

**ECONOMICS OF DRYLAND AGRICULTURE  
IN MAHARASHTRA WITH PARTICULAR  
REFERENCE TO MANDRUP PROJECT,  
DISTRICT SHOLAPUR**

**SATISH D. KULKARNI**

**MAY 1983**

FORM 'A'

**CERTIFIED that the work incorporated in the thesis  
"Economics of Dryland Agriculture in Maharashtra  
with particular reference to Mandrup Project,  
District Sholapur" submitted by Shri Satish D.  
Kulkarni was carried out by the candidate under my  
supervision. Such material as has been obtained  
from other sources has been duly acknowledged in the  
thesis.**

*D. Rath*  
**(D. Rath)  
Supervisor**

**ECONOMICS OF DRYLAND AGRICULTURE  
IN MAHARASHTRA WITH PARTICULAR  
REFERENCE TO MANDRUP PROJECT,  
DISTRICT SHOLAPUR**

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**SATISH D. KULKARNI**

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CHAPTER I  
INTRODUCTION

The history of Indian Agriculture is one of low productivity of land and instability of farm output and income. Economic planning during the last two decades and the biological breakthrough achieved in Indian Agriculture in the 1960s have, however, resulted in considerable improvement in this respect. But the problem of low and unstable output and incomes still remain to be fully tackled in large agricultural tracts of the country characterized by low and erratic rainfall conditions. The rise in agricultural productivity so far achieved has not been equally shared by all the agro-climatic regions of the country. The Green Revolution, in fact, has been confined till now to a few areas in the country which are well endowed with natural resources, especially irrigation. In fact, irrigation has been a key factor in this change.

It has been estimated that it would not be possible to irrigate more than 61 per cent of the arable areas in the country from all the available surface and groundwater resources.<sup>1</sup> However, according to the report of the Irrigation Commission (1972), "about 13 per cent of the

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1. Planning Commission, Fifth Five Year Plan (1974-79), Part I (Draft), The Controller of Publications, Government of India, 1973, p. 107.

cropped area of the drought affected region is irrigated. This is likely to rise to about 19 per cent when the execution of the schemes is completed. In the drought areas of Madhya Pradesh, Mysore, Maharashtra and Gujarat, where the present level of irrigation is lower than 13 per cent, the position may be worse."<sup>2</sup>

In Maharashtra agriculture over large areas is carried on under dry conditions. Present irrigation facilities hardly cover about 11 per cent of the cropped area<sup>3</sup> and on account of the undulating terrain and other limitations, the irrigation facilities in the State are not likely to be extended to more than 30 per cent of the total cultivated area.<sup>4</sup> Under such circumstances the importance of dry farming practices needs no further emphasis.

There has been an increasing awareness and concern about the problems and prospects of dryland areas during recent years on account of the relative neglect of these areas during developmental efforts of the earlier plan periods. "Agriculture in these areas is characterized by

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2. Report of the Second Irrigation Commission (1972), Vol. I, Ministry of Irrigation and Power, New Delhi, Chapter XIX, p. 401.
  3. Season and Crop Report (1976-77), Director of Agriculture, Maharashtra State, p. 3.
  4. Report of the Maharashtra Irrigation Commission (1962), Government of Maharashtra, Chapter VIII, p. 168.

technological backwardness and widespread economic poverty and stagnation. A breakthrough in agricultural production in these areas can be achieved only through a planned technological transformation of agriculture, calling for quantitative and qualitative changes in inputs and cultural practices along with the necessary infrastructural support. Such a transformation should in turn be based on the development of a technology suitable for such areas."<sup>5</sup>

For a farm technology to be widely adopted, the following conditions must exist:

- (a) It must be economically viable.
- (b) Farmers must have the economic strength and mental inclination conducive to its adoption.
- (c) There must be the right institutional infrastructure including research, extension and financial and other rural institutions.

The adoption of a new farm technology, therefore, is dependent on a variety of environmental and socio-economic factors. Efforts to identify the availability of a suitable technology, to ascertain the level of its adoption, to examine its viability under the conditions prevailing at the farm level and to extend support in

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5. Krishnaswami M.S., and Patel K.V., "Managing an Action Programme for Dryland Agriculture" (C.M.A. Monograph 46). Centre for Management in Agriculture, Indian Institute of Management, Ahmedabad, and National Institute of Bank Management, Bombay, p. 1.

terms of necessary infrastructure are considered imperative in order to achieve a breakthrough in dryland agriculture.

1.1 Description of the Terms 'Drought Prone Areas' and 'Dry Farming Area'

Before examining the objective criteria for the identification of drought prone areas and dry farming areas, it is necessary to arrive at the precise description of the term 'drought'. In fact, there is no universally acceptable definition of the term 'drought'. The term is used differently by different research workers depending upon the context and the purpose for which it is being used. Likewise, dry land farming is sometimes equated with rain-fed farming.<sup>6</sup>

Definitions

1. Agricultural Drought

Various authorities have evolved their own definitions of agricultural drought. In the case of agricultural drought, the minimum water need varies from crop to crop; and it varies in the different stages of growth of each crop.

Van Barel<sup>7</sup> treats agricultural drought as a condition

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6. Singh Tapeshwar. "Drought Prone Areas in India." Centre for the Study of Regional Development, Jawaharlal Nehru University, New Delhi. Peoples Publishing House, New Delhi, p. 82.

7. Report of the Fact Finding Committee for Survey of Scarcity Areas, Maharashtra State (1973), Government of Maharashtra, Vol. I, Chapter IV, pp. 36-43.

in which there is insufficient soil moisture available for the crops. Richard<sup>8</sup> amplified Barel's definition and considered that agricultural drought exists when the soil moisture in the root zone is at or below permanent wilting percentage. Throntwaite<sup>9</sup> has described agricultural drought as a condition when the amount of water need in the form of evaporation and transpiration exceeds the moisture supply that is available as rainfall and soil moisture.

Taking into consideration these theoretical premises the Fact Finding Committee<sup>10</sup> for Survey of Scarcity Areas in Maharashtra State (1973) felt that "agricultural drought is a situation arising out of adverse balance between available soil moisture and evapo-transpiration needs of an area, impeding normal agricultural operations and ultimately resulting in total or almost total failure of crops."

In spite of the difficulties in defining the term 'agricultural drought' with precision it is not disputed that if agriculture is to be successful, there must be water available to meet the evaporation and transpiration needs of the soil. Drought results when there is adverse

8. Ibid.

9. Ibid.

10. Ibid.

(Above definitions are based on Dr. Kotteshwaran's paper presented at the symposium on 'Drought in Asiatic Monsoon', at Pune. We have collected these definitions from the report mentioned above.)

balance between available soil moisture and evapo-transpiration needs of an area. Evapo-transpiration is the loss of water vapour to the atmosphere in the form of evaporation from soil-water surfaces and transpiration from plants. Evaporation in any region is controlled by the availability of moisture at earth's surface and ability of atmosphere to supply energy to vaporise the water and transport the vapour. The basic characteristic of drought is steady rise in temperature with absence or severe deficiency of rainfall over a long period. Even though drought is the functions of interaction of several variables such as precipitation, temperature, wind velocity, sunshine, soil texture, soil moisture and antecedent rainfall, the dominant factor is rainfall, total precipitation, its distribution and variability and its capacity to meet evapo-transpiration needs.

## 2. Dry Farming

The dry farming areas have been defined by the Indian Council of Agricultural Research (ICAR) as those receiving a rainfall of between 400 mm and 1000 mm and are predominantly rainfed, viz., with less than 25 per cent of the area under irrigation.<sup>11</sup>

In brief, one can say that in drought prone areas

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11. Indian Council of Agricultural Research. "A New Technology for Dryland Farming." Indian Agricultural Research Institute, New Delhi, 1970, p. 5.

there is a rainfall deficiency and also uncertainty whereas the term dry farming represents the scanty and uncertain rainfall condition along with the peculiarities of soil conditions such as low retentivity, poor organic matter, etc. As the dryland areas are spread over the length and breadth of the country, their physical, economic, social and technological characteristics differ widely and so do their economic potentialities. For instance, at the one extreme are the tracts which receive reasonably high rainfall and are climatically as well placed as areas with assured irrigation. At the other extreme are the areas receiving miserably low rainfall and with inadequate or almost no irrigation network, and these areas, therefore, lack the resource potential necessary for development. In general, these areas have lagged behind the irrigated areas in the country which have so far been the only beneficiaries of green revolution. The solution to their agricultural problems lies in the development of dry farming.

The first exercise that must be undertaken is the identification of areas which are liable to suffer drought conditions chronically. Various fact finding committees had been set up by the Government. A survey of the criteria that these committees selected for this purpose is given below.

1.2 Criteria for Identification of Drought Prone Areas

1. Criteria Adopted by the Fact Finding Committee (1960)

A Fact Finding Committee was appointed in 1958 under the chairmanship of Shri N.S. Pardasani to identify chronically scarcity affected areas of Bombay State and to suggest long term ameliorative measures. This Committee adopted the following criteria for identification of chronically scarcity affected area:

- (a) Rainfall.
- (b) 'Annewari' and suspension of land revenue.
- (c) Declaration of scarcity in the past.

The Committee outlined the scope of each of the above criteria and the extent to which they had been used in the identification of drought prone areas. It recognized the importance of total precipitation and its distribution in relation to soils in identifying chronically scarcity affected areas, in the following words:

"Where the soil was deep and retentive, normal productivity was generally high and shortages in the rainfall would not constitute a serious threat as in the case of light and non-retentive soils, where the problem of adequate and well distributed water supply was crucial. In the latter soils, delay in the commencement of rains, recurrence of dry spells over a long period or absence of



rainfall at certain crucial points in the growth of plants were of special significance.<sup>12</sup>

The Committee considered the coefficient of variation of rainfall of each of the important months or pairs of months as one of the important tools for ascertaining the uncertainty of rainfall. In the chapters on districts, the Committee considered the coefficient of variation in respect of some districts only, while in a larger number of districts, the Committee indicated the yearly and monthly figures of rainfall to exhibit the uncertain character of rainfall in the area. The important aspects of rainfall pattern relating to weekly distribution of rainfall, its relations with soil and cropping pattern of the area was not considered in detail by this Committee. On the other hand, the Committee considered annewari as a fairly reliable and convenient index of the incidence of scarcity in the area. It was frank in its admission of the earlier comment presented by divergent procedures for declaration of annewari and scales of suspension. But in the final analysis, the Committee laid greater emphasis and reliance on the frequency of suspension of land revenue and declaration of scarcity conditions rather than rainfall. The Committee sorted the revenue circles in each taluka in

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12. Report of the Fact Finding Committee (1960).  
Director, Government Printing Publications and  
Stationery, Maharashtra, Bombay, Chapter III, p. 9.

which not less than 1/3 number of villages were affected by scarcity or in which annewari was less than 4 annas, and graded them in accordance with the number of times they were affected in the past.

This Committee's reliance on annewari and declaration of scarcity in the past in identifying chronically scarcity affected area is further evident from the basis which it has adopted for gradation of areas. The Committee graded chronically scarcity affected areas only on the basis of frequency with which the area was affected by scarcity conditions in the past. The Committee was aware of the limitations of such an approach as it qualified the said approach with further modification by saying, "Due to variations in the normal yields and difference in the system of assessment in different regions, the information regarding annewari and official declarations of scarcity did not give comparable picture for all parts of the State."<sup>13</sup> It emphasized the need for a study of some specific factors affecting agricultural production, independent of annewari. Even after recognizing the limitations, the Committee, by and large, relied on annewari and declaration of scarcity conditions in the past for identification of areas. In very few cases, the Committee

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13. Report of the Fact Finding Committee (1960),  
Ibid, Chapter I, p. 11.

did not consider an area as chronically scarcity affected even when the annevari data and the criteria it has laid down indicated such a recognition. The example of Niphad and Lasalgaon circles with the exception of 10 villages eligible to be grouped under category 'e' can be cited; the Committee excluded because of other considerations like better soil and increasing acreage under irrigation. But these are only exceptions.

Even after recognizing the subjective element in the determination of annevari and its resulting arbitrary character, the Committee seemed to have been constrained by the absence of any other data for the identification of chronically scarcity affected areas. The Committee particularly was handicapped while identifying the areas in Marathwada, as there was no settled system of declaration of annevari and declaration of scarcity conditions. Ultimately, these areas were recognized in the lowest category of chronically scarcity affected areas. It was, therefore, necessary to probe deeper into the main causative factors of drought, namely, rainfall with reference to annual rainfall, its variability and its weekly distribution in relation to soil and cropping pattern of the area in order to identify the drought prone areas with precision.

However, other definitions considered by the Second Irrigation Commission (1972) need to be considered to get

an idea of the difference in its approach as compared to the one adopted by the 1960 Committee, and the modifications made by it in categorizing areas which are drought prone. This Committee introduced some new criteria and rejected some others used by the earlier Committee (1960). An examination of its position would be desirable.

2. Criteria Adopted by the Second Irrigation Commission (1972)

The Second Irrigation Commission (1972) was set up by the Government of India to go into the question of future irrigation development in the country in a comprehensive manner. By one of its terms of reference, the Commission was required to analyse the irrigation facilities available in the chronically drought affected and food deficit areas and suggest essential and minimum irrigation works to be promptly undertaken in these areas. The Commission had first to identify the areas which could be considered as chronically drought affected before recommending the measures for the minimum irrigation works. The Commission gave consideration to the following criteria in identifying the drought affected areas:

- (a) Meteorological data
- (b) Revenue remissions
- (c) Frequency of famine or scarcity
- (d) The availability of irrigation facilities.

Out of these considerations, the Commission dismissed the method of identification of drought affected areas on

the basis of annewari as "the subjective element in the assessment of annewari by village officers was so large as to vitiate any delineation of drought areas based on annewari."<sup>14</sup>

The Commission mainly relied on the meteorological data in adopting the criteria for drought affected areas. It adopted the definition of 'drought' set out by the India Meteorological Department "as a situation occurring in any area when the annual rainfall is less than 75 per cent of normal." (The Department, in its paper on "Rainfall and Droughts in India" published in March 1971 considered those areas as drought areas where the above phenomenon has 20 per cent probability of occurrence. Using the annual and south-west monsoon rainfall data from 1901 to 1960 for about 500 stations, the above paper indicated frequency of rainfall variations in the different parts of the country.) The Commission also accepted the distinction between the drought areas and chronically drought affected areas. (Areas where there is 40 per cent probability of negative-rainfall departure of more than 25 per cent were identified as chronically drought affected areas.) On this basis the Commission considered western part of Rajasthan and Kutch only as chronically drought affected areas. But the Commission clearly stated that the distinction between drought affected areas and chronically drought affected areas is one of degree. The Commission's finding was that

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14. Report of the Second Irrigation Commission (1972).  
Op.Cit. Chapter VII, p. 172.

most of the areas identified as susceptible to drought very clearly fall within the arid and semi-arid zones.<sup>15</sup>

Chronically drought affected areas are identical with the intensely arid zone.

The Commission while outlining the dimension of the problem assumed that the districts which receive less than 750 mm of rainfall are liable to drought and also further considered districts lying between 750 mm and 850 mm of annual rainfall as vulnerable where the rainfall is of doubtful efficacy and the irrigation facilities are limited.

The Commission demarcated a broad drought zone by adopting the taluka as unit of identification and excluded (a) those talukas which lie outside the drought zone; (b) those where 30 per cent or more of the cropped areas was under irrigation; and (c) those which comprise only a small portion of a district with an adequate rainfall or irrigation.

The Government of Maharashtra had recognized 53 talukas (including some parts of the taluka) as chronically

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15. Areas having less than 500 mm of annual rainfall and where rainfall exceeds potential evapo-transpiration (PET) for less than 2.5 months during the year are broadly defined as arid areas. The semi-arid areas on the other hand, have 500 to 1500 mm average annual rainfall which exceeds PET for 2.5 to 7 months in a year. (We have collected the above definition from N. S. Jodha, "Production Patterns and Dynamics of Resource Use in Arid and Semi-arid Tropical India," International Crop Research Institute for the Semi-Arid Tropics (ICRISAT), Discussion Paper-4, February 1978, p. 1.)

scarcity affected following the criteria laid down by the Fact Finding Committee (1960). The Commission eliminated 8 talukas out of them and considered 45 talukas as drought affected. The approach of the Irrigation Commission in identifying the broad drought zone was on the basis of rainfall and not on the basis of other factors like annewari. It is the rainfall and its pattern of distribution related with the stages of crop growth and the cropping pattern which are more relevant for the effect of rainfall on agricultural production and consequent scarcity conditions.

The Commission recognized the significance of the 'timeliness of rainfall' in the following words:

"It will be noticed that the definition of drought given .... does not take into consideration the timeliness of rainfall. However, because of difference in the cropping pattern and distribution of rainfall from region to region it would be difficult to qualify the definition of drought with sufficient exactness by introducing this element."<sup>16</sup>

Further, the exclusion of the talukas on the ground that the irrigation is available for 30 per cent of the cultivable areas, though in conformity with the unit which the Commission has adopted, is not proper. The parts of

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16. Report of the Second Irrigation Commission (1972).  
Op. Cit. Chapter VII, p. 164.

taluke which do not enjoy the protection against drought through irrigation facilities require to be recognized as drought prone provided they fall in the broad drought zone and exhibit the erratic character of distribution of rainfall.

The issue of delineation of areas liable to drought was further investigated by the Fact Finding Committee (1973) appointed by the Government of Maharashtra. It investigated several variables in its study. The criteria it finally settled on, and the reasons given for doing so deserve a brief consideration.

Method of Identification of Drought Prone Area by the Fact Finding Committee for Survey of Scarcity Areas, Maharashtra State (1973)

Before finalizing the procedure for identification of drought prone areas the Fact Finding Committee (1973) has discussed the following possible criteria:

- I. Criteria based on causes of drought:
  - (a) Normal precipitation;
  - (b) Timeliness of rainfall with reference to cropping pattern; and
  - (c) Soils.
- II.
  - (a) Annewari and suspension of land revenue;
  - (b) Declaration of scarcity in the past;
  - (c) Outturn;
  - (d) Marketable surplus;
  - (e) Migration;



- (f) Fluctuation in the prices;
- (g) Foodgrains offtake; and
- (h) Density of population.

After discussing the various possible criteria for identifying the drought prone areas, the Committee concluded that normal precipitation in an area should be the only criterion which can serve as the basis for delineating, broadly, a drought prone zone. This was because, firstly, the Committee felt that measurement of precipitation is simple and data are available for an extended period. Secondly, it is undoubtedly the basic cause of all droughts. Thirdly, it is not possible to measure quantitatively in a unique manner the effects of a drought situation by using any of the other criteria mentioned above. Fourthly, what is required is a criterion which would correctly indicate the area liable to drought rather than identification of an area precisely affected by drought in a particular year. The Committee thus finally came to the conclusion that it should adopt normal rainfall as the criterion for demarcation of a broad drought zone. The Committee also clarified that "It will be observed that the isohyete of 750 mm divides some of the talukas. In order that the delineation of broad drought zone on the basis of isohyete does not become too arbitrary, this Committee has included the remaining parts of those talukas in broad drought zone where soils are shallow and the character of rainy season

is marked by intermittent breaks even if the rainfall exceeds 750 mm provided the rainfall does not exceed 800 mm. The droughts may occur in areas falling outside this region but they are of the contingent type. Thus the areas beyond this region cannot be considered as drought prone."<sup>17</sup>

On the basis of the criterion of normal rainfall, the Committee decided that the broad drought zone should consist of the following areas:

- (a) Areas falling within the isohyete of 750 mm
- (b) Areas falling within isohyete 750 mm to 800 mm, which have shallow soils.

For delineating the drought zone on the basis of normal annual precipitation this Committee mainly relied on the isohyetal map prepared by the India Meteorological Department (IMD). The map prepared by IMD is based on the rainfall data collected from a sufficiently larger number of rain-gauges mainly maintained by State authority for over five decades. The IMD considers that the present number of rain-gauges are reasonably adequate for broad analysis of rainfall for drawing isohyete. The Committee also, therefore, placed reliance on this map for the identification of areas within broad drought zone as

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17. Report of the Fact Finding Committee for Survey of Scarcity Areas, Maharashtra State (1973).  
Op.Cit. Vol. I, Chapter IV, p. 52.

defined earlier. No doubt, additional rain-gauges at closer intervals of space are bound to give a finer picture of rainfall pattern and may aid in closer analysis of the problem of the normal precipitation and the pattern of distribution of rainfall in the State.

While discussing importance of the timeliness of rainfall to the plant growth, the Committee accepted the existence of at least 11 drought weeks<sup>18</sup> in the monsoon season (22 weeks from June to October<sup>19</sup>) as convenient index for revealing the erratic character of rainfall in the drought zone. The number of drought weeks in the monsoon season have been indicated in respect of each taluka. The frequency of the occurrence of 11 drought weeks during the last 15 years has been used as one of the convenient indices for confirming drought prone character of an area. In some cases the Committee also took into consideration the predominant soil type. Generally the Committee considered taluka as the unit of identification, with a few exceptions.

18. According to Remdee, drought is an occurrence when the rainfall for a week is half of the normal or less when the normal weekly rainfall is 5 mm or more.

19. The period of the south-west monsoon rainfall is from June to October and comprises of 22 weeks. (Because of difficulties in getting original references we have taken the above explanations from the Fact Finding Committee Report (1973), Op.Cit., p. 45.)

The procedure adopted by the Fact Finding Committee for Survey of Scarcity Areas (1973), for identifying the drought prone areas consisted of:

1. Identifying a broad drought zone on the basis of normal annual precipitation indicating water balance. The broad drought zone consists of areas falling within the isohyete of 750 mm along with areas lying in the region between 750 mm and 800 mm where the soils are less retentive of moisture;
2. Verifying the drought prone character of areas falling within the broad drought zone on the basis of frequency of occurrence of large number of drought weeks (rainfall deficient weeks) in the monsoon period over a period of years; and
3. Eliminating the areas within the broad drought zone which are sufficiently drought resistant on account of the moisture retentive capacity of soils or which have become drought resistant on account of the facility of canal irrigation from assured source namely the command of large irrigation canal systems whose gross commands exceed 10,000 hectares.

Apart from the total precipitation, its timeliness is one of the most important requirements for the growth of plants. The growth of plants has certain important phases, viz., (a) Sowing and germination; (b) Tillering and vegetative growth; (c) Flowering and grainfilling;

and (d) Grain drying and harvesting. The water requirement of crops at the first three stages (i.e., a, b and c) is very crucial. If there is prolonged break, drought situation is created and yields are severely affected. There can be generally four types of variations in the normal pattern, namely, (1) Delay in the commencement of rains; (2) Considerably prolonged intermediate breaks; (3) Very uneven distribution of rain; and (4) Failure of late rain.

