6 10	24.00	18Qty 40
10.	Return Gross (Rs)	2385.00	2550.00	1050.00	3300.00	2440.00
11.	Return Net (Rs)	1769	1345	89.00	2456.40	1564.00

ANNEXURE XI

Cost and Return Analysis of Demonstration on Potato (Kufri Chandra Mukhi)

(Per acre)

Sl. No.	Item	(Value Rs) 1975	1976
1.	Seed	1,441.00	3,150.00
2.	Fym	800.00	1,500.00
3.	Fertilizer and plant protection	1,034.00	547.40
4.	Field preparation and sowing	220.00	122.00
5.	Interculture	155.00	88.00
6.	Irrigation	200.00	203.00
7.	Harvesting	200.00	180.00
8.	Total Cost	5,156.00	5,931.40
9.	Yield Quant/ac.	80.00	100.00
10.	Return - Gross	12,000.00	12,000.00
11.	Return - Net	7,030.00	6,068.00

ANNEXURE — XII

ESTIMATES OF EXPENDITURE FOR CONTROL OF INSECTS AND PESTS ON 1 ha AREA IN SEMI—ARID REGIONS.

Budget involved.

1. (a) For the control of white grub in one hectare land		
Cost of BHC dust 10%	= Rs.	140.00
Labour	= Rs.	5.00
Total	= Rs.	145.00
11. For the control of termites in forest tress		
Cost of aldrin 30 Ec for 40 trees	= Rs.	12.80
Spraying charges for 40 trees	= Rs.	10.00
	Rs.	22.80 (Total cost for 40 trees)
111. For the control of termite in wheat		
Cost of 10% BHC dust per hectare	= Rs.	140.00
Labour	= Rs.	50.00
TOTAL	Rs.	190.00

(For one ha.)

ANNEXURE – XIII

COST OF ANALYSIS OF THE GOBAR GAS PLANT

S.No.	Item	Number	Cost
1.	**LABOUR CHARGES**		
a.	Pit digging	25 Males	150.00
b.	Mason charges	28½ ,,	259.00
c.	Labour charges	47 ,,	173.90
			582.90
1.	**CONSTRUCTION MATERIAL**		
a.	Stone	4 Truck	240.00
b.	Cement	13½ Bags	271.77
c.	Lime	100 CFT	200.00
d.	Mungia	1 Peti	7.50
e.	Bajri	1 Truck	60.00
f.	Concrete	—	35.00
g.	Cement pipe	4M3"	13.25
			827 52
3.	**GAS HOLDER ETC.**		
a.	Gas holder	4 Drums	319.40
b.	Wire	15 Meter	62.80
c.	Bucket	3	36.00
d.	Rounds	I	25.17
e.	Gas stove	1	28.17
f.	Gas coke	1	18.00
g.	Gas lamp	1	75.00
h.	Taxes, Transport charges etc.		55.00
i.	G.I. Pipe 7.3 M	40 MM	123.00
j.	Brass value	1	28.00
k.	Hose pipe	2 ft.	8.00

l.	G.I. Albow	9	9.00
m.	G.I. Tee	2	3.08
n.	Safeda	1 Tin	1.50
o.	G.I. socket	5	5.00
p.	G.I. pipe	10.06 Mt.	86.90
q.	G.I. pipe	72×15mm	7.55
r.	Pipe threading		4.50
			870.09
		Total cost :	2,280.50

ANNEXURE – XIV

STAGE-WIRE COST ANALYSIS OF THE DRIP SYSTEM

Material	Market	Rates (Rs. 1000 PC drippers or 1000 m pipe Institute workshop			
		Original design	Changed designed	Present cost*	Improved drippers.
1. Drippers	1000-2000	500-550	350-370	330-350	130-135 (two piece dripper
2 Laterals					
PVC flexible pipe 12 mm 10-15 mm	1200-1600 (12 to 15 mm 1D)	1500-1600 (15mm 1D)	1200-1300 (12mm 1D)	1200-1300 (12mm (1D)	1200-1300 12mm (1D)

* mainly due to lowering down in cost of raw material.