If the commencement of rains is delayed, sowing operations are delayed, resulting in the reduction of the period of crop growth and finally affecting the yields adversely. The second and the third situations may result in affecting adversely the vegetative growth, resulting in lower yields depending upon the deficiency of rainfall in these periods. Flowering and grain-filling stages require adequate rainfall, failing which the grain size and yields are affected. Very early stoppage of rain may cause shrivelled grains while continuance of rains late in the season is likely to cause lodging of crop and reduction in the yields. The ideal distribution of rainfall in drought prone areas has to be considered in relation to the cropping pattern. Any variation in that distribution particularly relating to the crucial stages of growth may result in either partial, almost total, or total failure of crops according to the extent of variation. In dry

farming areas, the soil moisture is the controlling factor for plant growth.

The Second Irrigation Commission (1972) had considered the introduction of this criterion as desirable but abandoned it on account of the complexities of the problem which it presents. This Committee has not suggested any direct and simple measure of timeliness on account of different moisture retentive capacity of the soils and different requirements of various crops at crucial stages of their growth. Hence, this Committee considered an indirect measure in the form of a large number of deficient weeks occurring in the monsoon period, and the frequency of such occurrence over a period of years has been used to verify the drought prone character of the area falling within the broad drought zone. For this purpose the data relating to weekly distribution of rainfall during the south-west monsoon period (June to October) over a period of the recent 15 years was analysed by this Committee.

The Second Irrigation Commission (1972) adopted the taluka as a unit of identification. This Committee also has generally taken the taluka as a unit but wherever areas smaller than a taluka such as a revenue circle showed distinct change in the physical characteristics particularly in relation to moisture retentive capacity of the soils and crop pattern, this Committee has considered the smaller

unit of a revenue circle for identification. Though the detailed information regarding predominant soil type (particularly percentage of areas covered by various soil types) was not available, this Committee has ascertained the general characteristics of the soils in an area qualitatively from the published information in the Gazetteers, the report of the Fact Finding Committee (1960) and the publication on soil types of the agricultural department.

### 1.3 Estimation of Dry Farming Areas

As per estimates given in the Fourth Plan<sup>20</sup> document, there are 128 districts in the country which have low to medium rainfall (under 1125 mm) annually with very limited irrigation facilities. These districts account for nearly 68 million hectares or about half of the total net sown area. Out of these districts the very high intensity dry farming areas (i.e., with rainfall ranging from 375 mm to 750 mm and irrigated area below 10 per cent of the cropped area) mainly cover central parts of Rajasthan, Saurashtra region of Gujarat and rain-shadow region of Western Ghats of Maharashtra and Mysore. Twenty-five districts fall in these areas accounting for about 18 million hectares of the net sown area. Out of the remaining districts, 12 districts

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20. Planning Commission. Fourth Five Year Plan (1969-74) (The Manager of Publication Branch, Government of India, Delhi), pp. 152-153.

already have irrigation covering about 30 to 50 per cent of the cropped area and, hence, the problem of these districts is no longer acute. The remaining 91 districts spread out mainly in Andhra Pradesh, Gujarat, Punjab, Haryana, Madhya Pradesh, Maharashtra, Mysore, Tamil Nadu and Uttar Pradesh represent the typical dry farming tracts.

#### 1.4 Dimension of the Problem

The problems posed by drought vary from area to area depending on the amount of rainfall and its variability and also the extent to which irrigation has been developed. The Irrigation Commission (1972)<sup>21</sup> separated out areas which are prone to drought on the basis of rainfall, irrigation and such relevant considerations. Districts having less than 750 mm of rainfall were considered drought prone in the first count 77 out of 328 districts (34 per cent of the net sown area) were thus singled out. Some of these districts had fairly developed irrigation facilities. Excluding these districts there still remained 50 districts (about one-fourth of the cultivated area of the country). In addition, some districts in the States of Maharashtra, Gujarat, Madhya Pradesh, Mysore, Rajasthan and Uttar Pradesh received rainfall between 750 and 850 mm. This being of doubtful use, and irrigation being virtually non-existent, these

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21. Report of the Second Irrigation Commission (1972).  
Op.Cit. Vol. I, Chapter VIII, pp. 157-158.



areas also were considered as drought prone. With these additions, the drought prone areas in the country constitute about one-third of the net cropped area in the country.

The Commission also expressed its concern over the socio-economic disparities being accentuated because of these differences in agricultural opportunities between the dry and drought prone areas on the one hand and high rainfall and/or well irrigated areas on the other.

#### 1.5 Characteristics of Agriculture in Drought Prone Areas

It is necessary to outline the characteristics of the drought-prone areas pertaining to agriculture before looking into the problems of agricultural development in dry land regions. The characteristics relating to land utilization, cropped areas and soil types are as follows:

##### 1. Land Utilization

One of the significant characteristic of the drought prone areas is the high percentage of the cultivable land to the geographical area, namely, 81 per cent as compared to the State average of 60 per cent. Two reasons can be attributed to this. Firstly, the marginal and sub-marginal land where the cultivator ordinarily faces severe handicaps, may have been brought under the plough. Secondly, the area under forest is insignificant and it, therefore, increases the availability of cultivable land. This, however, aggravates the problem of soil erosion and surface runoff

because of the absence of protective vegetative cover.

## 2. Cropped Areas

Another characteristic of the drought prone areas is the predominance of area under cereals, mainly jowar and bajra, in the cropped areas. The percentage of area under cereals is as high as 65 per cent as against the State average of 56 per cent. The main reasons for the predominance of area under cereals is the reluctance on the part of the farmers to risk a larger investment which the cultivation of cash crops entails.

## 3. Soil Characteristics

The soils of drought prone areas are derived from basaltic rock. They contain clay and free lime. On wetting, these soils exhibit high volume expansion which results in impeding the percolation of rain water. The soils crack heavily on drying, resulting in loss of moisture and ultimately damaging the root system of growing crops. In addition, they have high moisture at wilting point. The wilting point is a stage of soil moisture when the plant begins to dry as it is unable to extract the moisture which is held fast by the soil particles. The soils have varying depths which determine total available moisture for plant growth.

### Types of Crops

#### (a) Kharif

Very shallow soils which are undulating are subject

to severe erosion which results in very poor soil cover. Due to their limited depth, shallow soils have very low moisture holding capacity. Generally the crops like bajra, green gram, black gram and groundnut are grown in the kharif season when the rains in June, July and August saturate the soil profile. But the success of these crops largely depends on the distribution of rain and duration of dry spells.

The medium deep soils are heavy in texture and are more moisture retentive. Therefore, these soils are generally put under such crops as groundnut, red-gram and bajra in kharif. But the kharif cropping on these soils is risky on account of high probability of occurrence of dry spells.

(b) Rabi

Medium deep soils and deep soils are generally put under rabi crops. Jowar is the predominant rabi crop. Next in importance is gram. Mixed cropping is also followed by putting safflower along with jowar. The drainage of these soils is moderately low and infiltration rate is also low. Hence, rain water does not saturate the profile easily. The success of rabi cropping in these soils, therefore, depends upon the extent of precipitation in the months of September and October. Deep rooted crops such as gram, safflower and sunflower are more suited for extraction of moisture from lower layers.

In brief, one can say that the most relevant characteristics of the drought prone areas are as follows:

1. Intensive rainfall interspersed with unpredictable droughts.
2. Relatively short rainy season.
3. Highly variable rainfall during the rainy season.
4. High evapo-transpiration rates throughout the growing season.
5. Low soil organic matter content.
6. Low infiltration capacity of soils.
7. Great water erosion hazard.
8. Limited capital resources.
9. Mainly animal or human labour power sources.

1.6 Problem of Agricultural Development in Dry Land Regions

Simply stated, there are two major problems facing most of the farmers living in these regions:

1. Problem of very low annual precipitation, its uncertainty and consequent low and unstable crop yields.
2. An accelerating rate of soil erosion.

Very low and uncertain rainfall increases the risk of cultivation. Therefore, to stabilize farm income in this area, a three-pronged strategy of agricultural development has been suggested by the Fact Finding Committee (1973).<sup>22</sup> The strategy suggested is as under:

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22. Report of the Fact Finding Committee for Survey of the Scarcity Areas, Maharashtra State (1973). Vol. I, Chapter X, p. 186. Op.Cit.

1. Suitable crops may have to be adopted to suit the type of soil and its moisture retentive capacity.
2. Methods of cultivation require reorientation to suit the condition in drought prone areas in the light of the results of research available from time to time.
3. Integrated programme for dry land development and water harvesting should be taken up.

The Dry Farming Research Station, Sholepur, has carried out research work in evolving suitable cropping for the dry farming areas. The Research Station recommended the following cropping in the drought prone areas according to the type of soil.<sup>23</sup>

1. Very Shallow Soils

These soils are mostly observed in the upper ridges and are undulating and subject to severe erosion. These soils are unfit for cultivation and can only be put under grasses such as Blue-panic and Marvel-8. The average yield of grass on such soils is about 6-7 tons per hectare.

2. Shallow Soils

These soils occur on rolling plains with a slope range of 3-8 per cent and even more. Due to its limited

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23. We have taken the above recommendations from the various published and unpublished reports of the Research Station.

depth the soil has low moisture holding capacity. The rainfall in June and July generally saturates the soil profile and hence kharif crops can be grown. With the later showers in August and September the crops can be grown with the accumulating soil moisture. Hence, the shallow soils are more suitable to kharif crops such as bajra, groundnut, sunflower, tur and other pulses by following the method of strip cropping. The crop rotation can be first year bajra, second year groundnut, third year sunflower resulting in a three-year rotation.

### 3. Medium Deep Soils

These soils can be grouped further into medium deep upto 45 cms and moderately deep upto 90 cms. The soils having 45 cms depth have limited moisture holding capacity and require less rainfall for saturating the soil profile and hence these soils can be put under kharif cropping. The moderately deep soils are heavy and hence difficult to sow in the kharif season. Hence rabi cropping is possible in these soils. If the distribution of rainfall is proper in June, July and August and later part of September, then both kharif and rabi cropping is possible. Kharif crops like bajra, groundnut, sunflower, tur, mung, urid and rabi crops like jowar, gram, sunflower and safflower can be grown on these soils. While rotating the crops the cereals should follow the legumes.

#### 4. Deep Soils

These soils occur in low-lying areas at the extreme end of the watershed. The drainage and the infiltration rate of these soils is low, hence the early rain do not saturate the whole of the soil profile easily. Moderate to heavy rains in September or October saturates the soils and hence only rabi cropping is possible. Deep rooted crops such as gram, safflower and sunflower are more suited for extraction of moisture from lower layers.

The criteria for selection of crops in the drought prone areas should be as follows:

##### (a) Short Duration

Uneven and untimely distribution of rainfall is the characteristic of drought prone areas. If the duration of crop is long the probability of occurrence of stress during the maturity period of crop growth is high and this affects the yields adversely. If the growth period is shortened, the chances of overcoming this stress are more. Therefore, an important criterion for selection of crop should be its short duration and early maturity.

##### (b) Photo-Insensitivity

As a rule, plants require certain amount of sunlight for their normal growth. Certain varieties of plants are so sensitive to this factor that in the absence of adequate sunlight, the duration of their growth is shortened, thereby resulting in reduction in the out turn. In the drought

prone areas due to the erratic nature of weather, the availability of required sunlight during the period of crop growth may vary. To overcome this difficulty, it is necessary to evolve varieties of crops which can sustain fairly normal growth even under condition of varying availability of sunlight. Such varieties of crops are called photo-insensitive.

(c) Strong Root System

The plants having strong root system can extract the soil moisture from larger area of soil and can give better yields as compared with the plants having a shallow root system. Such crops can generally withstand long dry spells.

(d) Type of Soils

Type of soil with particular reference to its depth is another important determinant governing the selection of crops. The details of soil type and suitability of crops in the particular type of soil have been discussed above.

Given that some areas in the country are prone to drought conditions as pointed out by the several indicators described earlier, the question immediately arises as to whether some method of alleviating these conditions can be devised. That there is an imperative for such measures is obvious; for imbalance in regional development as between these and the other areas which were benefited by the Green Revolution of the 1960s has wide-ranging socio-economic repercussions. The question of the feasibility of Dryland



farming has, as a result, gained high importance. The basis for research in this field ought to be made explicit at this juncture.

#### 1.7 Research Base of Dry Farming

As far back as 1880, the First Famine Commission had recommended that protective irrigation projects be taken up by the State for the benefit of the dryland tracts. Research efforts at enhancing the productivity of crops grown under rainfed conditions were initiated in this country as far back as 1905 with the establishment of the Imperial (now Indian) Council of Agricultural Research. However, the first systematic efforts on scientific lines were initiated by Kanitkar in 1926, who, after satisfactory trials both on experimental farms and on farmers' fields, evolved a package of practices suitable for jowar in the Bombay Province. Suitable modifications were made from time to time in different elements of this package. Similar packages of practices were also suggested for the dry tracts of Hyderabad (Raichur), the Madras Province (Hajeri) and North India (Rohtak) in course of time. But a well-organized action programme for the adoption of at least some of the dry farming practices was taken up only in Maharashtra.<sup>24</sup> Few years later the Royal Commission (1928) emphasized the importance of the development of dry

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24. Indian Council of Agricultural Research. A New Technology for Dryland Farming (1970), p.3, Op.Cit.

farming and observed "..... it happens, moreover, that these crops that have received least attention such as millets are amongst the typical crops in most of the unirrigated districts. The problems of cultivation in such tracts in which crops are entirely dependent upon rainfall are, in our opinion, deserving of far closer attention than they have received from the agricultural Departments."<sup>25</sup>

A few years later the then Imperial (now Indian) Council of Agricultural Research (ICAR) sponsored an integrated research scheme under which research work on various aspects of dry farming was initiated at five regional centres, viz., Sholepur and Bijapur in 1933, Raichur and Hajeri in 1934 and Rohtak in 1935.

With the beginning of the era of planning, the problem of dry farming, though not entirely forgotten, did not receive the attention it deserved. The Third Plan did refer to the concentrated efforts needed to enable the millions of dry farmers to participate, on a large scale, in programmes of development of dry farming.<sup>26</sup> However, the programmes of the Plan concentrated on the quick

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25. Kenitkar N.V. Dry Farming in India (Indian Council of Agricultural Research, New Delhi, 1969, 2nd Edition), p.2.

26. Planning Commission. Third Five Year Plan (The Manager of Publication, Government of India, 1961), pp. 49-50.

yielding strategy of Intensive Agricultural District Programme (IADP), Intensive Agricultural Area Programme (IAAP) and High Yielding Varieties Programme (HYVP) which helped accelerate the green revolution.

With the green revolution<sup>27</sup> becoming a reality, there arose the problem of imbalance in the development of irrigated and dryland agriculture. The new needs which formed the basis of the Green Revolution required other factors for greater production.

"The introduction of hybrids and high yielding variety of seeds of most of the important cereals grown in the country is expected to make a basic difference in the prospects of agricultural development. The relevant characteristic of these seeds is that they are far more responsive to the application of plant nutrients to the soil, in terms of yield per acre. Naturally, this requires assured, adequate and timely water supply to the fields growing these crops. This condition would limit the area that can be put under these improved varieties of cereals to lands that have either adequate irrigation facilities or receive adequate and timely precipitation in the growing season. The question of adequacy and timeliness of precipitation will depend not only on the particular crop, but also on the soil concerned, and will, therefore,

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27. Green revolution technology refers to the high yielding varieties.

very from region to region."<sup>28</sup>

Commenting on the unequal opportunities and incomes created and accentuated by the green revolution, Jakhade observes: "..... if new technology bring about a major aggregate increase in production ..... this region (dry region) for which no innovation has been evolved, will have no advantage of increased efficiency and reduced cost in productivity, but still will be affected by the decline in the prices. Hence, in this region incomes may decline in an absolute as well as relative sense."<sup>29</sup>

The growing disparities in the economic opportunities and income between these tracts and those with assured irrigation and/or high rainfall are so great and alarming that M.S. Swaminathan<sup>30</sup> rightly considers the development and deployment of a new technology for dry farming an urgent socio-economic necessity.

To sum up, these areas (dry) have lagged behind the irrigated areas in the country which have so far been the only beneficiaries of the green revolution. The solution

28. Beth N. "A Note on Dry Agricultural Regions and Small Farmers with Special Reference to Maharashtra," (Unpublished). Gokhale Institute of Politics and Economics, Pune, 1969, p. 1.

29. Jakhade V.M. "Agricultural Development and Income Distribution," Indian Journal of Agricultural Economics, Vol. XXV, No. 1, January-March 1970, p. 4.

30. Swaminathan M.S. "Pinsong Agriculture," The Agricultural Finance Corporation Ltd., Vol. III, 2 July 1971, p. 41.

to their agricultural problems lies in the development of dry farming.

Alarmed by such considerations, the Fourth Five Year Plan specifically emphasized the urgent need for creating circumstances that would enable the hitherto neglected dry farmers to meaningfully participate in the agricultural development process.<sup>31</sup> The policy was sought to be translated into action through (1) the All India Coordinated Research Project for Dryland Agriculture sanctioned by the Indian Council of Agricultural Research in 1970, (2) Rs. 20 crore centrally sponsored Fourth Plan Scheme, viz., the Integrated Dryland Pilot Development Project. The project envisaged the improvement of agriculture through 24 pilot projects by adopting a two-pronged approach of undertaking research for evolving suitable crop varieties and related agronomic practices, and the practical application of results of available knowledge in this field. The ICAR research centres, located in the proximity of the pilot projects, were to provide the requisite technical supervision. Two of such pilot projects were sanctioned in the State of Maharashtra, one at Mandrup in Sholepur district (October 1970) and another in five villages in Akola district (August 1971). It was contemplated to cover an area of 3,200 hectares of

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31. Planning Commission. Fourth Five Year Plan 1969-74. p.112. Op. Cit.

a sub-watershed in each of the project with integrated dryland practices in a period of four years in a phased manner. The main components of the scheme were:

(1) Intensive research for evolving techniques which would give maximum returns from the available soil and moisture resources in the dry areas. Among others, this includes research on suitable crops, soil and water management, water harvesting and suitable implements.

(2) Practical application of the result of available knowledge on soil and water conservation practices, cultivation of drought tolerant and short duration varieties of crops, new techniques of application of fertilizers including foliar spraying, adoption of plant protection measures, etc., with necessary infrastructure and training.

#### 1.8 The Physical Programme in Pilot Projects

The new strategy of development of dryland areas requires more detailed and integrated planning, execution and supervision. The main emphasis is laid on treating the land according to its need and using it according to its land use capability to keep it permanently productive while in economic use. This objective is successfully achieved when whole watershed/sub-watershed is suitably treated in an integrated manner and saturated basis. These projects aim at this end. The items of physical programme are as under:

(a) Land Development

This includes soil conservation, land grading, ploughing, etc. Soil conservation is the basic need of land and without bunding, land levelling and other protective practices, a permanent system of agriculture cannot be sustained. Soil and water conservation work results in permanent benefit by providing a secure foundation for rainfed agriculture. Further, the programme of bunding, land levelling and other similar conservation works are executed by manual labour and generate a large amount of local employment.

(b) Water Harvesting Practices

These include farmponds, flooding schemes, nala diversion, percolation tanks, etc. Most of the rainfall in dry areas is received during the south-west monsoon period and because of the poor structure and undulating topography, much of the moisture is lost. Urgent steps are, therefore, needed for development and popularization of water harvesting techniques. If rain water can be stored for one or two protective irrigations during drought spells, considerable progress can be achieved in increasing the yield of kharif as well as rabi crops.

(c) Minor Irrigation

Tapping of groundwater is highly essential for supporting dryland agriculture and therefore the programme of sinking of new wells, repairs/renovation of old wells,

etc., is given due importance in the physical programme under the dryland project.

(d) Improved Agricultural Practices

These include introduction of drought tolerant short duration varieties, application of fertilizers, adoption of agronomical practices like contour cultivation, strip cropping, addition of organic matter, good crop protection and improved tillage and soil management.

(e) Infrastructure

Farmers' education is an important tool in advocating and popularizing new dry farming techniques among the cultivators. Crop demonstrations, demonstration of improved implements and farmers training play an important role in disseminating information on improved dryland agriculture to the cultivators and therefore farmers' education is an integral part of the dryland projects that are presently operated.

(f) Supporting Occupation

This includes animal husbandry, poultry, dairy development, etc. These supporting occupations are essential to increase income of the participating farmers and also provide wholesome and nutrient diet. The details of such programmes vary from area to area and as such are decided and planned by the project implementation committee.

Incentives

As the farmers in the dryland areas are generally



poor, following incentives in the shape of loans and subsidies are provided to them in this scheme to execute the work.

(i) Inputs

Seed/fertilizers/pesticides are given to the farmers at 50 per cent subsidy during the first year and 25 per cent subsidy during the second year. For introduction of new crops 100 per cent grant is given for seed, loan portion is to be obtained from the institutional finance.

(ii) Permanent Works

For soil conservation and land development there is 75 per cent long term loan and 25 per cent grant. For programmes under water harvesting 100 per cent grant is given by the Government of India.

(iii) Demonstrations and Training

Since this is mainly a demonstration-cum-training scheme, 100 per cent grant is given under these two items.

(iv) Foliar Spraying

Under this item the cost of urea is subsidized to the extent of 50 per cent.

(v) Minor Irrigation

There is 75 per cent loan and 25 per cent subsidy. For sprinkler irrigation, if it is undertaken on community basis, it is given only as a loan. Individual farmers are given 50 per cent loan and 50 per cent subsidy.

**(vi) Animal Husbandry**

Grant and loan in the ratio of 1:2 are given to the deserving farmers having holding of 10 acres or less.

**Research Findings**

Crop research has indicated the following crops for adoption in scarcity area (Sholapur and the like):

Sr. No.	Crop	Existing	Proposed
<b><u>Kharif</u></b>			
1.	Bajra	Local N-28-15	HB-3
2.	Groundnut	Local	SB-XI K-4-11
3.	Redgram.	T-84	T-184
4.	Green Gram	Jalgaon 781	HY-45
5.	Cowpeas	-	C-152
<b><u>Rabi</u></b>			
1.	Jowar	ND-15 Maldandi local	M-35-1
2.	Gram	Local	M-59
3.	Wheat	Local	N-59 Kalyan Sona
4.	Safflower	Local	N-62-8 A-300-7-13-3
5.	Sunflower	No crop	EC-68413
6.	Cotton	Laxmi	Laxmi (no change)
7.	Gross	Local	Blue panie Marvel-8

The demonstration plots as per the new technology, were laid on the cultivators fields during the year 1973-74. The results of some of the demonstration plots conducted at Mandrup during the year 1973-74 gave encouraging results; they are given below:

(Yield Q/Ha)					
Sr. No.	Name of crop	District average	Average of the cultivators' field this year	Average of the Demonstration plots	Highest yield of Demonstration plots
1.	Hy. Bajra	1.80	3.14	15.34	42.05
2.	Green gram	2.00	3.03	9.79	17.12
3.	Groundnut	3.75	3.00	12.05	20.00
4.	Sunflower	No crop	No crop	5.00	6.00

#### Double Cropping

Monoculture has been the rule because of traditional varieties. With the availability of drought tolerant short duration varieties it is now possible to take two crops in the same year profitably wherever conditions permit. In Mandrup, a crop combination of Hy. Bajra (HS-3) and gram (M-59) was considered most remunerative. An alternate combination is identified as Moong (Jalgson 871) and rabi Jowar (M-35-1). Hy. Jowar (GHS-1) had not proved beneficial because of the attack of shootfly in the early stage. Sunflower came in handy as mid-season correction.

In the package of dryland practices, contour

cultivation, using the land according to its capability and optimum plant population are as important as other practices and directly or indirectly help in stepping up crop yield. These practices do not generally cost money but they had not been convincingly and adequately demonstrated to the cultivators. These simple items, if followed, would sustain the crop production even during adverse climatic conditions:

(1) Contour Cultivation

Cropping up and down the slope is a usual sight. This leads to erosion due to rains and impoverishment of the soil. Contour cultivation abstracts runoff and helps in uniform applications of water all over the area.

(2) Using the Land according to Its Capability

It is usually seen that the land is not used according to its land use capability. The shallow soils which are suitable either for pasture or minor millets are used for crop like jowar or cotton which it cannot sustain and ultimately gives poor yield.

(3) Optimum Plant Population

Sowing by conventional seed-drills gives a very defective and un-uniform crop stand. Sometimes it is too thick and sometimes too sparse or combination of both. This adversely affects the yield in spite of following the other practices. Optimum plant population can be obtained by uniform and proper sowing by the help of mechanical seed-drills. Good mechanical seed-drill, specially bullock

drawn, which would help uniform sowing needs to be innovated and needs to be made available to the cultivators at a reasonable price.

Some of the land development and water harvesting techniques required still further refining and its economics tested. After all, crop production depends on good soil-water-crop relationship. In the coordinated research project, main emphasis was given on crop research, but crop research alone cannot achieve the goal. In the scheme of crop production, soil and water management plays a basic role and needs equal attention.<sup>32</sup>

#### 1.9 Previous Studies on Dryland Agriculture

There are quite a few studies on problems of dry farming, the reviews are grouped under different subject heads. Naturally, this division is not mutually exclusive. However, for bringing out the main problem in sharp focus, this division is helpful.

1. Some scholars concentrated their attention on the two-fold problems of instability and growth in dry farming areas and on development of arid agriculture while others have attempted to discuss the nature and extent of yield,

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32. The information about the Integrated Dryland Agricultural Development Project, Mandrup, which is given here, is taken from the unpublished note, viz., "Pilot Projects for Integrated Dry Land Agricultural Development," which was made available by the Project Officer, IDLAD Project, Mandrup (Sholapur), at the time of personal visit to their office.

and income variability. Measures such as crop insurance, improved breeds of milch animals, etc., are suggested to reduce income instability.

Jodha and Purohit<sup>33</sup> have put forth their attention on the two-fold problems of instability and growth in dry farming areas. They properly set forth the problem of crop yield instability and surveyed the effects of weather variability on some major crops in the dry (arid) region of Rajasthan. The coefficient of variation is taken as a measure of crop yield instability. After having mentioned the 'time honoured' devices like diversification, etc., as adjustment devices to crop yield instability, the authors come forward to suggest remedial measures such as increased irrigation facilities, bunding, shelter belts, wind breaks and perennial grass farming.

M.K. Shingare<sup>34</sup> used only yield and price data for a period of 5 years (1951-56). He rightly pointed out that high correlation between prices of different crops makes price stability difficult. Then he switches over to crop yield and gross income correlations, without stating any

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33. Jodha N.S. and Purohit S.D. "Weather and Crop Instability in the Dry Region of Rajasthan," Indian Journal of Agricultural Economics, Vol. XXVI, No. 4 (Conference Number), October-December 1971, pp. 286-295.
34. Singare M.K. "Diversification of Cropping to Reduce Instability in Dry Farming Area of Maharashtra," IJAE (Conference Number).

meaningful relevance to the problem of crop yield/income instability.

N.S. Jodha<sup>35</sup> emphasized the need for a new approach to the development of arid agriculture and argued that unscientific use of arid lands through overgrazing and ploughing for a long time in Rajasthan has disturbed the ecological equilibrium of nature resulting into the operation of law of diminishing returns.

2. For profitable exploitation of drylands some research workers have laid the emphasis on the management of soils and efficient water use, while others felt that apart from the limitations imposed from low and uncertain moisture levels, the missing links in elevating and stabilizing yields of rainfed agriculture have been non-availability of suitable varieties of crops, cropping patterns and the necessary package of practices, e.g., maintenance of optimal plant populations, application of fertilizers and pesticides, etc., for such areas.

In regard to this first major issue G. Krishnamurthy<sup>36</sup> has opined that the average yield of any rainfed crop in the scarcity area of Andhra Pradesh, Mysore, Madras and

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35. Jodha N.S. "Development of Arid Agriculture -- Need for a New Approach," Indian Journal of Agricultural Economics, Vol. XXVI, No. 4 (Conference Number), October-December 1971, pp. 361-362 and 362-363.

36. Krishnamurthy G. "New Hope for Dry Farming Areas of Andhra and Mysore," Indian Farming, Vol. 18, No. 5, August 1968, pp. 30-32.

Maharashtra is in the order of 200 kgs to 500 kgs per hectare. The most obvious need is to conserve moisture, yet even after bunding and adoption of the dry farming practices the yield increase was about 15 to 20 per cent, not spectacular enough to catch the eye of the farmers. Many of the past attempts to increase crop production through manuring and fertilization were more or less unsuccessful. The response was either not there or was not economic. According to him the reason that led to this state of affairs was that practically no attention was paid to utilize efficiently the moisture stored in the soil. Thus, although the conservation practices resulted in increased storage of moisture, they did not result in higher yield of crops.

C. Krishnamurthy<sup>37</sup> further observed that the weakest link in the chain of factors affecting crop production in the scarcity areas, are the crop varieties. Rabi crops are the rule in the black soils which are dependent entirely on the moisture (from the south-west monsoon) stored in the soil. It was also observed that some time around the third week of December or the first week of January the soils begin to develop cracks and the rate of moisture depletion becomes extremely rapid. The defect with the popular varieties, like H-1 Jowar and W-1 Cotton as in

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37. Ibid., pp. 30-32.



Bellary tract, is that they are of long duration and suffer from drought at the most crucial stage of flowering or early fruit formation. The obvious solution suggested by the author is short duration varieties which enter maturation stage by the time moisture becomes critical.

Krishnamurthy<sup>38</sup> also pointed out that it is wasteful to wait for the onset of the monsoon for tillage as this invariably delays sowing. He explained that low monetary inputs such as post-harvest tillage, choice of suitable crops and varieties, early sowing with optimum plant population density and weed control are prerequisites. They are to be mastered before cash inputs such as fertilizers, plant protection, etc., are introduced. Otherwise, cash inputs might not pay.

In connection with the same aspect described above, M.S. Swaminathan<sup>39</sup> observed: "..... that the earlier efforts in the field of dryland farming were largely restricted to soil and moisture conservation measures. These steps which could increase yield and income by 10 to 15 per cent failed to exert a catalytic effect on the minds of the farming community and consequently did not catch on. Thus what is needed in these areas is a synergistic package

38. Ibid.

39. Swaminathan M.S. "New Techniques for Dryland Farming," Agricultural Situation in India, April 1970-March 1971, pp. 3-4.

of practices which could help to at least double the best yield obtained now. Recent research has shown that apart from the limitations imposed by low and uncertain moisture level, the missing link in elevating and stabilizing yield of rainfed agriculture have been the non-availability of crop varieties of suitable durations and growth rhythm, poor plant population, absence of attention to rectifying the defects in soil structure, improper tillage, lack of application of nutrients and plant protection procedures, poor storage and marketing. In addition, problems like fragmentation of holding and lack of organized supply of inputs made the few steps taken in the past in the field of soil and moisture conservation even less effective than they might have otherwise been."

3. In regard to financial aspects of adoption of dry farming technology Krishnaswami and Patel<sup>40</sup> identified the variability of the known dry farming technology and estimated the magnitude of finance for its wider adoption. The contention behind it is that the available dry farming technology meet the variability criteria of simplicity, acceptability and feasibility in terms of inputs availability and profitability. To meet the financial

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40. Krishnaswami M.S., and Patel K.V. "Viability of Available Dry Farming Technology and Some Financial aspects of Its Adoption in Selected Villages in Mysore State," Indian Journal of Agricultural Economics, Vol. XXVI, No. 4, (Conference Number), October-December 1971, pp. 368-369.

requirements necessary for stepping up the technological levels of lower adopters, the nationalized banking sector is suggested as a leading source, since the performance of cooperative credit institutions, according to them, has not been impressive in the past.

To sum up, attempts were made by the various authors to show how important it is to select a crop variety to overcome the limitations set by the soil moisture, importance of package of practices, etc., for dryland farming. Financial aspects are also important for adoption of various dry farming techniques. In short, a new agronomy has, therefore, to play an active role if we are to elevate the yield levels of these regions.

#### 1.10 The Present Study

A short review of the previous studies on dryland agriculture is given in the present chapter. By and large, the problems faced have been looked into in isolation. The present study makes an effort at examining the results of a set of measures and practices, advocated by the research stations on an actual farming area in a dry agricultural region. The project (IDLAD) propagates the adoption of these techniques at the cultivators level and it may be agreed that in the ultimate analysis adoption of these techniques by the cultivators will largely depend on their own assessment of the benefits endowed by the adoption of these techniques on their own fields. In this

study we make an effort to examine the experience of farmers at their farm level of the effect of the various measures for improving dryland farming advocated by the Research Station. The main thrust is the economic worthwhileness of these measures. In addition, effort is also made to examine the reaction of farmers to the different measures advocated.

#### 1.11 The Objectives of the Study

(i) To study the extent of adoption of various dry farming techniques by the sample farmers from the Integrated Dry Land Agricultural Development Project, Mandrup, district Sholapur.

(ii) To study the economic benefits accrued by these sample farmers by adopting various dryland techniques.

(iii) To study the factors effecting the adoption or non-adoption of the dryland techniques.

(iv) To examine the feasibility of various soil conservation/land development and water harvesting measures.

#### 1.12 The Plan of Work

This study includes in all eight chapters. The Second Chapter aims at briefly describing the background condition of the IDLAD Project, Mandrup. In the same chapter we also discuss the plan of survey, its design and a brief methodology. An attempt is made in Chapter III to assess the economic viability of various improved agronomical practices recommended for dryland farming.

The viability has been assessed both by qualitative and quantitative analysis. In Chapters IV to VII, we estimate the social returns and costs of the soil conservation/land development and water harvesting schemes. The schemes are male-training, male-check, drainage and fernponds. To assess the economic efficiency of these schemes we have calculated the benefit-cost ratios for the respective schemes. The eighth is the concluding chapter.

## CHAPTER II

### AGRO-ECONOMIC PROFILES OF THE IDLAD PROJECT (MANDRUP)

The focus of this chapter is on the agro-climatic profiles of the Integrated Dry Land Agricultural Development Project, Mandrup, District Sholepur. In preparing these profiles emphasis is laid on the following inter-related agro-climatic dimensions. The data used in this chapter have been taken from various published and unpublished reports that were made available by the project authorities.

#### 2.1 Agro-Ecological Features

##### (1) Location

Integrated Dry Land Agricultural Development Project is located at village Mandrup in South Sholepur Tehsil, District Sholepur. The area of the project starts from 18 km from Sholepur city and 24 km from Agricultural Research Station, Sholepur, where All-India Coordinated Research Project for Dry Land Agriculture, Main Centre, Sholepur, is located. The area of the project spreads over parts of four villeges, viz., Mandrup, Wadakhel, Wangi and Nandni, upto the year 1975-76. Village Wangi is to the north and village Wadakhel to the north-east while the village Nandni to the south-east of village Mandrup. The river Sine flows on the northern boundary of the village Wangi from west to east. The total area covered by the project upto 1975-76 is 5156 hectares. As per the guideline of the scheme,

every year there should be inclusion of 800 hectares of area in the project watershed. The yearwise (annual) coverage of area (with some other details e.g., total cultivable area, non-cultivable area, etc.) by the project is not given here because of non-availability of all the annual reports, i.e., from 1970-71 to 1975-76. The details of the area included in the project during 1973-74, 1974-75 and 1975-76 are presented in Table 2.1.

Table 2.1 shows that the area included in the project (watershed) during the year 1970-71 is being continued upto the year 1973-74. The available reports for the years 1970-71 (blueprint) and 1973-74 (annual report) too support the above fact. The cultivable area covered by the project from village Wedakbal and Wengi, upto the year 1973-74, had come down in the years 1974-75 and 1975-76. The reasons for this are not mentioned anywhere in the reports. Area for the village Nandni has been included in the project during the year 1975-76 only.

(2) Climate

The agro-climate of the project villages is semi-arid. The year can be divided into three seasons, i.e., summer season from March to June, rainy season from July to October, which is followed by winter from November to February.

The period from March (9th Met. week) to June (24th Met. week) is one of continuous rise in temperature. May

**Table 2.1: The Yearwise Details of the Area Included in the Project from 1970-71 to 1975-76**

Sr. No.	Details	Mandrup			Wadakbal			Wangi			Nandni		
		Upto 1973-74	From 1974-75	From 1975-76	Upto 1973-74	From 1974-75	From 1975-76	Upto 1973-74	From 1974-75	From 1975-76	Upto 1973-74	From 1974-75	From 1975-76
1.	Total area of the village (hectares)	7431	7431	7431	580	580	580	2222	2222	2222	*	*	1098
2.	Area covered by the project (hectares)	3342	3395	4010	408	408	408	346	346	346	*	*	392
3.	Cultivable area (hectares)	3300	3353	3946	373	332	332	296	286	286	*	*	352
4.	Non-cultivable area (hectares)	42	42	64	35	76	76	50	60	60	*	*	40

\* Area from village Nandni has been included in the project during the year 1975-76.



(from 17th Met. week to 20th Met. week) is the hottest period recording a mean maximum temperature of  $40^{\circ}\text{C}$ . December and sometimes January is the coldest month recording a mean minimum temperature of  $13^{\circ}\text{C}$  (52nd Met. week).

In short, except for the hot months of March, April and May the climate is agreeable and free from extreme of heat or cold. Climatologically the entire district falls in the rain shadow area. There are little variations in the climate in different parts of the district.

(3) Rainfall

The annual average rainfall in the project area is 690 mm distributed over 42 rainy days. The rainfall is scanty, erratic and also ill-distributed. Rainfall during June and July is uncertain and coupled with prolonged dry spell extending upto 9 weeks. Besides this, September rains are more sure with high intensity and generally responsible for soil erosion.

(4) Temperature

(A) Minimum Temperature

The weekly mean minimum temperature ranges between  $13^{\circ}\text{C}$  in December-January and  $25^{\circ}\text{C}$  in May. Winters are very mild. In a few years, the temperatures have fallen<sup>to</sup> as low as  $8^{\circ}\text{C}$ , but such occasions are very rare. Another interesting fact to be noticed is that, the period of maximum clouding, as indicated by hours of sunshine, is

associated with the period of high wind velocities, which generally disperse the clouds and results in a decrease in rainfall. The weather is sultry-moist but oppressive during monsoon, and dry and hot during other months.

(B) Maximum Temperature

Mean maximum temperature varies from 30°C in winter to 41°C in summer. The peak period is reached between mid-April to mid-May. These temperatures generally follow the normal trend.

(5) Soil Moisture

Generally the soil moisture shows a surplus over potential evapo-transpiration (PET) from July to December. After December soil moisture decreases and shows a deficit over PET values. The deficit gap widens at a very fast rate from February onwards. Soil moisture values are above the wilting coefficient from July to mid-December.

In the years when the late rains are received in December-January the soil moisture remains above wilting coefficient as late as February. On the contrary, when the rains are totally over by September-end, the soil moisture falls below wilting point as early as November. These observations will have to be modified in the cases of water-logged and low-lying areas.

(6) Water Availability Period

Considering the total evapo-transpiration, its half and one-fourth values and balancing these against the

rainfall, the year is divided into four periods as humid, moist, moderately dry and dry.

During the humid period, there is no moisture stress but moisture is surplus. During the moist period there is not much of moisture stress and it is most suitable for crop growth. The moderately dry period is characterised by some moisture stress and the crops suffer a little. Drought resistant varieties of crops do well in this period. The dry period exhibits severe moisture stress causing permanent crop wilting.

Periods for this area are as follows:

- |                 |  |
|-----------------|--|
| Humid:          | Last week of August to end of September      |
| Moist:          | 1) First week of June to last week of August |
|                 | ii) First week of October to mid-October     |
| Moderately dry: | 1) Last week of May to first week of June    |
|                 | ii) Mid-October to end of November.          |

The remaining part of the year is taken as dry period unfit for dry land cultivation. Even in the moderately dry period, period between last week of May to first week of June is unfit for any crop growth, as the soils may not be fit for receiving seed.

(7) Soils

(i) Geology

The soils of the region are derived from the Deccan trap, a volcanic formation of basic rock known as basalt. It is more or less uniform in composition and is rich in ferro-magnesium minerals. This rock weathers slowly but yields a rich soil.

(ii) Physiography and Drainage

The major slope of the project area is from south to north. There are three main nales running east-west and north-south and finally uniting in Wadakbal area and ultimately drains into the river Sina. Besides, there are several small gullies which finally join the above three nales. The topography of the entire project area is that of a gently rolling plain. The nales are seasonal in nature. Most of the wells are situated along these water courses.

(iii) Soil Types

On the basis of information collected regarding physico-chemical properties of soils as revealed from field and laboratory studies, it is observed that deep and heavy textured soils (more than 90 cm depth) occupy a major proportion i.e., 55 per cent of the total area of the project. Shallow and light textured soils with a depth of 22.5 cm are also found in high proportion i.e., 33 per cent. Area under different soil types in the project is presented below.

(a) Very Shallow Soils (0-7.5 cm Depth)

These soils are mostly observed in the upper ridges of the project area. They are undulating and subject to severe erosion which results in leaving behind practically no soil cover. Rock, stones and disintegrated or hard murum is observed all over these areas. These soils are unfit for cultivation of any field crops, except grasses and forestry. The area under this type is 12 hectares, which accounts to 0.4 per cent of the total area.

(b) Shallow Soils (7.5 to 22.5 cm Depth) (High level, moderate lime, reddish brown, sandi loam soils)

These soils are seen in the southern and western parts of the project area. The area occupied by this soil type is 1,094 hectares which accounts for 33 per cent of the total area of the project. The erosion is severe. The drainage is good. Yellowish murum is observed below the soil column. The available  $P_2O_5$  and available  $K_2O$  contents are low and moderate respectively. Organic matter content is found to be low. These soils are likely to respond to the application of N, P fertilizers and manures. These soils are suitable for kharif crops such as groundnut, bajra and mung, redgram and pulses.

(c) Medium Deep Soils (22.5 to 90 cm Depth)

The area under medium deep soils is 390 hectares which is about 12 per cent of the total area. This type can be further subdivided into two groups:

Soils having depth of 22.5 to 45 cm; and

Soils having depth of 45 to 90 cm.

- (A) Reddish brown to dark brown, moderate lime, medium deep, sandy clay loam, resting on murum

The area occupied by this soil type is 257 hectares.

These soils are seen mostly in the southern and western regions of the project area. The topography is generally sloping plain. The erosion is severe. The texture is sandy clay loam to clay loam. As the depth increases there is a change in texture from sandy clay loam to clay.

- (B) Dark brown, moderate deep, high lime clay loam to clays resting on murum

These soils are seen on gently sloping plain. The area under this type is small as compared to other types (133 hectares accounting for 4 per cent of the total area). The erosion is severe.

Though (A) and (B) types vary in depth, texture and lime content, these two types do not show much difference in chemical properties and hence they are dealt with together. These soils are moderate in their  $P_2O_5$  and  $K_2O$  content. The organic matter content is low. Hence N, P fertilizers and manures are likely to give better response on these soils. Kharif crops like bajra, groundnut, mung, tur, etc., can be taken on lighter type of soils while rabi crops such as jowar, gram, safflower, cotton, etc., can be grown on comparatively deep and heavy textured soils.

(d) Deep Soils (more than 90 cm Depth)

This soil type occupies the largest area in the project (1799 hectares accounting for 55 per cent of the total area). It extends in the north-east direction upto the Sina river covering almost half of the project area. Around Wadekbal it is rather uneven and eroded. The soils are dark brown to grayish brown in colour, clay in texture. Erosion is severe. As far as fertility is concerned, it is observed that the available  $P_2O_5$  and  $K_2O$  of soil is moderate to high organic matter content is low to slightly moderate. N, P fertilizers and manures are likely to benefit these soils.

Groundnut and tur in kharif and jowar, wheat, gram, safflower and cotton in rabi season can be grown successfully. Sugarcane, banana and some of the vegetables are also grown in irrigated areas.

It is observed from the above discussion that the soils in general in the project area are low in nitrogen, low to medium in phosphate and rich in potassium. Soils are neutral to slightly alkaline.

(8) Land Use Capability

The capacity of the soil to produce substantial crop yields for a long period largely depends on its capability. In classifying soils on its capability all features that influence its use are taken into consideration. These include the type of soil, slope, degree of erosion, drainage,

salinity or alkalinity, etc. Based on the soil survey the land classification of the project area and the cropping system based on land use classification is given in Tables 2.2 and 2.3 respectively.

**Table 2.2: Area Under Land Use Capability Classes**

Sr.No.	Class	Area (Ha.)	Percentage
1.	I	19	0.38
2.	II	1,730	35.20
3.	III	921	18.74
4.	IV	2,021	41.11
5.	V	225	4.57
	<b>Total</b>	<b>4,916</b>	<b>100.00</b>

**Class I**

Lands coming under this class have few or no limitations in their use and can be cultivated with ordinary management practices. Lands are fairly deep with good tilth, productive, easily workable and well drained. These are suitable for intensive cropping without any major soil amendments. A very small area of 19 hectares (0.38 per cent) comes under this class.