ANNEXURE — XV

1. Detailed layout of drip irrigation system.

Crop/plant	Area (ha)	Plant Spacing (m)	Row Spacing (m)	Lateral Spacing (m)	Emitter Spacing (m)	Total Capacity (gpm)
Potato	(100m × 100'	0.15	1.0*	1.0	0.5	140
Pomogranate	(100 × 100m)	6.0	6.0	6.0	6.0	0.90

* Double row planting at rows 20 cm apart

2. Cost of installation of drip irrigation system on 1 ha area.

Items	Vegetables			Orchard	
	Rate Rs.	Qty	Total	Qty.	Total
A. Main line (90mm G.I. PVC)	25/m	75m	1,875	75m	1,875
B. Sub-main (40mm PVC)	3.50m	200m	700	200m	700
C. Laterals(12-15mmPVC)	1.20m	10,000m	12,000	2000m	2.400
D. Emitters (Two piece)	140/pc	20,000pc.	2,800	1500 pcs.	210
E. Fitter (Brass sieve)	400/pc	one pc.	400	one pc.	400
F. Fertilizer Applicator	4/00pc	one	400	one	400
G. Nipples (PVC)	90/1000pc	200pc.	18	200 pcs.	18
H. End stops (PVC)	80/100 pc.	200 pc.	16	200 pcs.	16
I. Bends and joints	—	—	100		100
J. Others	—	—	100		100
		Total	18,409		6,219.00
		Say Rs.	18,500/-		6,200

ANNEXURE - XVI

Water use, Irrigation command and Economics of sprinkler system in wheat production *

1.	Details	Irrigation systems conventional	sprinkler	Increase over conventional
1.	Cost of seed bed preparation for irrigation (Rs./ha)	75	0	75
2.	Irrigation cost including water electricity (Rs./ha)	470	280	195
3.	Measured irrigation command from 12.3 x 12.6 x 2.3 ml 3 size pond (ha)	0.80	1.60	6.80
4.	Grain yield on area basis (q/ha)	20	25	5
5.	Grain yield on irrigation command (q)	20	50	30
6.	Value of grain on total irrigation command basis (Rs.)	2724	6800	4080
7,	Equipment cost/year	—	455	455
8.	Net gain on irrigation command basis (Rs.)	2170	6065	3895

* A study conducted on the farmers field in O.R.P. area.

ANNEXURE - XVII

Installation cost of Sprinkler Systems 15 acre area water source in centre.

A. Details of the System:

1. Number of Sprinklers	12
2. Discharge / Sprinkler	9 gps
3. Average operating pressure	43 P S
4. Total water discharge	99 gpm
5. Sprinkler spacing	18 m
6. Irrigation/shift	0.5 acre
7. Water application rate	0.44″/hr.
8. Application shift of 5 hrs.	2.2″
9. Irrigation/line/5 hrs.	0.5 acre
10. Irrigation in 3 shifts of 5 hr each/day	1.5 acre
11. Total area covered at 10 day irrigation interval.	15 acre

B. Detailed cost analysis	Rs
1. Main line 21 PCS-100mm x 6m @ 29.30/pc	3,691.08
2. 21 PCS main line canpler @ 84=/ pc.	1,764.00
3. 2 pcs 4″ x 3″ reducer canpler @ 85 each	170.00
4. 2 pcs 4″ Bends 90° @ 174 each	384.00
5. 1 Pc 4″ served canpler @ 84/pc	84.00
6. 1 Pc 4″ side Tee @ 226/pc	226.00
7. 21 Pc 75mm x 6m portable sprinkler line @ 20.80/m	2,620.00
8. 10 Pc 3″ mainline canpler for aluminum pipe @ 69 each	690.00
9. 11 PCS 3″ sprinkler canpler for pipes @ 86/pc	946.00
10. 11 PCS 3/4 x 36″ riser pipe @ 29/pc	319.00
11. 11 pcs model 150 sprinkler with 15/64 nozzels @ 140/pc	1,540.00
12. 2 PCS 3″ end stop @ 34/pc	78.00
13. 11 PCS bipod @ 54/pc	594 00
14. Pressure gauge @ 74/pc	74 00
15. 1 pc fertilizer applicator with 4″ line	1,898.00
16. Excise duty etc.	1,496.88
17. C. sales tax @ 4%	661.20
TOTAL	17,236.16

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