**Table 2.3: Cropping System Based on Land Use Classification**

Sr. No.	Depth of soil (cm)	Crops suggested
1.	Less than 10	Grosses.
2.	10 - 22.5	Red gram, horse gram, kidney bean and bajra.
3.	22.5 - 45	Bajra, redgram, groundnut, sunflower, green gram, black-gram, cowpea.
4.	45 - 60	Bajra, groundnut, sunflower, bajra and redgram as intercrops in kharif.  Jowar, safflower and gram for early sowing.
5.	60 - 90	Double Cropping:  i) Green gram followed by rabi jowar.  ii) Bajra followed by gram.  iii) Bajra and redgram winter crops.
6.	90 and above	Rabi jowar, safflower and gram.

**Note:** In order to utilize the lands to their optimum utility, the above schedule has been suggested to plan the crops.

**Source:** Annual Progress Report, Project Officer, Integrated Dry Land Agricultural Development Project, Mendrup (Sholapur), for the Year 1975-76. Department of Agriculture, Maharashtra State, p. 11.

### **Class II**

Lands gently sloping to gently rolling plains and moderately susceptible to erosion with moderate depth come under this class. The defects, if any, are easily

correctable. Land can be cultivated with some soil conservation practices, such as strip cropping, contour cultivation, suitable rotations with legumes and occasional green manuring. Large area of 1,730 hectares comes under this class.

#### Class III

Land with moderately to steep slope, susceptible for erosion restricted drainage, varying depths presenting problems of soil conservation, drainage and poor fertility fall under this class. These soils can be used for cropping by adopting suitable soil conservation measures, such as providing drainage, additions of bulky manures and adoption of suitable rotations. Medium deep soils and ill-drained eroded and undulated soils from the project area have been included under this class. An area of 921 hectares (i.e. 18.74 per cent) is included in this class.

#### Class IV

In this class predominantly shallow soils are included. The land use is restricted to one season crops. An area of 2,021 hectares (i.e. 41.11 per cent) of the total area is included in this class.

#### Class V

Very shallow soils and severely affected saline and alkali soils along the water course are included in this class. An area of 225 hectares (4.57 per cent) has been included in this class. Very shallow soils can be used

for grasses. Saline and alkali soils can be brought under cultivation after reclamation.

(9) Irrigation Resources of the Project

The main source of irrigation in the project area was the wells and to some extent through lifts installed on river Sina. Out of 110 wells in the project, 75 wells were not in use because of one or the other reason, e.g., unavailability of water in the wells, leak of pumping devices, salty water, etc. The information regarding the number of wells and the village-wise area under irrigation is presented in the Tables 2.4 and 2.5 respectively.

Table 2.4: The number of Used and Unused Wells in the Project Area

Sr. No.	Water-table	Mendrup	Wadakbal	Wangi	Total
<u>Used Wells</u>					
1.	Upto 3 metres	12	1	-	13
2.	3 to 6 metres	43	1	-	44
3.	6 to 9 metres	14	1	1	16
4.	9 to 12 metres	2	-	-	2
Total		71	3	1	75
<u>Unused Wells</u>					
Total		34	1	-	35
Total		105	4	1	110

From the above Tables one can observe that the village Mandrup alone accounts for most of the wells from the catchment area. The remaining two villages, viz. Wadakbal and Wangi, were having very few wells, i.e., 4 and 1 respectively. The water-table of the wells at different times of the year is something really very interesting. However, even after perusing the annual reports, no information was available. Then the concerned officials at Mandrup were consulted. Even at this level no information was made available and every query in this respect invariably ended with the stock answer that the matter needs to be looked into and rectified.

**Table 2.5: Villagewise Area Under Irrigation in the Project**

					(Area in hectares)
Sr. No.	Name of the Village	Total area under irrigation	Seasonal irrigation	Perennial irrigation	Source of irrigation
1.	Mandrup	95	86	9	Wells.
2.	Wadakbal	10	2	8	Partly from well and partly from lifts installed on Sina river
3.	Wangi	9	2	7	- do -
Total		114	90	24	

The testing of the quality of irrigation water was done by the Agricultural Research Station, Sholapur. It was observed that the well water and the water from Sina

river is quite suitable for irrigation.

(10) Principal Crops Grown in the Project

Rabi jowar, the main crop of the region, is also the main crop of the project. Groundnut, Bajra, Tur, Mung and other pulses in kharif and gram, safflower, wheat, cotton in rabi are the other crops grown in the project. Sugarcane, chillies, vegetables and wheat are some of the irrigated crops in the project. Area under different crops along with the average yields in the project area are presented in Table 2.6.

From the data presented in the Table 2.6, it is observed that the average yields of the crops are low. Some of the reasons for the low yields of dry crops can be attributed to inadequate soil and water management practices and low fertility status of soil and absence of plant protection measures.

Jowar after jowar is the common rotation followed by the farmers since it occupies 77 per cent area under cultivation. Very few farmers grow groundnut in one year followed by rabi jowar in the second year. Tur is mixed with bajra and safflower, gram are mixed with rabi jowar. These practices fulfil the requirements of pulse and oilseeds. Cotton-Rabi Jowar is an important rotation with cultivators growing cotton. Area under cotton is increasing due to its high ruling price.

**Table 2.6:**

Sr. No.	Name of the crop	Area (Hectares)			Total	Average yield Q/Ha.
		Mandrup	Wadakbel	Wangi		
<b><u>Kharif</u></b>						
1.	Groundnut	433	42	33	508	3.75
2.	Bajra	16	2	2	20	1.80
3.	Paddy	5	1	1	7	3.50
4.	Tur	15	25	23	63	3.20
5.	Other Pulses	65	15	19	99	2.00
<b>Total for Kharif</b>		<b>534</b>	<b>85</b>	<b>78</b>	<b>697</b>	
<b><u>Rabi</u></b>						
1.	Jowar + Safflower	2068	246	224	2538	2.60
2.	Gram	37	19	32	88	3.25
3.	Wheat	40	21	4	65	3.00
4.	Cotton	20	2	5	27	2.50
5.	Other Crops	40	18	25	83	2.00
<b>Total for Rabi</b>		<b>2205</b>	<b>306</b>	<b>290</b>	<b>2801</b>	

**Source:** "Blueprint for Action and Vision for the Future", Integrated Dryland Agricultural Development Project, Mandrup, Dist. Shelapur, Presented by Chief Scientist, AGRPDLA and Project Officer, IDLADP, M.P.K.V., Rahuri. Department of Agriculture, Maharashtra, pp. 8-9.

2.2 Physical and Financial Achievement  
vis-a-vis Targets and Provisions

The yearwise (from 1970-71 to 1975-76) targets in both physical and financial terms and actual achievements of the Integrated Dry Land Agricultural Development Project, Mandrup, district Sholapur, are given in the Appendix I to VI.

From the above, it will be seen that the expenditure is much below the allocations. The main reasons underlying the shortfall, as explained by the Project Officer, IDLAD Project, Mandrup, are as below:

1. The schemes were sanctioned late in the year (i.e. 1970) and hence except preliminaries nothing substantial could be done during the first year of sanction.
2. The second year was mostly devoted to different surveys (topographical, soil and hydrological), and preparation of blueprint of action programmes, etc. Similarly, terms and conditions of loans of different kind were also finalised apart from organizing the work in the manner required by the Government of India. During this year efforts were made to push the land development work also.
3. The third year was the real take-off year but being a severe scarcity year, crop production and animal husbandry programmes could not be implemented. Moreover, the cultivators were not in a mood to participate in the programmes in Mandrup project due to the acute scarcity

conditions.

4. Since the programme is restricted to an area of 3,200 hectares, the implementation of the same had to confront many inhibitors like non-creditworthiness of the cultivators to obtain different kinds of loans, difficulty in smooth flow of the institutional finance and inadequate period available for propagating the dry farming technology among the cultivators.

The year 1973-74 had, however, started with a good rhythm of satisfactory rainfall and had given a fillip for promoting dry farming technology in the project. The programme assigned to the project in this year (i.e. 1973-74) had, therefore, been largely fulfilled.

### 2.3 Data Source

The major source of data for the study of selected topic is primary investigation of cultivators from the Integrated Dry Land Agricultural Development Project, Mandrup and the cultivators from adjacent area as a control. Some secondary data (i.e., annual reports, data relating to the demonstration plots, etc.) was also collected from the IDLADP, Mandrup and ACRPDLA, Sholapur.

### 2.4 Methodology of the Study

The improved dry land farming techniques recommended by the Research Station may be grouped under three broad categories:

(A) Soil conservation and land development measures



- (B) Water harvesting measures
- (C) Improved agronomical practices for different crops grown on dry lands.

In the Mandrup project three techniques, viz., nala-training, drainage and contour bunding were included under the category of soil conservation and land development measures. By and large, the work of contour bunding had been almost completed throughout the State in the drylands and as such it was not considered feasible to study the differential impact of this technique in this study. Water harvesting included construction of farmponds and the work of nala-checks only. In fact, the work of nala-checks also serves, besides water harvesting measure, the measure of prevention of soil erosion. The techniques, viz., nala-training, drainage, nala-checks and farmponds were implemented on a limited number of farms depending upon the physical lay of the land. The coverage by the time the study was decided upon was limited to three villages, namely, Mandrup, Wadakbal and Wangi.

Considering the number of participants in the three villages the need to draw a sample was necessary for two sub-categories, nala-training and drainage work, under soil conservation and land development measures. Similarly, under water harvesting measures the two techniques implemented were nala-checks and farmponds with 20 participants in each. So far as agronomic practices was

concerned, it was decided that rather than drawing an independent sample for this it will be convenient to cover all the participants under agronomic practices from the participants under soil conservation and land development measures and the water harvesting measures.

The participants under soil conservation measures were as below:

Sr.No.	Village	Nala-training	Drainage
1.	Mandrup	61	39
2.	Hedakbal	18	2
3.	Wangi	16	-
	Total	95	41

Effectively Mandrup was the only village where major part of the work was conducted. As the number of participants under water harvesting measures (i.e., nala-checks, and farmponds) was only 20 for both the techniques no necessity was felt to draw a sample. The sample was necessary only in respect of soil conservation measures and considering the total number of participants a 20 per cent coverage was deemed adequate, which boils down to collecting information from the 20 under nala-training scheme. To repeat, the total number of participants under drainage work was only 41, and to keep the coverage uniform it was decided to cover 20 participants under this scheme.

The sample as drawn is related to the participants under the respective schemes. Though, it would have been desirable to draw the same considering the area to be benefited as a result of the measures undertaken. Since, no such data, not only at the time of survey, was available, but even by the end of the survey period of about four months, the official data was not ready. Under the circumstances, drawing the sample by number of participants was the only alternative left.

For the purpose of comparison between the cultivators within the project area who were following the recommended practices with the cultivators not following such practices, 20 participants were selected from the adjacent area having similar soil type but not included in the project area.

## 2.5 The Schedule

The principal features of the schedule are as under:

### Block

### Details

1. General information of sample cultivators and total family labour force.
2. Land holding pattern, type of tenancy, etc.
3. Information on various soil conservation and land development measures undertaken by the sample cultivators. From this block the detailed information concerning the drainage, male-training, male-checks, rectification activity, land levelling, graded bunding, etc., was obtained.

BlockDetails

4. Details concerning to wells.
5. Information concerning to farmponds.
6. Cropping pattern.
7. Crop yields.
8. Cost of cultivation of various crops and level of adoption of various agronomic practices.
9. Adoption level of improved implements and machinery by the sample cultivators.
10. Opinion survey of the sample cultivators from the project area.

Judging by the response obtained by the sample cultivators, the survey may be deemed to have been successful. The quality of response on the whole, was satisfactory. To obtain as much accuracy as possible in the quantitative data special measures were adopted. For instance, before canvassing the schedule in any village, inquiries were first made about the rate of hired human and bullocks labour and materials, about the character of season and harvests, etc. The field survey lasted for about four months from May to August 1977. Most of the farms covered under the survey were seen by making personal visits to the spot and some visits with the Project Officials.

**Appendix I <sup>2.1</sup> : Statement Showing Target and Achievement, Provision Made and Expenditure Incurred in the IDLAD Project, Mandrup, during the Year 1970-71**

Sr. No.	Item	Target	Achievement	Provision	Expenditure
1.	Inputs	2000 acres	122 acres	2.00	0.01
2.	Permanent works:			5.00	
A.	<u>Soil Conservation</u>				
	i) Rectification	1000 acres	-	-	-
	ii) Land grading	-	-	-	-
	iii) Graded bunding	-	-	-	-
	iv) Contour bunding	300	292	-	0.10
	v) Ill-drained works	-	-	-	-
	vi) Deepening	-	-	-	-
	vii) Tractor ploughing	-	-	-	-
	viii) Planetable survey	-	-	-	-
	ix) Ayscut development	-	-	-	-
	x) Land levelling	-	-	-	-
B.	<u>Water Harvesting</u>				
	i) Feraponds	-	-	-	-
	ii) Nala flooding	50	-	-	-
	iii) Community wells	2	-	-	-
	iv) Percolation tanks	1	-	-	-
C.	<u>Minor Irrigation</u>			2.25	
	i) Individual wells	5	-	-	-
	ii) Renovation of old wells	15	-	-	-
	iii) Exploratory surface bore	-	1	-	0.10
	iv) Electric motors and oil engines	20	-	-	-

2.1  
Appendix I (contd.)

Sr. No.	Item	Target	Achievement	Provi- sion	Expendi- ture
<b>D. <u>Infrastructure</u></b>					
	i) Demonstrations	100 plots	-	-	-
	ii) Farmers training	-	-	-	-
	iii) Implements and machinery	-	-	-	0.20
<b>E. <u>Animal Husbandry</u></b>					
	i) Poultry birds	10 units	-	-	-
	ii) Cows	20	-	18	-
	iii) Sheep	20	10 units	-	0.12
	iv) Bull	20	2	-	0.03
	v) Goats	5	5	-	0.01
	vi) Purchase of medicine	-	-	-	0.01
	vii) Transportation	-	-	-	0.01
	viii) Maintenance of Bulls (two)	-	-	-	-
	ix) Buffalo	-	-	-	-
<b>F. <u>Establishment</u></b>					
		-	-	0.55	-
<b>Total</b>				<b>10.57</b>	<b>0.67</b>

2.2  
**Appendix II : Statement Showing Target and Achievement; Provision Made and Expenditure Incurred in the IDLAD Project, Mandrup during the Year 1971-72**

Sr. No.	Item	Target	Achievement	Provision	Expenditure
1.	Inputs	4000 acres	3300 acres	3.01	0.53
2.	Permanent Works:				
A.	<u>Soil Conservation</u>			5.77	
	i) Rectification	1000 acres	3178 acres	-	0.57
	ii) Land grading	500 acres	-	-	-
	iii) Graded bunding	500 acres	175 acres	-	0.09
	iv) Contour bunding	300 acres	124 acres	-	0.13
	v) Ill-drained works	150 acres	15 acres	-	0.17
	vi) Deepening	4000 sft	8040	-	0.31
	vii) Tractor ploughing	1000 acres	654	-	0.33
	viii) Planetable survey	-	-	-	-
	ix) Ayscut development	-	-	-	-
	x) Land levelling	-	-	-	-
B.	<u>Water Harvesting</u>				
	i) Fermponds	10 Nos.	11	-	0.48
	ii) Male flooding	20 Nos.	9	-	0.48
	iii) Community wells	2 Nos.	-	-	-
	iv) Percolation tanks	-	-	-	-
C.	<u>Minor Irrigation</u>			6.88	
	i) Individual wells	12 Nos.	15	-	0.70
	ii) Renovation of old wells	15 Nos.	5	-	0.07
	iii) Explorery surface bore	2	1	-	0.01
	iv) Electric Motors and oil engines	40 Nos.	-	-	0.02

2.2  
Appendix II (contd.)

Sr. No.	Item	Target	Achievement	Provision	Expenditure
<b>D. <u>Infrastructure</u></b>					
	1) Demonstrations	100 plots	-	-	-
	ii) Farmers training	200 Nos.	225	-	0.03
	iii) Implements and machinery	-	-	-	0.07
<b>E. <u>Animal Husbandry</u></b>					
	i) Poultry birds	-	10 units	7 units	0.21
	ii) Cows	8 Nos.	20	12	0.06
	iii) Sheep	20 Nos.	10	-	0.14
	iv) Bull	-	-	-	-
	v) Goats	-	-	-	-
	vi) Purchase of medicines	-	-	-	0.03
	vii) Transportation	-	-	-	0.01
	viii) Maintenance of bulls (two)	-	-	-	-
	ix) Buffalo	-	-	-	-
<b>F.</b>	<b><u>Establishment</u></b>	-	-	53	38
<b>Total</b>				<b>16.96</b>	<b>4.82</b>



**2.3**  
**Appendix III: Statement Showing Target and Achievement; Provision Made and Expenditure Incurred in the IDLAD Project, Mandrup during the Year 1972-73**

Sr. No.	Item	Target	Achievement	Provision	Expenditure
1.	Inputs	6000 acres	4700 acres	3.00	0.03
2.	Permanent Works:				
A.	<u>Soil Conservation</u>			6.80	
	i) Rectification	2000 acres	1294 acres	-	0.15
	ii) Land grading	1000 acres	2	-	0.002
	iii) Graded bunding	500 acres	342 acres	-	0.11
	iv) Contour bunding	150 acres	161 acres	-	0.008
	v) Ill-drained works	200 acres	175 acres	-	0.92
	vi) Deepening	2000 sft	5425	-	0.92
	vii) Tractor ploughing	2000 acres	823	-	0.62
	viii) Planetable survey	-	1426	-	0.02
	ix) Aysout development	-	-	-	-
	x) Land levelling	-	-	-	-
B.	<u>Water Harvesting</u>				
	i) Fermponds	10 Nos.	2	-	0.22
	ii) Nala flooding	20 Nos.	7	-	0.26
	iii) Community wells	2 Nos.	2	-	0.19
	iv) Percolation tanks	-	-	-	-
C.	<u>Minor Irrigation</u>			1.71	
	i) Individual wells	20 Nos.	13	-	1.26
	ii) Renovation of old wells	25 Nos.	9	-	0.28
	iii) Exploratory surface bore	-	-	-	-
	iv) Electric motors and oil engines	60 Nos.	-	-	0.09

2.3  
Appendix III (contd.)

Sr. No.	Item	Target	Achievement	Provision	Expenditure
<b>D. <u>Infrastructure</u></b>					
	i) Demonstrations	100 plots	-	-	0.03
	ii) Farmers training	200 Nos.	360	-	0.02
	iii) Implements and machinery	-	-	-	0.01
<b>E. <u>Animal Husbandry</u></b>					
	i) Poultry birds	10 units	7 units	-	0.09
	ii) Cows	20 Nos.	-	-	-
	iii) Sheep	20 Nos.	-	-	-
	iv) Bull	-	-	-	-
	v) Goats	5 Nos.	-	-	-
	vi) Purchase of medicines	-	-	-	0.03
	vii) Transportation	-	-	-	0.002
	viii) Maintenance of bulls (two)	-	-	-	0.007
	ix) Buffalo	-	-	-	-
<b>F.</b>	<b><u>Establishment</u></b>	-	-	1.27	0.60
<b>Total</b>				<b>16.16</b>	<b>6.169</b>

2.4

**Appendix IV : Statement Showing Target and Achievement; Provision Made and Expenditure Incurred in the IDLAD Project, Mandrup during the Year 1973-74**

Sr. No.	Item	Target	Achievement	Provision	Expenditure
1.	Inputs	8000 acres	6478 acres	-	0.422
2.	Permanent Works				
A.	<u>Soil Conservation</u>				
	i) Rectification	560 acres	284 acres	-	0.10
	ii) Land grading	1200 acres	-	-	-
	iii) Graded bunding	1500 acres	6 acres	-	0.002
	iv) Contour bunding	170 acres	-	-	0.005
	v) Ill-drained works	270 acres	155 acres	-	0.42
	vi) Deepening	6000 sft.	815 sft.	-	0.46
	vii) Tractor ploughing	1500 acres	294 acres	-	0.002
	viii) Planetable survey	-	-	-	0.003
	ix) Ayscut development	200 acres	-	-	-
	x) Land levelling	300 acres	70 acres	-	0.24
B.	<u>Water Harvesting</u>				
	i) Farmponds	10 Nos.	7 Nos.	-	0.34
	ii) Nala flooding	5 Nos.	5 Nos.	-	0.32
	iii) Community wells	2 Nos.	2 Nos.	-	0.01
	iv) Percolation tanks	-	-	-	-
C.	<u>Minor Irrigation</u>				
	i) Individual wells	10 Nos.	9 Nos.	-	1.41
	ii) Renovation of old wells	3 Nos.	2 Nos.	-	0.24
	iii) Exploratory surface bore	-	-	-	-
	iv) Electric motors and oil engines	49 Nos.	52 Nos.	-	1.05

Appendix IV <sup>2.4</sup> (contd.)

Sr. No.	Item	Target	Achievement	Provision	Expenditure
<b>D. <u>Infrastructure</u></b>					
	1) Demonstrations	100 Plots	214 Plots	-	0.17
	ii) Farmers training	460 Nos.	510 Nos.	-	0.08
	iii) Implements and machinery	-	-	-	0.026
<b>E. <u>Animal Husbandry</u></b>					
	1) Poultry birds	15 Units	1 Unit	-	0.11
	ii) Cows	40 Nos.	15 Nos.	-	0.30
	iii) Sheep	40 Nos.	-	-	-
	iv) Bull	10 Nos.	-	-	-
	v) Cests	-	-	-	-
	vi) Purchase of medicines	-	-	-	-
	vii) Transportation	-	-	-	0.002
	viii) Maintenance of bulls (two)	-	-	-	0.005
	ix) Buffalo	10 Nos.	7 Nos.	-	0.10
<b>F. <u>Establishment</u></b>					
		-	-	-	0.78
<b>Total</b>				<b>9.19</b>	<b>6.831</b>

**Note:** No itemwise provision for 1973-74 can be shown as revised provision of Rs. 9.19 lakhs is sanctioned by Government recently.

2.5  
**Appendix V : Statement Showing Target and Achievement; Provision Made and Expenditure Incurred in the IPLAD Project, Mandrap during the Year 1974-75**

(Rs. in lakhs)

Sr. No.	Item	Unit	Target	Achievements	Provision	Expenditure
I.	Inputs				1.60	-
	New area	Ha.	800	400		
	Follow up area	Ha.	3200	2510		
	1) <u>Seeds</u>					
	a) Quantity distributed	Qtl.	-	68	-	0.04
	b) Area benefited	Ha.	4000	2220		
	ii) <u>Fertilizers</u>					
	a) Quantity distributed	Qtl.	-	413	-	0.02
	b) Area benefited	Ha.	4000	240	-	0.03
	iii) <u>Pesticides</u>					
	a) Quantity distributed	-	-	32		
	b) Area benefited	Ha.	4000	50	<u>1.60</u>	<u>0.09</u>
II.	1) <u>Permanent Works:</u>				1.29	-
	a) Rectification work	Ha.	600	819	-	0.36
	b) Graded bunding	Ha.	40	28	-	0.05
	c) Land grading	Ha.	120	25	-	0.01
	d) Ill-drained works	Ha.	40	30	-	0.29
	e) Nala-training (r.m.t.)	Ha.	500	500	-	0.16
	f) Land levelling	Ha.	90	40	-	0.30
	g) Contour bunding	Ha.	-	3	-	0.013
	h) Ayscut development	Ha.	80	-	-	-

Appendix V <sup>2.5</sup> (contd.)

Sr. No.	Item	Unit	Target	Achievements	Provision	Expenditure
	<b>ii) <u>Water Harvesting</u></b>					
	a) Farmponds	Nos.	7	6	-	0.97
					<u>1.29</u>	<u>2.153</u>
III.	<b>i) <u>Infrastructure</u></b>					
	a) Tractor ploughing	Ha.	200	5	-	0.04
	b) Demonstrations	Plots	100	171	0.15	0.32
	c) Farmers training	Nos.	560	50	0.10	0.18
	d) Implements and machinery	Nos.	-	286	0.38	0.19
	<b>ii) <u>Minor Irrigation</u></b>					
	a) Community wells	Nos.	2	2	-	0.30
	b) Renovation of old wells	Nos.	6	-	-	0.025
	c) New wells	Nos.	5	-	1.76	0.415
	d) Electric motors and pumpsets	Nos.	21	-	-	0.278
					<u>2.39</u>	<u>1.753</u>
IV.	<b>Animal Husbandry</b>				0.68	-
	a) Poultry	Units	5	-	-	0.016
	b) Cows	Nos.	20	-	-	-
	c) Buffaloes	Nos.	5	-	-	-
	d) Bull maintenance and medicines					0.004
					<u>0.68</u>	<u>0.02</u>
V.	<b>Establishment: Pay and Allowances</b>				1.25	1.19
	<b>Grand Total (Rs. in lakhs)</b>				<u>7.21</u>	<u>5.206</u>

2.6  
**Appendix VI : Statement Showing Target and Achievement: Provision  
 Made and Expenditure Incurred in IDLAD Project,  
 Mandrup during the Year 1975-76**

(Rs. in lakhs)						
Sr. No.	Item	Unit	Target	Achieve- ments	Provi- sion	Expendi- ture
I.	<b>Inputs</b>				3.75	
	New area	Ha.	842	700		
	Follow-up area	Ha.	4078	3600		
	a) <u>Seeds</u>	Qtl.	-	224	-	2.205
	Farmers benefited	Nos.	-	600	-	-
	b) <u>Fertilizers</u>	Qtl.	-	900	-	-
	Farmers benefited	Nos.	-	274	-	0.029
	c) <u>Pesticides</u>	Qtl.	-	11	-	-
	Farmers benefited	Nos.	-	17	-	0.006
					<u>3.75</u>	<u>2.24</u>
II.	<b>1. <u>Permanent Works</u></b>					
	a) Rectification	Ha.	500	480	2.12	2.935
	b) Graded bunding	Ha.	20	33		
	c) Ill-drained work	Ha.	44	31		
	d) Ayscut development	Ha.	80	12		
	e) Nala-training (r.m.t.)		-	177		
	<b>ii. <u>Water Harvesting</u></b>					
	a) Nala checks	Nos.	7	3	2.12	2.935
	b) Farmponds	Nos.	7	4		
III.	<b>1. <u>Infrastructure</u></b>					
	a) Demonstration	Plots	100	93	0.20	0.22
	b) Farmers' training	Camps	12	7	0.19	0.17
	Farmers trained	Nos.	172	392		

2.6  
Appendix VI (contd.)

Sr. No.	Item	Unit	Target	Achieve- ments	Provi- sion	Expendi- ture
<b>ii. <u>Implements and Machinery</u></b>						
	a) Small machinery for cultivators on 50% subsidy	Nos.	100	119	0.20	0.18
	b) Project machinery	Nos.	5	3	0.25	0.14
<b>iii. <u>Minor Irrigation</u></b>						
	a) New wells	Nos.	10	3	1.00	0.23
	b) Renovation of old wells	Nos.	12	2	0.24	0.08
	c) Electric motors	Nos.	41	35	2.05	2.05
					<u>4.13</u>	<u>3.07</u>
<b>IV. Animal Husbandry</b>						
	a) Cattle development for small farmers	Nos.	59	35	0.69	0.811
					<u>0.69</u>	<u>0.811</u>
<b>V. Establishment</b>						
					1.75	1.44
<b>Grand Total (Rs. in lakhs)</b>					<b>12.44</b>	<b>10.50</b>



CHAPTER IIIASSESSMENT OF ECONOMIC EFFICACY OF THE  
DRY LAND TECHNIQUES

The present chapter takes up the central aspect of the study, i. e., the economic efficacy of dry land technology advocated and implemented in the selected villeges. In assessing the efficacy of techniques we must, at the outset, underline the fact that most of these techniques are expected to yield benefits both in terms of increased output and in terms of stabilizing the output. However, the long term benefit of reducing the year to year variations in yield is difficult to assess with the help of data pertaining to only one year, collected in the present study. We have tried to the extent possible to keep this long term aspect in mind in assessing the efficacy of the different dry land techniques adopted on the farms under the scheme.

It is also necessary to note that many farms had adopted more than one technique advocated by the Research Station. The results on the farmer's field are often, though not necessarily always, the result of adoption of more than one technique. It is not always possible to separate the impact of the different techniques on crop production, etc. This has to be kept in mind in the following presentation of the impact of the different techniques.

We intend to take up each technique one by one and

in the present chapter we consider the first technique, viz., nala training scheme.

### 3.1 Nala-Training Scheme

#### Background

This technique involves the work of deepening the nala from its starting point and finally draining it into the river. In absence of nala training the nala fills up with mud and this forces the runoff water into the adjacent fields, forming big gullies. As a result, whole fields get eroded and the land becomes unfit for cultivation. Nala training was advocated to save the land from erosion and restore it to cultivation. The nala in the surveyed villages was deepened and strong earthen bunds (embankments) were provided on both sides of the nala to prevent the water in the nala from overflowing into the adjacent fields. The overflowing nala, besides resulting in soil erosion, was creating problem for drainage of rain water from adjacent fields. In the first place, the overflowing water of the nala not only created gullies but also resulted in some parts of the fields being waterlogged due to inadequate natural drainage conditions, aggravated by the choked nala. Secondly, some type of land, with heavy black soil, suffered from the rising underground water-table due to flooding from the nala and there was no way of reducing this water. The deepening and training of the nala resulted in creating the physical condition necessary for taking special measures to

drain such fields. Thus we may summarize the objectives of nala training as follows:

- (i) To reduce the erosion of soil in lands lying on either sides of nala.
- (ii) To solve the drainage problem.
- (iii) To reclaim the land for cultivation.
- (iv) To increase the watertable of the wells situated along the nala.

Let us first look at the long term benefits which are of a permanent nature. The long term benefits are: (a) additional land brought under cultivation through control of soil erosion and reduction in waterlogging and (b) greater availability of irrigation water. Of these we will first take up the additional land brought under cultivation. The addition of cultivated land may be due partly to control of soil erosion and/or reduction in waterlogging, which go to make the land fit for cultivation. These permanent long term benefits, of course, are subject to the nala being kept clear and unlogged.

The benefit of addition to cultivated land can be assessed fairly easily. Table 3.1 gives the necessary details of number of plots and their area affected by the untrained nala in the surveyed villages.

The data show that 15 per cent of the area of the sample plots had remained out of cultivation due to soil erosion, etc., as a result of the flooding by the nala.

Nala training resulted in 94 per cent of this eroded, land being brought back to cultivation, the remaining 6 per cent going under the newly built embankments of the nala.

Cultivators had begun using all this land for cultivation.

**Table 3.1: Details of Number of Plots, Area, etc., of Land Affected by Nala in the Surveyed Villages**

Sr.No.	Items	Area (Aores)
(1)	Total number of plots partly or wholly effected by the nala in the villeges surveyed (Mandrup 61, Wengi 16 and Wadebal 18)	95
(2)	Total area of the above 95 plots	1985.33
(3)	Total number of plots (out of (1) above) sampled for survey	25
(4)	Total area of the above 25 plots	593.54
(5)(A)	Of the total area in number (4) above, area eroded by nala	89.00
(B)	(A) as per cent of (4) above	14.99
(C)	Total land reclaimed after implementation of nala training scheme	85.00

Another long term benefit of the nala training scheme consists of additional water availability for irrigation. The scheme increases the water availability of old wells and in addition makes feasible the creation of new wells.

In Table 3.2 the data regarding watertable of the old wells and the cropwise area irrigated by these wells in different seasons are presented. For this purpose the

Table 3.2: Details About the Old Wells (Male Training Group)

Sr. No.	Case No.	Survey No.	Water table of the Wells (in feet)						Cropwise Total Area Irrigated by These Wells in Different Seasons															
			Present Position			Past Position			Present Position				Past Position											
			June/July	Oct./Nov.	April/May	June/July	Oct./Nov.	April/May	Kharif Crops	Area (acres)	Rabi Crops	Area (acres)	Summer Crops	Area (acres)	Total of all Seasons (acres)	Kharif Crops	Area (acres)	Rabi Crops	Area (acres)	Summer Crops	Area (acres)	Total of all Seasons (acres)		
1.	3	324	2	19	2	2	15	2	Sugarcane	0.50		0.50		0.50	3.00	*								
									Paddy	1.00	Grass	0.50	-	-										
2.	10	289	3	20	2	3	20	2	H.Jewar	1.00	Wheat	0.50	-	-	3.00	Veg.	2.00	Wheat	1.00	-	-	-	-	3.00
									Onion	0.50	Jowar	1.00	-	-										
3.	11	1	4	10	4	8	12	7	⊙		⊙		⊙	⊙		Sugarcane	2.00		2.00				2.00	8.00
																		Wheat	2.00					
4.	12	4/2	5	15	2	5	15	2	Chillies	1.00	Wheat	2.00	-	-	5.00	Chillies	3.00	Wheat	2.00	-	-	-	-	5.00
									Veg.	2.00	-	-	-	-										
5.	18	333	1	13	Nil	Nil	5	Nil	Jowar	2.50	-	-	-	3.00	Veg.	0.50	Jowar	1.00	-	-	-	-	-	1.50
									Wangi	0.50	-	-	-	-										
6.	23	6	Nil	10	4	#	#	#	-	-	Jowar	4.00	-	-	4.00	#		#		#		#		#
7.	45+	317	3	10	3	3	10	3	Chillies	1.00	Wheat	2.00	-	-	4.00	Chillies	1.00	Wheat	2.00	-	-	-	-	4.00
									Maize	1.00	-	-	-	-		Maize	1.00	-	-	-	-	-	-	-
8.	51	61/1	4	10	3	2	5	1	Sugarcane	1.00		1.00		1.00	6.00	-	-	Wheat	1.00	-	-	-	-	1.00
									Wheat	1.00	-	-	-	-										
									Jowar	2.00	-	-	-	-										
9.	57	7	10	20	10	7	15	7	Sugarcane	2.00		2.00		2.00	10.00	Paddy	2.00	-	-	-	-	-	-	2.00
									Paddy	2.00	Wheat	2.00	-	-										
Total									16.00		18.50		3.50	38.00		11.50		11.00		2.00	24.50			

\* - Because of brackish/saline water previously no irrigation was given. Now water is fit for irrigation.

⊙ - Oil engine has broken down and therefore no irrigation was possible. Watertable had decreased due to heavy mud accumulation in the wells. The well requires renovation.

# - Newly purchased farm and as such unable to give past information.

+ - Rhote is used as water lifting device and as such there is no scope for increasing irrigated area although the water is ample in the well.

watertable of the wells at the beginning of the three seasons, viz., kharif, rabi and summer, were measured. Out of the 9 old wells situated on either side of the nala, data could be obtained for 8. The data relating to one well was not available because the plot of land on which the well is located has just been purchased by the respondent at the time of our investigation. From the Table it is also seen that the watertable of 4 of these wells increased considerably, 3 wells did not show any change in the watertable and in the case of only one well the watertable had decreased.

In the case of one of the 3 wells which did not show any change in the watertable, it was reported that although water was available in the well the farmer was not able to increase the irrigated area because he was using the traditional water lifting device, i.e., 'Mhote'. Of the remaining two wells, one became a useful source of irrigation after implementation of the nala training scheme. In this case it is observed that previously, due to brackish/saline water, no irrigation was given but after implementation of nala training scheme the brackish water has now become suitable for irrigation. The reason is that before implementation of the nala training scheme the deposition of salty minerals accumulated in the field affected the water in the wells situated in the fields. After implementation of the scheme these deposited minerals

were washed away into the nala and beyond, and consequently the water from the adjacent wells became fit for irrigation purpose.

We further observe from the same Table that the total area irrigated by these old wells in all seasons i.e., the gross irrigated area) increased by 13.50 acres. In calculating the gross irrigated area we have added the area under sugarcane thrice thrice - in all the three seasons. Even if we take it into account only once, which is the common way of calculating the gross irrigated area, it can be seen that the irrigated area increased by 9.5 acres in these sample farms. One farmer had stopped irrigation during the survey year due to breakdown of his oil engine. He would be able to resume after replacement and repair which would add another 8 acres, making the total irrigated area 21.5 acres (i.e.,  $13.5 + 8$ ). Thus, we find that as a result of the nala training the gross irrigated area under old wells had increased by 55 per cent and with the repair of the machine of one farmer, it would increase by about 84 per cent.

In Table 3.3 the data regarding the watertable of the new wells and the cropwise area irrigated by these wells in different seasons are presented. It should be noted here that all these new wells (i.e., 9) are situated along the nala and were sunk by the farmers after the implementation of nala training scheme. Out of 9 new wells,

**Table 3.3: Details About the New Wells (Nala Training Group)**

Sr. No.	Case No.	Survey No.	Watertable (in feet)			Cropwise total area irrigated by these wells						Total of all seasons (acres)	
			June/July	Oct./Nov.	April/May	Kharif	Area (acres)	in different seasons		Area (acres)	Area (acres)		
								Rabi	Area (acres)	Summer	Area (acres)		
1.	3	331	2	15	2	⊙		⊙		⊙		⊙	
2.	15	420	10	24	10	-	-	Wheat	3.00	-	-	3.00	
3.	16	382	3	20	3	-	-	Wheat	3.00	Ground-nut	1.00	4.00	
4.	53	48	10	20	5	Sugarcane	1.00		1.00		1.00	} 9.00	
						Chillies	0.50	Wheat	2.00	-	-		
						Paddy	2.50	Wangi	1.00	-	-		
5.	54	321	10	12	8	*		*		*		*	
6.	55	104/1	10	15	7	Paddy	2.00	Wheat	2.00	-	-	4.00	
7.	55	104/2	7	10	6	Sugarcane	2.00		2.00		2.00	6.00	
8.	55	102	8	10	6	Paddy	3.00	Wheat	3.00	-	-	6.00	
9.	56	105	10	25	10	Paddy	2.00	Wheat	2.00	-	-	4.00	
Total							13.00		19.00		4.00	36.00	

⊙ Water was not used due to unavailability of water lifting devices.

\* There is ample water in the well due to nala training scheme but water was not used because of some domestic troubles (conflicts).



4 were sunk in the year 1972, one each in 1973 and 1974, and 3 in 1975. From the above discussion it is clearly observed that after the implementation of nala training scheme total number of wells have doubled (9 old and 9 new) on the sample farms. The effect on the watertable of the old wells after implementation of the nala training scheme must have persuaded these farmers to invest in new wells. They would not have made this investment without the nala training scheme. We further observe from the same Table that in spite of the obstacles (mentioned in the Table) the total area irrigated by these new wells in all seasons (i.e., the gross irrigated area) establish a substantial addition (i.e., 36 acres), in the reference year.

### 3.2 Benefits of the Nala Training Scheme

The benefits and costs of the nala training scheme can be judged by a benefit-cost exercise. But a simple approach to this question is comparing the cost per acre of land restored to cultivation with the price of such land currently used for cultivation. The total capital cost of deepening and training the nala was Rs. 3,35,955.86. We said that in the 25 sample plots covering 593.54 acres, nearly 15 per cent had been rendered unfit for cultivation as a result of erosion, due to the untrained nala. After training the nala 95 per cent of this land was restored to cultivation. Therefore, along the nala the total area rendered unfit for cultivation through erosion may be

estimated at about 298 acres (i.e., 15 per cent of 1984 acres) and 95 per cent of this, i.e., 283 acres, were made fit for cultivation as a result of nala training. The cost of restoring this land to cultivation was (Rs. 3,35,955.86 divided by 283 acres =) Rs. 1,187 per acre. The cultivators used on an average additional Rs. 100 per acre to level this land for cultivation, thereby making the cost of each acre equal to Rs. 1,287. However, as against this cost of preparing an acre of land for cultivation, enquiry in the area shows the market price for this type of land was about Rs. 2,000 an acre. In one sense this may be considered the benefit as against the cost of Rs. 1,287.12 per acre, estimated above if we consider the eroded land to be of no value. This benefit-cost ratio comes to 1.55. This, of course, ignores all the other benefits of the nala training scheme discussed earlier in this chapter. We may now turn to a more conventional cost-benefit analysis of the nala training scheme.

#### BENEFIT-COST ANALYSIS (NALA TRAINING SCHEME)

### 3.3 Points of View in Project Analysis

Project analysis is undertaken from two points of view. Firstly, for any project we are interested in the return to the capital that the individual financial entities contribute and we determine it through what is called 'financial analysis'. Secondly, for the same project we are also interested in the total return or productivity or

profitability to the whole society or economy of all the resources committed to the project regardless of who in the society receives the benefit. This is termed as 'economic analysis' of the project. The difference between the economic analysis and the financial analysis lies in the valuation of inputs and outputs. It is, therefore, necessary to discuss the costs and benefits that enter into social benefit-cost analysis and into financial analysis of the scheme. "..... The methodology of comparing costs and benefits discussed here is the same whether we are seeking the economic or financial returns. The difference lies essentially in what is defined as a cost and what is considered a benefit."<sup>1</sup>

In financial analysis, these are valued at prices paid/received by the project authorities as well as farmers. In social benefit-cost analysis, these are at social opportunity cost. This implies that firstly taxes on commodities (whether inputs or outputs) are to be excluded from and subsidies are to be included in the prices. For, these are mere transfer payments. To work out the benefit-cost analysis of the Nais training scheme, we are mainly interested in economic analysis because our point of view is that of the society as a whole and it is assumed that all capital is supplied by the society and it is not

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1. Gittinger J. Price. Economic Analysis of Agricultural Projects. A World Bank Publication, p.8.

necessary to the recovery of this capital from the direct beneficiaries.

Secondly, the market prices, net of taxes/subsidies may not always indicate social opportunity cost. The Little-Mirrlees valuation method,<sup>2</sup> essentially prices everythings which is importable at international prices to reflect its true social value.<sup>3</sup> Mishan<sup>4</sup> takes this approach to task and points out that it runs counter to the principle of opportunity cost. He presents several examples, under various institutional set-ups, and in each case shows that the proper social value is domestic value (with due allowances for all the relevant distortions) of the resources given up (gained) in order to increase imports (exports). After all, if government for reasons of security or self-sufficiency in food wants a crop to be produced domestically rather than to import it, the estimated import price (or foreign exchange price) is irrelevant.

The maximum variability in all the past benefit-cost

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2. Little I.M.D. and Mirrlees J.A. Manual of Industrial Project Analysis in Developing Countries, Vol. II - Social Cost-Benefit Analysis. O.E.C.D., Paris, 1969.
  3. Lal Deepak, Wells and Welfare, Development Centre of the O.E.C.D., Paris, 1972, gives an application of this method in the case of well irrigation in Maharashtra.
  4. Mishan E.J. "Cost-Benefit Rules for Poorer Countries", Benefit-Cost Analysis, 1971, An Aldine Annual, ALDINE ATHERTON, Chicago, New York, 1972, p. 15.

studies has been observed in pricing human labour. There has been a continuous discussion about the nature of opportunity cost of agricultural labour in the country. Suggestions have ranged between a zero shadow price of labour at one extreme and prevailing market wage rate at the other. Intermediate positions have also been suggested by taking the existing market wage rate at the time of peak employment period and zero wage rate at other times. The Indian Irrigation Commission (1972) considered the social opportunity cost of hired labour equal to its prevailing market wage rate, while that of farm family labour equal to zero.<sup>5</sup> This is an inconsistent treatment of the social opportunity cost of hired and farm family labour, since most farm family labour also works on wages on other people's farms.

For calculation of financial profitability, it is appropriate to value hired labour at the going wage rate. The same wage rate may also be imputed to family labour employed on the family farm though it has sometimes been argued that the proper wage rate to apply to family labour is the daily wage equivalent of the annual earnings of the annual farm servant, since family labour has greater assured employment on own farm than hired labour. For calculation of social cost and benefit, in which we are interested here,

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5. Report of the Second Irrigation Commission (1972), Vol. I. p. 256. Op.Cit.

it is necessary to estimate the social opportunity cost of farm labour.

The opportunity cost of labour may be viewed as its 'reservation price', i.e., the average daily cost of living of the worker in his family.<sup>6</sup> The workers would not be willing to go out to work at the wage less than this. It is often seen, as in the Employment Guarantee Scheme Works in Maharashtra, that for as small an actual average wage as Rs. 3 per day or even less, workers from landless and small farmer households come to work, while workers from medium or large farm households do not turn up for work at this wage rate even when they are without any work on their farms. This would imply different reservation price of different groups of labour or even individuals. Nevertheless, operationally it is not easy to estimate these varying opportunity costs of labour in different farm households. A single rate, therefore, is used for convenience.

Taking into consideration these some of the difficulties in calculating the true opportunity cost of farm labour, we have decided to compute our analysis by two extreme approaches, i.e., with inclusion of the cost of labour (both family and hired) in the total cost of

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6. Harberger Arnold C. "On Measuring the Social Opportunity Cost of Labour," Benefit-Cost Analysis, 1971, An Aldine Annual, ALDINE ATHERTON, Chicago, New York, 1972, p. 88.

cultivation and also by excluding it from the total cost of cultivation of the crops. The contention behind excluding the labour cost (family and hired) from the total cost of cultivation at the first instance is that we assumed this labour force as idle from society's point of view and as such the social opportunity cost of this labour force is considered to be zero. These labourers would not have got the work as wage labour elsewhere because in this drought-prone area there is least possibility of jobs availability for unskilled labourers, as the creation of employment potentiality both in agriculture and industries, is remote. On the other hand, it may be argued that though these are the idle labour force, their reservation price for their labour, nevertheless, is not likely to be zero. Since it is not feasible to estimate this reservation price for different groups of rural farm workers, or individuals, the best alternative may be to assume this to be the going wage rate in the market, for both landless labour and labour with land. This may be an over-estimate for some, or even many. But the cost-benefit estimates with this alternative social costs of labour may provide us with upper and lower limits of the real ratio.

Benefit-cost ratio is used most commonly as a measure of social returns and helps in identifying the scheme (project) which renders maximum contribution to the

society. On the other hand, financial analysis is used to assess whether the project would be financially worthwhile, for the project authorities as well as to the farmers who participate in the project. A project justified on social benefit-cost considerations, therefore, may not necessarily be financially worthwhile to the investor. Rath points out that not only have many past studies in India been exclusively concerned with the calculation of social benefits and costs without any attention to financial profitability of the projects, but also the procedure of estimating the benefit-cost ratio has not been properly followed in these past studies in the country.<sup>7</sup>

#### 3.4 Identification of Costs

For the purpose of estimating the benefits and costs of Nala-training Scheme, the items of costs considered are as follows:

##### (A) Capital Cost on Nala-Training Scheme

The capital cost incurred on nala-training scheme was spread over three years, 1972-73 to 1974-75. The yearwise capital cost incurred on nala-training scheme was made available by the project authorities. The capital cost was mainly incurred for deepening the Nala and providing strong bunds (embankments) to the sides of the Nala.

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7. Rath N. "Benefit-Cost Analysis of Agricultural Projects," Indian Journal of Agricultural Economics, Vol. XXIX, No. 1, January-March 1974, pp. 22-25.



**(B) Operation and Maintenance Cost**

Every year there may be some repairs and maintenance cost which the project authority has to incur, like keeping the Nala channel clear and repairing any damages to the side bunds. In consultation with the Joint Director, Soil Conservation (Maharashtra State) and the concerned project officials, the annual maintenance cost was estimated as equivalent to 5 per cent of the total capital cost (i.e., the actual investment incurred on the nala-training scheme).

**(C) Capital Cost Incurred by the Beneficiaries on Sinking New Wells and Energizing Them**

The investment on sinking new wells was made during the years 1972-73, 1974-75 and 1975-76, while the investment for energizing these wells was made during the years 1973 to 1977. The relevant cost data was collected from the respondent during the survey.

**(D) Cost of Cultivation of Crops**

This consists of the incremental cost of cultivation due to extension of irrigation as a result of the sinking of new wells or improved supply of water in the existing wells, and the cost of cultivation incurred in the case of reclaimed land. The costs taken into account consist of cost of seed, manure and fertilizers, insecticides and pesticides, labour (family and hired), cost of bullock labour, etc., which were collected from the sample farmers.

### 3.5 Identification of Benefits

#### (A) Total Production from the Reclaimed Land

The reclaimed land mentioned earlier (i.e., 85 acres) was completely useless and was not put under cultivation before implementation of the nala-training scheme. After implementation of the nala-training scheme almost all the uncultivated land (i.e., 85 acres out of 89 acres) was put under cultivation and hence the total production from this reclaimed land has been considered as one of the benefits of the nala-training scheme.

#### (B) Incremental Production in the Area Under the Command of the New Wells

We ascertained at the time of our survey that no new wells were likely to come up without the nala-training scheme in the area, so that the increase in the production under the new wells can be safely attributed to the nala-training scheme. To calculate the incremental production we deduct the estimated production that would have been obtained from these lands under unirrigated condition from the total production which was obtained from the area under command of the new wells.

#### (C) Incremental Crop Production from the Old Wells

While calculating the incremental crop production from old wells we consider the additional production from the additional area irrigated by the increased water available in the old wells because of nala-training scheme.

### 3.6 Procedure for Valuation of Costs and Benefits

We now turn to the question of valuation of the inputs, capital and current, and outputs identified above. It is obvious that valuation of all these should be at comparable prices. Under inflationary conditions all prices including those of capital change. Since, comparable prices are the important thing, it is not necessary to take the trouble of forecasting the inflationary prices in future years. The best estimates of current relative prices are appropriate to the task in hand. Of course, if there is reason to expect a change in the relative price of any input or output in future years (over the life of the project) then that has to be taken into account. Consequently we have expressed the prices of all inputs and outputs at 1976 prices. The prices of current inputs and outputs were available at the time of survey. The capital cost of nala-training and well sinking, etc., carried out over 2, 3 or 4 years were adjusted to 1976 prices by using price indices.

As mentioned earlier the capital cost of the nala-training scheme was spread over a three year period, i.e., from 1972 to 1975 and the cost reported was at the respective years' prices. The cost incurred by the beneficiaries in sinking new wells was also incurred over a four year period and the reported cost were also at the respective years' prices. For this purpose we used the index of agricultural

wages in the State of Maharashtra. Nearly 90 per cent of the capital cost of nala-training was for payment of wages, therefore, the actual expenses in years other than 1976 were revalued by using the index of agricultural wages in Maharashtra.<sup>8</sup>

The investment made on water lifting devices (i.e., 6 oil engines and 1 electric motor) with pumpsets, pipeline, etc., was spread over four years period, i.e., from 1973-74 to 1976-77. The prices of oil engines and electric motor used in the computation are those of 1976 and are net of excise duties and taxes. These were obtained from some major manufacturers of such equipment.

In addition to this cost, there is expenditure for installation, the expenditure on pipe line, and the cost of shed, etc., which comes to Rs. 250, Rs. 832 and around Rs. 100, respectively.<sup>9</sup> We assume 15 years life for both oil engine and electric motor<sup>10</sup> and hence all the oil engines/electric motors bought in the first year need to be replaced in the 16th year, and likewise for the subsequent

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8. Statistical Abstract, Government of India, Ministry of Planning, Central Statistical Organization, Department of Statistics, India, 1978, New Series, No. 23, p. 399.
  9. These calculations have been made by referring to: Mitra Ashok K. and Muranjan S.W. Economic Benefits of Rural Electrification in Maharashtra - A Case Study of Four Districts. Gokhale Institute of Politics and Economics, Pune 4, June 1980, pp. 32, 40.
  10. "Report of the Committee to Estimate the Demand for Pumpsets during 1978-83 and Study the Policy and Procedure of Financing It." Agricultural Refinance and Development Corporation, Bombay, 1979, Chapter IV, pp. 35-39, 59.

years. Making use of these prices and the number of energized wells every year we compute the annual capital expenditure on water lifting devices over the life of the project with the help of capital recovery factor (for 15 years) at 10 per cent interest rate.

### 3.7 Estimates of Benefits and Costs Over Project Life

In consultation with the Joint Director, Soil Conservation (Maharashtra State) and the concerned project officials, the life of the nala-training scheme is considered to be 50 years. Taking into account, the sufficient provision of annual maintenance cost (5 per cent of the total capital cost) for the scheme, one can safely consider the life of the scheme to be 50 years.

The stream of benefits with which we are here concerned begins to flow after the project is completed and continues over its life period. Even after the capital project is completed it requires a certain period for the command area to adapt itself to the new conditions. The farmers have to follow new method of farming, adopt new crops and to make necessary supplementary investment. The full potential annual benefits, therefore, do not appear right from the first year; they come rather slowly and accumulate steadily. Since it takes some years for the full potential annual benefits to be reached, it is necessary to estimate the stream of benefits from the first year of its completion to the end of the project life. An effort has been made in

this study to estimate the different levels of benefits as the development of the command area takes place from the first year of completion of the project to the stage of maturity, which in our project, took about four years. Thereafter, a constant stream of annual benefits is expected to flow till the end of the life of the project. This estimation has been made on the basis of available information pertaining to the area brought under cultivation in the case of reclaimed land, the area brought under irrigation in the case of new wells and the area brought under extra irrigation in the case of old wells, or the different level of returns of various crops at different stages of land development in the areas under the command of the Nale-training scheme.

### 3.8 Methodology of Analysis

The method of analysis used is what is generally referred to as the 'discounted cash flow technique'. The prime aspect of this technique is to compare the costs and returns over time. When we look at the project over its estimated life time, we can see it earning a stream of gross returns from which we must deduct the capital investment and pay the other costs (i.e., maintenance cost, cost of cultivation of crops, etc.). The major characteristic of the cash flow technique is that it includes, undifferentiated, both the returns of capital and the return to capital because in economic analysis our point of view

is that of the society as a whole and it is assumed that all capital is supplied by someone somewhere in the society.

### 3.9 Discounting of the Stream of Benefits and Costs

The estimated annual benefits and costs over the life time of the project are estimated in the manner stated above. To compare the overall stream of benefits and costs, it is necessary to discount to the present, by using a proper discount (or interest) rate. For financial purposes the going rate of interest like that of the LDB's is an appropriate rate of discount. The social rate of discount need not be the same. Irrigation Commission (1972)<sup>11</sup> used 10 per cent discount rate as social rate of return on capital in India. We also have assumed 10 per cent as the social rate of discount.

### 3.10 Appraisal of the Nala Training Scheme

In what follows first we examine the benefit-cost ratio of the nala-training scheme (see Tables 1 to 3). The benefit-cost ratio has been computed by dividing the present worth of the net benefits stream by the present worth of the capital costs stream. The benefit-cost ratio at 10 per cent social rate of discount shows that, without considering the labour cost in the total cost of cultivation of crops (if we assumed that the opportunity cost of labour, both family and hired, is zero), it is 1.60, indicating the nala-training

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11. Report of the Second Irrigation Commission (1972), op.cit., p. 253.

scheme to be a socially worthwhile proposition. On the other hand, assuming the opportunity cost of labour, both family and hired, to be the prevailing market wage the benefit-cost ratio is less than unity (0.93). Since the reservation price of labour in the rural areas, in general, is sure to be greater than zero, one can safely infer that the project is a socially worthwhile investment. The above calculations do not adequately take care of the economic and social effects of frequent drought and resulting scarcity that the areas like the one under survey are subject to.

As explained in the Chapter I the whole district (Sholapur) falling in the lower rainfall belt witnesses recurrent scarcity conditions. The history of past 30 years or more testifies that conditions akin to total scarcity have been recorded for almost all parts of the district once every two or three years. Thus frequent scarcity conditions stalk about 92 per cent of the gross cropped area of the district.<sup>12</sup> About 86 per cent of the rural population was engaged in agricultural activities. Scarcity means not only loss of production, but also diversion of social resources for relief of the affected

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12. Drought Prone Areas Programme for Sholapur District, Project for submission to the International Bank for Reconstruction and Development (World Bank), Government of Maharashtra, October 1973, pp. 3, 4.



**Table 3.4: Sala-Training: Benefit-Cost Analysis (with Considering Labour (Family + Hired) Cost)**

Sr. No.	Period	Investment on water lifting devices	Maintenance cost	Net increase in production costs			Gross costs	Net increase in crop production			Gross Benefits	Net Benefit
				New wells	Old wells	Reclaimed land		New wells	Old wells	Reclaimed land		
1.	1972-73	-	-	-	777.07	6166.30	6943.37	-	2681.74	15282.00	17963.74	11020.37
2.	1973-74	1393.84	3468.70	2715.00	1554.14	7024.22	16155.90	3545.69	5363.48	17890.00	16799.17	10643.27
3.	1974-75	2470.66	4391.60	5430.00	2331.22	9008.16	23631.64	7091.38	8045.22	20740.00	35876.60	12244.96
4.	1975-76	3167.58	5399.26	8145.00	3108.34	9008.16	28828.34	10637.07	10726.96	20740.00	42104.03	13275.69
5.	1976-77	4561.62	5399.26	10860.00	3885.39	9008.16	33714.43*	14182.76	13408.71	20740.00	48331.47*	14617.04*

\* The same figure will continue upto 50th year.

**Note:** The present worth at 10 per cent social rate of discount at the end of 50th year is B. 135619.60.

**Table 3.5: Male-Training: Benefit-Cost Analysis (Without Considering Labour (Family and Hired) Cost)**

Sr. No.	Period	Investment on water lifting devices	Maintenance cost	Net increase in production costs			Gross costs	Net increase in crop production			Gross Benefits	Net Benefit
				New wells	Old wells	Reclaimed land		New wells	Old wells	Reclaimed land		
1.	1972-73	-	-	-	439.52	920.00	1359.52	-	2681.74	15282.00	17963.74	16604.22
2.	1973-74	1393.84	3468.70	1575.00	879.04	1048.00	8364.58	3545.69	5363.48	17890.00	26799.17	18434.59
3.	1974-75	2470.66	4391.60	3150.00	1318.56	1344.00	12674.82	7091.38	8045.22	20740.00	35876.60	23201.78
4.	1975-76	3167.58	5399.26	4725.00	1758.08	1344.00	16393.92	10637.07	10726.96	20740.00	42104.03	25710.11
5.	1976-77	4561.62	5399.26	6300.00	2197.61	1344.00	19802.49*	14182.76	13408.71	20740.00	48331.47*	28528.98*

\* The same figure will continue upto 50th year.

**Note:** The present worth at 10 per cent social rate of discount at the end of 50th year is Rs. 257647.52.

**Table 3.6: Nala-Training Scheme: Benefit-Cost Analysis**

Sr. No.	Period	Investment on nala-training scheme	Investment on new wells sinking	Total investment	D.F. (10%)	Present worth at 10 per cent social rate of discount
1.	1972-73	69373.53	33307.20	102680.73	0.909	93337.03
2.	1973-74	18458.40	-	18458.40	0.826	15246.31
3.	1974-75	20153.21	14884.20	35037.41	0.751	26312.79
4.	1975-76	-	15568.20	15568.20	0.683	10632.94
<b>Total</b>						<b>145529.07</b>

1. (A) Benefit-cost ratio (with labour (F+H) costs) =  $\frac{\text{Rs. } 135619.60}{\text{Rs. } 145529.07} = 0.93$
2. (A) Benefit-cost ratio (without labour (F+H) costs) =  $\frac{\text{Rs. } 257647.52}{\text{Rs. } 145529.07} = 1.77$

population, which has not been taken into account in the above calculations. From 1960 to 1973 large sums (i.e., Rs.1,617.32 (in lakhs)) have been spent by the Government for providing relief after the occurrence of droughts.<sup>13</sup> Such expenditure has not helped to solve the basic problems of increasing/stabilizing the productivity of these areas and thereby reducing the impact of the severity of droughts on the human and cattle population.

In view of these, it is clear that investments in the type of nala-training scheme examined here are socially productive investments, and hold out good promise for the scarcity areas of the State. Such projects are labour intensive and may be taken up all over the drought-prone areas of the State. The present Government policy is to leave the task of maintenance to the affected farmers. In the absence of organized cooperative effort, this may often remain unattended to. It would be desirable for the local or State Government to undertake this task which can be fitted into their various routine public works and maintenance schemes, and would be in any event a better way of using funds for drought relief.

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13. Ibid., pp. 49, 8.

**CHAPTER IV****ASSESSMENT OF ECONOMIC EFFICACY OF THE  
NALLA-CHECK SCHEME****4.1 Background.**

The previous chapter dealt with the nalla-training scheme which involves the work of deepening of the nalla from its starting point so as to drain it into the river by constructing strong embankment on both sides of the nalla. The very purpose of the technique is to prevent soil erosion and waterlogging of the fields on either side of the nalla (stream).

Nalla-check scheme is another technique to prevent soil erosion. The distinction between nalla-training and nalla-check scheme, despite the same purpose of preventing soil erosion, lies essentially in the technique adopted for the purpose. The two techniques, therefore, are operative under two different topographical conditions. Nalla-training as said earlier, has been found useful in respect of broad seasonal streams. On the other hand, the nalla-check scheme is made operative on comparatively smaller nallas with lesser breadth. Instead of having an embankment along both the sides of nalla as in nalla-training scheme, the nalla-check scheme proposes to construct a bund across the nalla. In constructing such a bund, provision is invariably made to allow the smooth outflow of excess water by constructing a waste weir. This helps in prevention of

soil erosion by checking gully formation. As a result of the wastewair the drainage problem also gets resolved and in the process accumulation of fine silt (soil) behind the main weir, i.e. in the nalla bed results in reclamation of this land for cultivation except in the main rainy season. This reclaimed land can be considered as an additional benefit, besides the soil erosion, of the nalla-check scheme. In the nalla-training scheme the water is allowed to flow by giving the proper slope to the nalla bed. The prevention of erosion and thereby reclamation of land is limited to the plot adjacent to the embankment and not in the nalla bed. In the nalla-check scheme, along with control of soil erosion, some more land gets reclaimed in the nalla bed itself.

Thus, the main objectives of the nalla-check scheme can be stated as below:

- (1) To prevent soil erosion resulting from gully formation along the course of nalla,
- (2) To bring the area of nalla bed under cultivation, and
- (3) Increase the watertable of the wells situated along the course of the nalla.

It should be noted that in the IDLAD Project, Mandrup, in all 20 nalla-check schemes had been implemented, only on the upper and middle catchment areas. Out of these 20 nalla-check schemes, more than 50 per cent, i.e. 11

nalla-check schemes, were completed in the year 1972-73; 4 in the year 1973-74, 2 each in the years 1971-72 and 1974-75 and only 1 in the year 1976-77. In the present study, the data relating to all the 20 nalla-check schemes has been taken into account.

The long term benefits which are of a permanent nature in the case of nalla-check scheme are:

- (1) additional land brought under cultivation through control of soil erosion; and
- (2) greater availability of irrigation water, due to the increase in the watertable of the wells situated along the nalla course.

Let us first look at the benefit of additional land brought under cultivation. Table 4.1 gives the necessary details of number of plots and their area affected by the nalla. The data show that almost 17 per cent of the area of the sample plots had remained out of cultivation due to soil erosion, etc., as a result of the flooding by the nalla. Nalla-check scheme resulted in almost 75 per cent of this land being brought back to cultivation. The cultivators had begun using all this land for cultivation. The remaining 25 per cent (i.e. 22 acres) of land was still not put under cultivation because of one or the other reasons.

The yearwise details of the area uncultivated before implementation of the nalla-check scheme and the area

reclaimed after implementation of the scheme are presented in Table 4.2. From the Table, it is observed that, of the 22 acres (25 per cent) of uncultivated land the area of 7 acres was not put under cultivation because the main bund had cracked, as black soil was used in the construction of this bund and as a result the work of nalla-check, in this case, became useless. In another case, due to the implementation of nalla-check scheme, one acre of land got reclaimed but this work ultimately caused the drainage problem to another two acres of land due to faulty construction of wastewair. The remaining 13 acres of land will take some more time to get reclaimed because the gullies are not yet filled up by silt.

Another long term benefit of the nalla-check scheme is the availability of additional water for irrigation. The scheme increases the water availability in old wells; in addition it is expected to make feasible the sinking of new wells. These benefits are of long term nature.

In Table 4.3 the data regarding watertable of the old wells and the cropwise area irrigated by these wells in different seasons are presented. For this purpose the watertable of the wells at the beginning of the three seasons, viz., kharif, rabi and summer, were measured. Only two old wells were reported, which are situated adjacent to the nalla-check scheme. From the Table it is also seen that the watertable of both these wells increased



**Table 4.1: Details of Number of Plots, Area, etc., of Land Affected by Nalla in the Surveyed Villages**

Sr. No.	Items	Area (acres)
1.	Total number of plots surveyed	20
2.	Total area of the above (20) plots	537.00
3.	(A) Of the total area in No. 2 above, area eroded by nala	89.00
	(B) 'A' as per cent of No. 1 above	16.57
	(C) Total land reclaimed after implementation of nalla-check scheme	67.00

**Table 4.2: Nalla-check: Yearwise Details of the Reclaimed Land**

Sr. No.	Year	No. of schemes completed	Uncultivated land (Before) (acres)	Reclaimed land (After) (acres)	Area not reclaimed/ Likely to be reclaimed (acres)
1.	1971-72	2	3.00	1.00	2.00
2.	1972-73	11	48.00	43.00	5.00
3.	1973-74	4	32.00	19.00	13.00
4.	1974-75	2	5.00	3.00	2.00
5.	1976-77	1	1.00	1.00	Nil
	<b>Total</b>	<b>20</b>	<b>89.00</b>	<b>67.00</b>	<b>22.00</b>

**Table 4.3: Details About the Old Wells (Nalla-Cheek)**

Sr. No.	Details	Well-1		Well-2	
		Present situation	Past situation	Present situation	Past situation
1.	Watertable of the wells (feet)				
	A. June/July	2	1	15	4
	B. October/November	20	15	20	10
	C. April/May	2	2	15	2
2.	Cropwise total area irrigated in different seasons:				
	A. (i) Kharif crop	-	-	Sugarcane	Groundnut
	(ii) Area (acres)	-	-	4.00	1.00
	B. (i) Rabi Crops	Wheat	Wheat	Sugarcane	-
	(ii) Area (acres)	0.50	1.00	4.00	-
	C. (i) Summer crops	-	-	Sugarcane	-
	(ii) Area (acres)	-	-	4.00	-
3.	Total of all seasons (acres)	0.50	1.00	12.00	1.00

considerably. Of the two old wells the irrigated area in the case of one well had not increased (on the contrary it decreased by 0.50 acre), because, although the watertable of this well had increased, the farmer was not able to increase irrigated area due to the lack of adequate family

labour and his old age.

We further observe from the same Table that the total area irrigated by these old wells in all seasons i.e., the gross irrigated area) increased by 10.50 acres. In calculating gross irrigated area we have added the area under sugarcane thrice - in all the three seasons. Even if we take it into account only once, which is the common way of calculating the gross irrigated area, it can be seen that the irrigated area increased by 2.50 acres in these sample farms. We have mentioned earlier that one farmer was unable to increase the irrigation (though the water is ample in the well) due to some domestic difficulties during the survey year. If he would be able to overcome his difficulty of scanty labour force, the total irrigated area is expected to increase but at the time of survey, it was not easy to estimate it. Thus we find that as a result of the nalla-check scheme the gross irrigated area under old wells had increased by 84 per cent.

In Table 4.4 the data regarding the watertable of the new wells, water stored in the farm-ponds and the cropwise area irrigated by these wells/farm-ponds in different seasons are presented. It should be noted here that these new wells and farm-ponds are situated adjacent to nalla-check schemes and were sunk after the implementation of nalla-check scheme. Of the two new wells, one was sunk in the year 1971-72 and another in 1973-74. From the

**Table 4.4: Details About the New Wells and Farmponds (Nalla-shek)**

Sr. No.	Case No.	Survey No.	Watertable (in feet)			Cropwise total area irrigated in different seasons					Remarks		
			June/July	Oct./Nov.	April/May	Kharif Area (acres)	Rabi Area (acres)	Summer Area (acres)	Total of all seasons (acres)				
1.	22	464	3	30	3	-	-	Jowar	2.00	-	-	2.00	Wells
								Wheat	3.00			3.00	
2.	16	382	3	20	3	-	-	Wheat	3.00	Ground-nut	1.00	4.00	Well
3.	29	146	Nil	9	Nil	-	-	Jowar	10.00	-	-	10.00	Farm-pond
4.	34	444	Nil	9	Nil	Bajra	3.00	Wheat	2.00	-	-	5.00	Farm-pond
Total						3.00	20.00	1.00	24.00				

foregoing discussion it is clearly observed that after the implementation of nalla-check scheme total number of wells doubled (i.e., 2 old and 2 new) on the farms. We further observe from the same Table that two farm-ponds were also constructed during the year 1972-73 and the water stored was used for irrigation. Incidentally, it was reported by the pond owners that these ponds had suck an underground watertable and they could irrigate the farm as efficiently as wells. Finally, we observed from the same Table that the total area irrigated by these new wells and farm-ponds in all seasons (i.e., the gross irrigated area) resulted in a substantial addition (i.e., 24 acres), during the reference year.

#### 4.2 Benefits of the Nalla-Check Scheme

The benefits and costs of the nalla-check scheme can be judged by a benefit-cost exercise. But a simple approach to this question would be to compare the cost of nalla-check per acre of land restored to cultivation with the current price of such land restored to cultivation.

The total capital cost of nalla-check scheme, comparable at 1976 prices, (the method used is already discussed in the earlier chapter relating to nalla-training scheme), was Rs.138,050.81. We have mentioned in the earlier part of this chapter that in the 20 plots covering 537.00 acres of land nearly 17 per cent had been rendered unfit for cultivation as a result of erosion, etc., due to the

unchecked nalla. Almost 75 per cent of this was restored to cultivation after the implementation of nalla-check scheme. Therefore, the cost of restoring this land to cultivation was Rs. 2060.46 per acre. Like nalla-training scheme, this scheme did not require any expenses for levelling. However, as against this cost (i.e. Rs. 2060.46) of preparing an acre of land for cultivation, enquiry in the area shows the market price for this type of land was about Rs. 2500 an acre. In the absence of this nalla-check scheme, we assume the land would fetch no price. In one sense this may be considered the benefit as against the cost of Rs. 2060.46 per acre, estimated above. This benefit-cost ratio comes to 1.44.

Now, let us turn to a more conventional cost-benefit analysis of the nalla-check scheme. In the earlier chapter relating to the nalla-training scheme, we have discussed in detail the methodology used and also explained the various concepts concerning to the benefit-cost analysis. We have adopted the same methodological exercise for working out the benefit.

In conducting a benefit-cost analysis of the nalla-check scheme the following items of cost were considered:

(A) Capital cost on nalla-check scheme: The distribution of capital cost incurred on nalla-check scheme was reported from the year 1971-72 to 1974-75 and also in 1976-77, i.e., in five years period and the cost reported

was at respective year's prices.

(B) Capital cost incurred by the beneficiaries on sinking new wells/farm-ponds and energizing them: It has been reported that the investment on sinking two new wells was incurred during the years 1971-72 and 1973-74. While the investment incurred for energizing these new wells was made in the year 1974-75. The investment on constructing two farm-ponds was incurred in the year 1972-73 and the water-lifting devices (oil engines) used in this case were hired from project authorities. The reported cost in sinking new wells and constructing farm-ponds were also at the respective years prices.

The capital cost of nalla-check scheme and well sinking, etc., carried out over 2 to 5 years were adjusted to 1976 prices by using price indices. The prices of oil engines (two) used in the computation are those of 1976 and are net of excise duties and taxes. These were obtained from some major manufacturers of such equipment.

(C) Operation and maintenance cost: Every year the project authorities have to incur some repairs and maintenance cost for keeping the wastewair clear and repairing any damages to the main bund. It has been decided to consider the annual maintenance cost as equivalent to 5 per cent of the total capital cost.

(D) Cost of cultivation of crops: As discussed in the earlier chapter relating to the nala-training scheme, only

the incremental cost of cultivation of crops has been taken into account.

For the purpose of exercising the benefit-cost analysis of the nalla-check scheme the items of benefits considered were:

- (A) Total crop production from reclaimed land;
- (B) Incremental production from new wells and farm-ponds; and
- (C) The incremental production from the old wells.

The method for calculating the incremental benefits/costs, adopted in the earlier chapter (i.e. nala-training scheme) holds good in nalla-check scheme also.

#### 4.3 Appraisal of the Nalla-Check Scheme

The benefit-cost ratio of the nalla-check scheme has been calculated by the same method adopted while calculating the benefit-cost ratio of the nalla-training scheme. The benefit-cost ratio of the nalla-check scheme comes out to be positive (1.18) at 10 per cent social rate of discount, assuming the opportunity cost of labour (both family and hired) to be zero. This indicates that the scheme is economically viable. However, if the cost of labour at the going wage rate is taken into consideration while calculating total cost of production of crops, the ratio comes to be less than unity (0.61) thereby indicating the economic unfeasibility of the scheme (see Tables 4.5 to 4.7).

Incidentally, it was observed that sinking out new



wells and farm-ponds and energizing them adds to the total capital cost stream of the wells-check scheme. These added costs result in losses which means that the proposition of sinking new wells and farm-ponds is uneconomical and therefore adversely affects the total wells-check scheme. If this is so the above programme will have to be withdrawn. If the programme is withdrawn the estimated results of the scheme will show a different picture.

The results under the new situation, i.e., withdrawing of the programme of the new well and farm-ponds but retaining the benefits accruing to old wells, have also been analysed. The benefit-cost ratio under the new situation is positive with or without considering the cost of labour in the total cost of production. If the labour cost (family and hired) at the going wage rate is taken into account the scheme is economically feasible (Benefit-cost ratio = 1.00) and if labour cost is not taken into account, the scheme is profitable (B/C ratio = 1.57) (refer to Tables 4.8 to 4.10).

It has been observed earlier in this chapter, that out of the 22 acres of uncultivated area there is very remote possibility of 9 acres being reclaimed and brought under cultivation. The reasons for the same have been stated earlier, and need not be gone into again. The balance of 13 acres of land, out of the above 22 acres is likely to be reclaimed. The gullies formed earlier due to the implementation of the scheme are slowly getting filled

**Table 4.5: Kalla-Chacki Benefit-Cost Analysis (With Considering Labour (Family + Hired) Cost)**

Sr. No.	Period	Investment on water-lifting devices	Maintenance cost	Net increase in the production <del>costs</del>			Gross costs	Net increase in the crop production			Gross Benefits	Net Benefit
				New wells	Old wells	Reclaimed land		New wells	Old wells	Reclaimed land		
1.	1971-72	-	-	-	589.58	196.07	785.65	-	1683.33	150.00 <sup>3</sup>	1833.33	1047.68
2.	1972-73	-	955.40	2041.75	1179.16	8627.08	12803.39	981.62	3366.66	20175.00	24523.28	11719.89
3.	1973-74	-	4677.50	2041.75	1768.74	12352.40	20840.39	981.62	5059.99	25300.00	31331.61	10491.22
4.	1974-75	759.80	6435.00	4083.50	2353.32	12352.40	25989.02	1963.24	6733.32	25300.00	33996.56	8007.54
5.	1975-76	759.80	6654.35	4083.50	2947.90	12352.40	26797.95	1963.24	8416.65	25300.00	35679.89	8881.94
6.	1976-77	759.80	6654.35	4083.50	3537.50	12548.42	27583.57	1963.24	10100.00	25560.00	36723.24	10039.67
7.	1977-78	759.80	6902.45	4083.50	3537.50	12548.42	27831.67*	1963.24	10100.00	25560.00	37623.24*	9791.57*

\* The same figure will continue upto 50th year.

**Note:** The present worth at 10 per cent social rate of discount at the end of 50th year is Rs. 89593.56.

**Table 4.6: Wells-Check: Benefit-Cost Analysis (Without Considering Labour (Family + Hired) Cost)**

Sr. No.	Period	Investment on water-lifting devices	Maintenance cost	Net increase in the production costs			Gross costs	Net increase in the crop production			Gross Benefits	Net Benefit
				New wells	Old wells	Reclaimed land		New wells	Old wells	Reclaimed land		
1.	1971-72	-	-	-	297.33	105.88	403.21	-	1683.33	150.00	1833.33	1430.12
2.	1972-73	-	955.40	965.50	594.66	4658.72	7174.28	981.62	3366.66	20175.00	24523.28	17349.00
3.	1973-74	-	4677.50	965.50	891.99	6670.44	13205.43	981.62	5049.99	25300.00	31331.61	18126.18
4.	1974-75	759.80	6435.00	1931.00	1189.32	6670.44	16985.56	1963.24	6733.32	25300.00	33996.56	17011.00
5.	1975-76	759.80	5654.35	1931.00	1486.65	6670.44	17502.24	1963.24	8416.65	25300.00	35679.89	18177.65
6.	1976-77	759.80	6654.35	1931.00	1784.00	6776.10	17905.25	1963.24	10100.00	25560.00	37623.24	19717.99
7.	1977-78	759.80	6902.45	1931.00	1784.00	6776.10	18153.35*	1963.24	10100.00	25560.00	37623.24*	19469.89*

\* The same figure will continue upto 50th year.

**Note:** The present worth at 10 per cent social rate of discount at the end of 50th year is Rs. 171504.60.

**Table 4.7: Benefit-Cost Analysis (Nalla-Cheek)**

Sr. No.	Period	Investment of Nalla-check scheme	Investment of new wells/farm-ponds sinking	Total	D.F. (10%)	Present worth at 10% social rate of discount
1.	1971-72	19108.33	13086.90	32195.23	0.909	29265.26
2.	1972-73	74441.59	18828.44	93270.03	0.826	77041.02
3.	1973-74	35150.04	9815.40	44965.44	0.751	33768.72
4.	1974-75	4388.36	-	4388.36	0.683	2997.00
5.	1975-76	-	-	-	0.621	-
6.	1976-77	4962.49	-	4962.49	0.564	2798.57
<b>Total</b>						<b>145870.57</b>

- (A) Benefit-cost ratio (with labour (F+H) costs) =  $\frac{\text{Rs. } 89593.56}{\text{Rs. } 145870.57} = 0.61$
- (A) Benefit-cost ratio (without labour (F+H) costs) =  $\frac{\text{Rs. } 171504.60}{\text{Rs. } 145870.57} = 1.18$

**Table 4.8: Nalla-check: Without Labour Cost: Excluding New Wells/Farm-ponds Irrigation**

Sr. No.	Period	Maintenance cost	Net increase in production costs		Gross cost	Net increase in crop production		Gross Benefit	Net Benefit
			Old wells	Reclaimed land		Old wells	Reclaimed land		
1.	1971-72	-	297.33	105.88	403.21	1683.33	150.00	1833.33	1430.12
2.	1972-73	955.40	494.66	4658.72	6208.78	3366.66	20175.00	23541.66	17332.88
3.	1973-74	4677.50	891.99	6670.44	12239.93	5059.99	25300.00	30359.99	18120.06
4.	1974-75	6435.00	1189.44	6670.44	14294.76	3733.32	25300.00	29033.32	14738.56
5.	1975-76	6654.35	1486.65	6670.44	14811.44	8416.65	25300.00	33716.65	18905.21
6.	1976-77	6654.35	1784.00	6776.10	15214.45	10100.00	25560.00	35660.00	20445.55
7.	1977-78	6902.45	1784.00	6776.10	15462.55*	10100.00	25560.00	35660.00*	20197.45*

\* The same figure will continue upto 50th year.

**Note:** The present worth at 10 per cent social rate of discount at the end of 50th year is Rs. 174837.25.

**Table A.9: Nalla-check: With Labour Cost: Excluding New Wells/Farm-ponds Irrigation**

Sr. No.	Period	Maintenance cost	Net increase in production costs		Gross cost	Net increase in crop production		Gross Benefit	Net Benefit
			Old wells	Reclaimed land		Old wells	Reclaimed land		
1.	1971-72	-	589.58	196.07	785.65	1683.33	150.00	1833.33	1047.68
2.	1972-73	955.40	1179.16	8627.08	10761.64	3366.66	20175.00	23541.66	12780.02
3.	1973-74	4677.50	1768.74	12352.40	18798.64	5059.99	25300.00	30359.99	11561.35
4.	1974-75	6435.00	2358.32	12352.40	21145.72	3733.32	25300.00	29033.32	7887.60
5.	1975-76	6654.35	2947.90	12352.40	21954.65	8416.65	25300.00	33716.65	11762.00
6.	1976-77	6654.35	3537.50	12548.42	22740.27	10100.00	25560.00	35660.00	12919.73
7.	1977-78	6902.45	3537.50	12548.42	22988.37*	10100.00	25560.00	35660.00*	12671.63*

\* The same figure will continue upto 50th year.

**Note:** The present worth at 10 per cent social rate of discount at the end of 50th year is Rs.110613.45.

**Table A.10: Nalla-Cheek: Benefit-Cost Analysis**

Sr. No.	Period	Investment on nalla-check scheme	D.F. (10%)	Present worth at 10% social rate of discount
1.	1971-72	19108.33	0.909	17369.17
2.	1972-73	74441.59	0.826	61489.09
3.	1973-74	35150.04	0.751	26397.65
4.	1974-75	4388.36	0.683	2997.00
5.	1975-76	-	0.621	-
6.	1976-77	4962.49	0.564	2798.57
<b>Total</b>				<b>111051.48</b>
(1) B/C ratio (with labour cost)				$= \frac{110613.45}{111051.48} = 0.996$
(2) B/C ratio (without labour cost)				$= \frac{174837.25}{111051.48} = 1.574$

up and how long it will take to get those gullies completely filled up and the land therefore get reclaimed and brought under cultivation is difficult to estimate. In view of the above, the benefits accruing over time from this 13 acres of land cannot be taken into consideration and have not been considered in the calculation of benefit-cost ratio. At whatever period of time these 13 acres are brought into productive use, the benefit-cost ratio will obviously improve.

In view of these, it is clear that investments in the type of nalla-check scheme examined here are socially

**productive investments, and hold out good promise for the  
scarcity areas of the State. Such projects are labour  
intensive and may be taken up all over the drought prone  
areas of the State.**



CHAPTER VASSESSMENT OF ECONOMIC EFFICACY OF THE  
DRAINAGE SCHEME5.1 Background of the Scheme

Drainage of an area consists in providing an outlet for the excess water either from the surface or sub-surface. Field conditions in the area involved (i.e., the soil, the sub-soil, the groundfall, the crops raised and the value of land, etc.) determine the kind of drainage needed and the method of doing the work. To be successful and economical, drainage depends upon the availability of a suitable outfall and the existence of a pervious sub-stratum at suitable depth to facilitate sub-soil drainage.

The capacity of <sup>the</sup> soil to retain moisture bears a very close relationship <sup>with</sup> its structure and texture. Soil moisture can be brought under three heads: hygroscopic, capillary and gravitational. Hygroscopic moisture can disappear due to evaporation by heat and is, therefore, unimportant from the point of view of drainage. Capillary moisture is held by surface tension and the quantity present in a given soil depends upon the floor thickness, size and arrangement of particles and upon the source of supply. Gravitational moisture obeys the laws of gravity. If there is more water than is required to saturate the soil, the excess water gravitates towards a valley line, fills up soil pore space and suffocates vegetation unless

obstructed in any way. With moisture exceeding the optimum moisture content, the pore space becomes partly filled, <sup>or</sup> aeration deficient and conditions become less favourable for plant growth. The result of such conditions is commonly known as waterlogging. When the watertable rises from below by capillary action, it brings with it mineral salts in solution. When this water approaches the ground level, evaporation takes place resulting in deposition of salt at or near the surface.<sup>1</sup>

Before the execution of a drainage project is undertaken, sub-soil survey, survey of damaged lands and water levels including a contour survey is necessary. The sub-soil survey-including recuperation tests indicate the existence or non-existence of a porous sub-soil valley. This helps in the proper alignment of drain lines. Broadly speaking, we may have: (a) Open drains, (b) Pipe or tile drains, (c) Combination of (a) and (b), and (d) Pumping to remove excess of water to keep down the sub-soil watertable.

An open-drain is an excavated open-channel constructed to a predetermined size and grade for the purpose of removing surface or sub-soil drainage. They are comparatively cheap. However, its disadvantages are

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1. Rao Rama M.S.V. "Soil Conservation in India." Indian Council of Agricultural Research, 1972, Chapter 22, pp. 234-239.

loss of land, and maintenance costs.

A pipe or tile drain is a covered drain of pre-determined size laid beneath the ground surface at a specified depth and grade. Advantages in favour of the use of a pipe drain are the low cost of maintenance and no loss of land for the drain as the land above a pipe drain can be cultivated.

The choice of an open drain or a pipe (tile) drain laid underground depends upon the capital cost of the drain, the value of land, discharge anticipated and capitalized cost of maintenance and repairs. Pipe drain is preferable because its maintenance cost is much less than that of an open drain and it is less likely to be rendered useless by temporary neglect; where flood water has to be got rid off, an open drain is a necessity.

Along a pipe or tile drain man-holes are necessary for periodical rodding of the pipe-line to remove obstructions, etc. At the junction of a pipe-line with an open drain a head wall is constructed to fix the pipe-line properly. A combination of a pipe-line and an open drain would be necessary where the expected discharge cannot be provided by a pipe-line alone. Where there is no outlet to receive the flow by gravity from a drainage system, the water may be discharged by pumping into natural streams or open drains.<sup>2</sup>

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2. Ibid., p. 236.

Drains, to be efficient, must be kept clean. Pipe drains rarely get clogged if properly constructed. If there are wet spots on a drain line or a cave-in-sag above a pipe line, it indicates displacement or breakage and this should be <sup>corrected</sup> ~~set right~~ immediately as otherwise there is a possibility of the whole line getting clogged. Open drains should be inspected frequently and all weeds, grass, silt, etc., that obstruct the flow of water must be removed. Maintenance is, therefore, the backbone of successful drainage. When salt affected lands are drained so as to lower the sub-soil watertable, further cultural operations including a proper crop planning, use of chemicals like gypsum, etc., would become necessary before the land can be fully reclaimed and made ready to give good crops.

In the IDLAD Project, Mandrup, there were certain areas along the main courses which had suffered from waterlogging. With the help of these drainage systems (i.e. open and close) the problem of waterlogging has almost been overcome in the project area.

We may summarize the objectives of the drainage scheme as follows:

- (i) Reclamation of land suffering from waterlogging by way of some outlets, i.e. either by open or close drainage systems.
- (ii) To reduce the salinity of land (with the help of various measures mentioned earlier) so that

it could be successfully used for cultivation.

The long term benefits which are of a permanent nature in the case of <sup>the</sup> drainage scheme is additional land brought under cultivation by way of reduction in waterlogging. This permanent long term benefit, of course, is subject to the drains being kept clear and unlogged.

The benefit of addition to cultivated land can be assessed fairly easily. Table 5.1 presents the necessary details of number of plots and their area affected by waterlogging problem in the surveyed villages. Out of 39 plots having <sup>a</sup> total area of 808.77 acres, a sample of 20 plots (having an area of 675.78 acres) was selected randomly for the present study. The data show that 22 per cent of the area of the sample plots had remained out of cultivation due to waterlogging, etc. The execution of the drainage scheme resulted in almost 97 per cent of this land being restored to cultivation. The cultivators had begun using all this land for cultivation (refer to Table 5.2).

Table 5.3 gives the details of yearwise land reclaimed and the reasons for not putting the remaining 3 per cent of <sup>the</sup> land under cultivation. In one case it has been observed that the drainage outlets ended in an old well. When the well becomes full of water ~~then~~ the excess water, starts spreading in the adjacent area and thereby causing <sup>as</sup> a drainage problem. In another case the underground

**Table 5.1: Details of Number of Plots, Area, etc., of Land Affected by Waterlogging Problem in the Surveyed Villages: Drainage Scheme**

Sr. No.	Items	Area (acres)
1.	Total number of plots partly or wholly affected by the waterlogging problem in the villages surveyed	39
2.	Total area of the above 39 plots	808.77
3.	Total number of plots (out of 1 above) sampled for survey	20
4.	Total area of the above 20 plots	675.78
5.	(A) Of the total area in number 4 above, the unutilized area due to waterlogging	149.00
	(B) 'A' as per cent of (4) above	22.04
	(C) Total land reclaimed after implementation of drainage scheme	145.00

**Table 5.2: Crops Grown on the Reclaimed Land, 1976-77 (Drainage Scheme)**

Sr. No.	Crops	Area (acres)	Yield (Qtls.)	Value Rs.
1.	Jowar	129.50	154.00	12,600.00
2.	Bajra	2.00	6.00	900.00
3.	Paddy	8.00	7.00	910.00
4.	Wheat	4.50	10.00	1,750.00
5.	Groundnut	1.00	0.20	40.00
6.	Sugarcane	2.00	40.00 (tons)	5,000.00
	<b>Total</b>	<b>146.00</b>		<b>21,200.00</b>

Table 5.3: Details of Land Reclaimed (Drainage Scheme)

Sr. No.	Case No.	1971-72			1972-73			1973-74			1974-75			1975-76			(Area in acres)
		Bene-fited area	Uncul-tivated area	Re-claimed area	Bene-fited area	Uncul-tivated area	Re-claimed area	Bene-fited area	Uncul-tivated area	Re-claimed area	Bene-fited area	Uncul-tivated area	Re-claimed area	Bene-fited area	Uncul-tivated area	Re-claimed area	
1.	1	-	-	-	-	-	-	-	-	-	10.00	1.50	1.50	-	-	-	
2.	2	-	-	-	44.00	24.00	24.00	-	-	-	-	-	-	-	-	-	
3.	3	-	-	-	-	-	-	20.00	10.00	10.00	-	-	-	-	-	-	
4.	4	-	-	-	-	-	-	40.00	5.00	5.00	-	-	-	-	-	-	
5.	5	-	-	-	66.75	25.00	25.00	-	-	-	-	-	-	-	-	-	
6.	6	-	-	-	22.00	2.00	2.00	-	-	-	-	-	-	-	-	-	
7.	7	25.00*	3.00	1.00	-	-	-	-	-	-	-	-	-	-	-	-	
8.	11	-	-	-	-	-	-	-	-	-	-	-	-	47.000	2.00	-	
9.	12	-	-	-	-	-	-	-	-	-	-	-	-	87.43	15.00	15.00	
10.	13	-	-	-	-	-	-	8.00	5.00	5.00	-	-	-	-	-	-	
11.	14	-	-	-	-	-	-	-	-	-	30.00	3.00	3.00	-	-	-	
12.	16	-	-	-	28.00	3.50	3.50	-	-	-	-	-	-	-	-	-	
13.	17	-	-	-	32.00	16.00	16.00	-	-	-	-	-	-	-	-	-	
14.	26	-	-	-	43.45	6.00	6.00	-	-	-	-	-	-	-	-	-	
	26	-	-	-	13.15	5.00	5.00	-	-	-	-	-	-	-	-	-	
15.	32	-	-	-	-	-	-	40.00†	-	-	-	-	-	-	-	-	
16.	35	-	-	-	-	-	-	-	-	-	9.00	4.00	4.00	-	-	-	
17.	37	38.00	5.00	5.00	-	-	-	-	-	-	-	-	-	-	-	-	
18.	42	15.00	5.00	5.00	-	-	-	-	-	-	-	-	-	-	-	-	
19.	44	-	-	-	-	-	-	-	-	-	-	-	-	32.00	6.00	6.00	
20.	45	-	-	-	25.00	3.00	3.00	-	-	-	-	-	-	-	-	-	
Total		78.00	13.00	11.00	274.35	84.50	84.50	108.00	20.00	20.00	49.00	8.50	8.50	166.43	23.00	21.00	

\* Drainage outlets are ended in the old well. When the well becomes full, water starts spreading in the field and hence again waterlogging problem arises.

† Drainage pipes are shallow rooted and became uncured (choked), hence water does not flow from these pipes and as a result the benefit for the scheme is nil.

‡ This total land was under cultivation before implementation of the drainage scheme. The drainage problem arises only in rainy season when the well in this plot fills up fully. Now the excess water from this well is directly flowing out of the field (i.e. into the adjacent canal) through the connected pipe lines.

drainage pipes were choked and water stopped flowing from these pipes; ultimately the plot suffered from waterlogging condition.

From the same Table, it is also seen that in one case the total land (i.e. 40 acres) of a plot was under cultivation even before implementation of the drainage scheme. Only thing the farmer had to observe was to avoid kharif cropping. When the well in this plot fills up fully only then the plot suffers waterlogging problem. Now the excess water from this well is directly flowing out of the field (i.e. into the adjacent nala) through the connected pipe lines.

## 5.2 Benefits of the Drainage Scheme

As explained in the earlier chapter relating to the nala-training scheme, the benefits of the scheme can be judged by a benefit-cost exercise. But a simple approach to this question would be to compare the cost of drainage per acre of land restored to cultivation with the current price of such land.

To arrive at the per acre capital expenditure on the drainage scheme, firstly, the estimation of total area of uncultivated land and the estimated total area of reclaimed land for all the beneficiaries (i.e., from 39 plots) was worked out with the help of the available data relating to the sample plots (i.e., from 20 plots), collected at the time of the survey. From this information the per acre



capital cost incurred on reclaimed land was worked out. The data of yearwise distribution of reclaimed land on sample plots was collected at the time of actual survey and from this information the yearwise estimation of capital cost incurred on sample plots was worked out.

The total capital cost of <sup>the</sup> drainage scheme incurred on sample plots (i.e. 20), comparable at 1976 prices<sup>3</sup> was Rs. 1,75,098.66. We have mentioned in the earlier part of this chapter that in the 20 sample plots covering 675.78 acres of land, nearly 22 per cent had been rendered unfit for cultivation as a result of waterlogging, etc. Almost 97 per cent of this land (i.e., 145 acres) was restored to cultivation after the implementation of the drainage scheme. Therefore, the cost of restoring this land to cultivation was Rs. 1,207.58 per acre. Like <sup>the</sup> nala-training scheme, expenses on levelling were not required by this scheme. However, as against this cost (i.e., Rs. 1,207.58) of preparing an acre of land for cultivation, enquiry in the area shows that the market price for this type of land was about Rs. 1,500.00 <sup>per</sup> ~~an~~ acre. We have calculated the per acre price of this reclaimed land<sup>4</sup>, before its reclamation, which comes to Rs. 52.00 <sup>per</sup> ~~an~~ acre. To arrive at the benefit-cost ratio, we deduct this land value, i.e. Rs. 52.00, from

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3. The method used to make the capital cost comparable at 1976 prices, is already discussed in the earlier chapter relating to the nala-training scheme.

4. See Appendix 5.1.

its current market value of Rs. 1,500, which comes to Rs. 1,448 <sup>per</sup> acre. In one sense this may be considered the benefit as against the cost of Rs. 1,207.58 per acre, estimated above. This benefit-cost ratio comes to 1.20.

Now let us turn to the more conventional benefit-cost analysis of the drainage scheme. The detailed discussion of <sup>the</sup> various methodological concepts concerning the benefit-cost analysis has been given in the chapter relating to the male-training scheme. We have adopted the same methodology while exercising the benefit-cost analysis of the drainage scheme.

For the purpose of estimating the benefits and costs of the drainage-scheme the items of costs considered are as follows:

(A) Capital Cost on Drainage Scheme

The capital cost incurred on the drainage scheme was spread over five years, 1971-72 to 1975-76. The procedure adopted for yearwise estimation of capital cost incurred on sample plots <sup>has</sup> already been discussed in the earlier part of this chapter. The capital cost was mainly incurred either on preparing the appropriate drains of sufficient depth, i.e., open drainage system. Or for the purchase of porous pipes or tiles and its installation in the field, i.e., close drainage system.

As mentioned earlier the capital cost of the drainage scheme was spread over a five-year period and the

cost reported was at the respective year's prices. We have adjusted this cost to 1976 prices by using price indices (for details refer to Chapter IV relating to the nala-training scheme).

(B) Operation and Maintenance Cost

Every year the project authorities have to incur some repairs and maintenance cost for keeping the drains/pipes/tiles clean from weeds, grass, silt, etc. The annual maintenance cost was estimated as equivalent to 5 per cent of the total capital cost (i.e., the actual investment incurred on the drainage scheme).

(C) Cost of Cultivation of Crops

The items of costs incurred for production of various crops on the reclaimed land consists of the cost of manures and fertilizers, cost of family and hired labour, cost of bullock labour, etc., which were collected from the sample farmers.

The benefit side of the drainage scheme consists of the total production of crops from the reclaimed land.

Before considering the benefit-cost relating to drainage facility created, some clarification regarding cost of cultivation, etc., needs to be explained. It was observed that out of the 145 acres of reclaimed land, benefiting from the drainage facility, 91 per cent (132 acres) was unirrigated cropped area and the balance of 9 per cent (or 13 acres) was under irrigated cropping. The

irrigation facility pre-existed the drainage facility and was being used on other land. Effective use of <sup>the</sup> pre-existing irrigation facility on the reclaimed land was incidental and not the result of drainage works.

Since there is no increase in irrigated cropping resulting from drainage facility, it would be proper not to consider cost of irrigated crops on the reclaimed land for arriving at the benefits. This means that whatever land has been reclaimed and <sup>though</sup> irrigated crops have been raised on such land, for our purpose it is the unirrigated cropping that should be taken note of. This effectively will be <sup>an</sup> additional benefit resulting from drainage works.

Incidentally, it is also observed that the major portion of this reclaimed area (132 acres out of 145 acres) was under unirrigated jowar crop at the time of our investigation. To calculate the cost-benefit from the total of 145 acres of reclaimed land we assumed that, in the absence of the irrigated crops on the remaining 13 acres of land, jowar would have been taken as a sole crop and accordingly estimation of cost and income of jowar crop on this 13 acres of land has been done. The cost-income data of unirrigated jowar taken on 132 acres of reclaimed land was collected at the time of survey from the sample farms and the same rates have been used in estimating the cost-income from the 13 acres of land which was under the irrigated crops.

**Table 5.4: Drainage Scheme: Benefit-Cost Analysis:  
Considering Labour (Family + Hired) Cost  
in the Total Cost of Cultivation**

Sr. No.	Period	Maintenance cost	Net increase in the production cost	Gross costs	Net increase in the crop production (Gross Benefit)	Net Benefit
<b>I.</b>						
1.	1971-72	-	1135.43	1135.43	1968.62	833.19
2.	1972-73	1273.55	9857.58	11131.13	17091.21	5960.08
3.	1973-74	5073.40	11921.99	16995.39	20670.52	3675.13
4.	1974-75	6399.00	12799.37	19198.37	22191.72	2993.35
5.	1975-76	6857.00	14967.34	21824.34	25950.00	4125.66
6.	1976-77	8468.70	14967.34	23436.04*	25950.00*	2513.96*
<b>II. 1982-83</b>						7008.96*

\* The same figure will continue upto 50th year.

**Note:** 1) The present worth at 10 per cent social rate of discount (considering jowar as mono-crop on reclaimed land) at the end of 50th year is Rs. 28437.34.

2) The present worth at 10 per cent social rate of discount (considering prevailing unirrigated cropping pattern on reclaimed land from 11th year onwards) at the end of 50th year is Rs. 43765.20.

**Table 5.5: Drainage Scheme: Benefit-Cost Analysis:  
Without Considering Labour (Family + Hired)  
Cost in the Total Cost of Cultivation**

Sr. No.	Period	Maintenance cost	Net increase in the production cost	Gross costs	Net increase in the crop production (Gross Benefit)	Net Benefit
<b>I.</b>						
1.	1971-72	-	132.83	132.83	1968.62	1835.79
2.	1972-73	1273.55	1153.24	2426.79	17091.21	14664.42
3.	1973-74	5073.40	1394.76	6468.16	20670.52	14202.36
4.	1974-75	6399.00	1497.41	7896.41	22191.72	14295.31
5.	1975-76	6857.00	1751.15	8608.15	25950.00	17341.85
6.	1976-77	8468.70	1751.15	10219.85*	25950.00*	15730.15*
<b>II. 1982-83</b>						20242.55*

\* The same figure will continue upto 50th year.

**Note:** 1) The present worth at 10 per cent social rate of discount (considering jowar as mono-crop on reclaimed land) at the end of 50th year is Rs. 141279.01.

2) The present worth at 10 per cent social rate of discount (considering prevailing unirrigated cropping pattern on reclaimed land from 11th year onwards) at the end of 50th year is Rs. 156704.49.

**Table 5.6: Drainage Scheme: Benefit-Cost Analysis**

Sr. No.	Period	Capital investment on the scheme	Discount factor (10%)	Present worth at 10% social rate of discount
1.	1971-72	16746.90	.909	15223.02
2.	1972-73	109139.05	.826	90148.81
3.	1973-74	22837.16	.751	17150.59
4.	1974-75	7358.99	.683	5026.20
5.	1975-76	19016.56	.621	11809.56
<b>Total</b>		<b>175098.66</b>		<b>139358.18</b>

**I. Benefit-Cost ratio considering lower as mono-crop on reclaimed land:**

- Benefit-cost ratio (considering labour (F+H) cost in the total cost of cultivation)  $\frac{\text{Rs. } 28437.34}{\text{Rs. } 139358.18} = 0.20$
- Benefit-cost ratio (without considering labour (F+H) cost in the total cost of cultivation)  $\frac{\text{Rs. } 141279.01}{\text{Rs. } 139358.18} = 1.01$

**II. Benefit-cost ratio considering prevailing unirrigated cropping pattern on reclaimed land from 11th year onwards:**

- Benefit-cost ratio (with labour cost)  $\frac{43765.20}{139358.18} = 0.31$
- Benefit-cost ratio (without labour cost)  $\frac{156704.49}{139358.18} = 1.12$

### 5.3 Appraisal of the Drainage Scheme

The benefit-cost ratio of the drainage scheme has been calculated by using the same method adopted while calculating the benefit-cost ratio of the male-training scheme. The benefit-cost ratio of the drainage scheme comes out to be just above unity (1.01), at 10 per cent rate of discount, assuming the opportunity cost of labour (both family and hired) to be zero. However, if the cost of labour at the going wage rate is taken into consideration while calculating total cost of production of crops, the ratio comes to very much less than one (0.20), thereby indicating the economic unjustifiability of the scheme (for details refer to Tables 5.4 to 5.6).

While discussing with the experts (agronomists, etc.) it came to our notice that the land reclaimed after implementation of the drainage scheme, is less fertile (as compared to the other cultivated land) in the beginning and will take some time to restore its full fertility. The full fertility of the soil could be restored in two ways: (1) addition of gypsum to the soil, and (2) by natural salt washings. Whether the farmers will bear the cost of adding gypsum to the soil is doubtful. As regards the latter method, it is a very slow process and as such it will take, it is guessed, at least 10 years to restore it to its full fertility.

When this reclaimed land will reach its full



fertility level, there is every possibility of a change in the cropping pattern on this land. One can properly expect the crop pattern and the yield rates to be what they are today on other unirrigated land in the neighbourhood. Presently, the reclaimed lands were growing only one crop, jowar, while the crop pattern on similar other unirrigated lands in the neighbourhood was as follows: The major crops grown were jowar + safflower, groundnut, hulga, tur, matki, paddy, bajra, etc., wherein the percentage share of jowar + safflower, groundnut and hulga, in the total cropping pattern is 65 per cent, 12 per cent and 5 per cent respectively. Assuming that this change will take place at the end of 10 years, we have recalculated the benefit-cost ratios.

The benefit-cost ratio, in this case, including the labour cost (family and hired) in the total cost of cultivation of crops, comes to much less than one (0.31), indicating the scheme as economically unfeasible. However, assuming the opportunity cost of labour (family + hired) to be zero, the benefit-cost ratio is 1.12 (refer to the Tables 5.4 to 5.6).

Taking into consideration the benefit-cost ratios, calculated by both the approaches, i.e., considering jowar as monocrop on this reclaimed land and by estimating the benefit-cost by adopting the prevailing unirrigated cropping pattern on this reclaimed land, it does not show

a significant difference in the results.

In view of this it appears that unlike the sale-training and sale-check schemes, the investment in the drainage scheme examined here is not a productive investment. The drainage scheme may not be accepted by the farmers as this scheme, at the most, covers only capital cost and the farmers do not even get the wage for their labour. As long as the Government undertakes and bears the cost of this scheme in view of the national objectives, i.e., reclaiming such land for productive purposes, preventing further damage to the adjacent areas, etc., the scheme may be undertaken. However, the exercise shows that the farmers cannot bear the cost of this investment, for in that case they will get nothing towards their family and even hired labour employed in crop production on the reclaimed land. If the Government starts recovering this investment from the beneficiaries the scheme may not be accepted by the latter because of huge capital investment (Rs. 139358.18) involved with annual maintenance cost of Rs. 8468.70. Compared to this investment the income from the reclaimed land is not sufficient to cover the capital cost and the wages for the labour put in by the beneficiaries.

APPENDIX 5.1PRICE CALCULATIONS AS PER SECTION 23 OF THE  
MAHARASHTRA AGRICULTURAL LANDS ACT (CEILING  
ON HOLDING), 1961

No clear guidelines for valuation of fallow lands are available from whatever sources. Under the circumstances it was inevitable to evaluate it by accepting some prescribed method of valuation such as compensation paid to landlords whose lands have been acquired by the State Government. No such data was available and hence it was decided to accept the provisions for compensation of surplus land acquired by the Government for distribution to landless persons, etc. Relevant extracts of section 23 of the Maharashtra Agricultural Lands (Ceiling on Holding) Act, 1961 (as amended upto 5th October 1975) are given below.

Quantum of Compensation

In each of the districts and talukas specified in column 1 of the First Schedule, for each class of land described in columns 2, 3, 4, 5 and 6 of that Schedule, the amount of compensation for surplus land acquired by the State Government under section 21 shall consist of -

- (a) in the case of dry crop land falling under column 5 or 6 the price calculated at the price per hectare specified in column 7 of that Schedule, or

- (b) in the case of land falling under columns 2, 3 and 4 of that Schedule the price calculated at the price per hectare of dry crop land increased by one hundred, by fifty and by 25 per cent, respectively.

Explanation

In the case of land referred to in clause (a), the price shall not in any case exceed one thousand rupees per hectare and in the case of land referred to in clause (b), the price shall not in any case exceed 5,000 rupees per hectare.

Provided that in the case of land which is not cultivated for a continuous period of three years immediately before the commencement date, the price shall be 25 per cent of the price calculated under clause (a) or (b), as the case may be.

Table A<sub>5</sub>.1: Price Calculations as per Section 23 of the Maharashtra Agricultural Lands (Ceiling on Holdings) Act, 1961

Case No.	Survey No.	Area of plot (acres)	Land revenue (Rs.)	Price calculated at 200 times of land revenue *	Per acre price	Maximum per acre compensation as per section 23 for dry crop land	Fallow land re-claimed	Price of reclaimed land at accepted rate	Actual compensation at 25 per cent since land was fallow for more than 3 years	
1	384	10.00	10.00	2,000.00	200.00	400.00	1.50	300.00	75.00	
2	292	44.00	30.00	6,000.00	136.36	400.00	24.00	3,272.64	818.16	
3	324/1	20.00	20.00	4,000.00	200.00	400.00	10.00	2,000.00	500.00	
4	324/2	40.00	20.00	4,000.00	100.00	400.00	5.00	500.00	125.00	
5	367	66.75	75.00	15,000.00	224.72	400.00	25.00	5,618.00	1,404.50	
6	469	22.00	23.00	4,600.00	209.09	400.00	2.00	218.18	54.55	
7	461	25.00	40.00	8,000.00	320.00	400.00	1.00	320.00	80.00	
8 (11)	1	47.00	28.00	5,600.00	119.15	400.00	-	-	-	
9 (12)	4/2	87.43	66.00	13,200.00	150.98	400.00	15.00	2,264.70	566.18	
10 (13)	79	8.00	8.00	1,600.00	200.00	400.00	5.00	1,000.00	250.00	
11 (14)	448	39.00	27.00	5,400.00	180.00	400.00	3.00	540.00	135.00	
12 (16)	382	28.00	16.00	3,200.00	114.29	400.00	3.50	400.02	100.00	
13 (17)	421	32.00	38.00	7,600.00	237.50	400.00	16.00	3,800.00	950.00	
14 (26)	478	43.45	50.00	10,000.00	230.15	400.00	6.00	1,380.30	345.23	
	479	13.15	21.00	4,200.00	319.39	400.00	5.00	1,596.95	399.24	
15 (32)	437	40.00	37.00	7,400.00	185.00	400.00	-	-	-	
16 (35)	323/4	9.00	6.00	1,200.00	133.33	400.00	4.00	533.32	133.33	
17 (37)	470	38.00	80.00	16,000.00	421.05	400.00	5.00	2,000.00	500.00	
18 (42)	443	15.00	44.00	8,800.00	586.67	400.00	5.00	2,000.00	500.00	
19 (44)	1040	32.00	50.00	10,000.00	312.50	400.00	6.00	1,875.00	468.75	
20 (45)	317	25.00	24.00	4,800.00	192.00	400.00	3.00	576.00	144.00	
<b>Total</b>							145.00		7,548.94	
								$\frac{Rs. 7548.94}{145.00} = Rs. 52.06/\text{acre}$		

\* 200 times of land revenue of dry crop land, Sholapur district, as prescribed under First Schedule of the Maharashtra Agricultural Lands (Ceiling on Holdings) Act, 1961 (as amended upto 5th October 1975).

CHAPTER VIASSESSMENT OF ECONOMIC EFFICACY OF THE  
'FARMPOND' SCHEME6.1 Background of the Scheme

It was noted in Chapter III that the project area (i.e. IDLAD, Mandrup) suffers from excess runoff of water during the rainy and early rabi seasons. This is the characteristic of most dry farming areas in this part of the country. Since rainfall is both rather low and uncertain, the normal sources of irrigation like reservoirs on rivers and even wells are not available in any significant measure, it is considered desirable if any of this excess runoff rain water can be stored for supplementing the supply of moisture in the fields in such parts of the season when crops need it. One technique which has been suggested to harness this water is construction of 'Farmpond'. The idea behind the construction of farmpond is to give protective irrigation to the crops when there is a fairly long dry spell between two precipitations. Even though the monsoon starts in time and the crop is initially quite healthy, the long dry spell may affect the crop badly or in some cases completely. Under this situation a farmpond is expected to play an important role. With the help of one or two protective irrigations from a pond, the extent of crop loss can be minimized. In this situation it would be possible to

salvage some crop instead of losing it entirely.

The use of farmpond is supposed to be of two types: (1) The main use is to store runoff water and use it for supplementary irrigation during the crop season. (2) A further use would be the enhancement of supply of water in the wells in the neighbourhood of ponds through the percolation of stored water from the ponds. Of course, this is not the important justification of a farmpond, but only an incidental benefit.

On any given soil type the potential for supplementary irrigation from stored runoff is influenced strongly by the rainfall patterns and by sub-soil conditions. The actual feasibility of this technique will, therefore, always be highly location specific.<sup>1</sup>

In locating farmpond sites, some of the important physical features that must be considered are the watershed characteristics, silting possibilities, topography and soil types. The watershed must be capable of furnishing the annual runoff sufficient to fill the pond. Farmponds should be placed in well vegetated areas that are not subject to high siltloads when flood flows occur. Sparsely vegetated watersheds covered with gullies will cause excessive silting in the pond,

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1. Binswanger H.P., Virmani S.M. and Kempen J. Farming Systems Components For Selected Areas in India. International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) Research Bulletin No. 2, Patancheru P.O., Andhra Pradesh, 1980, p. 19.

shortening its period of usefulness. Considering silting and other factors, the minimum depth of the pond may be placed at 3 metres under average conditions. The soil type at the site should be thoroughly investigated to determine the permeability of the soils that will form the bottom and sides of the farmpond as well as to avoid cutting in very hard stuff. In many localities, pervious soils that are not favourable for farmpond construction exist below the heavier surface soils. Wherever this condition exists, the bottom of the farmpond may be covered with a seal coat of clay, if the cost is not prohibitive.<sup>2</sup>

It should be noted that in the IDLAD project, Mandrup, in all 20 farmpond schemes had been implemented. Out of the 20 farmponds, six were completed in the year 1973-74, eight were completed in the year 1974-75 and the remaining six in the year 1975-76. In the present study the data relating to all the twenty farmponds has been taken into account.

The size of a farmpond depends upon the total area of the catchment in which the farmpond is situated. Of the twenty farmponds considered in this study, the size of eleven ponds was 400 sq.m. each, five ponds were of the size 900 sq.m. each and the remaining three were of the

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2. Rao Rama M.S.V. "Soil Conservation in India". Chapter 18, pp. 189-215. Op.Cit.



size 2400 sq.m., 200 sq.m., and 100 sq.m., respectively. The total area that has gone under the twenty farmponds is approximately 3 acres (12,000 sq.m.). Of these twenty ponds land under eight ponds (approximately 1.5 acres) was under cultivation prior to the construction of the farmponds. The land under the remaining twelve farmponds (approximately 1.5 acres) was fallow.

During the year 1976-77, which was a year of normal rainfall in this area, 13 of the 20 ponds reached their full capacity, i.e., 3 metres depth some time during the period September to November; the remaining 7 could not fill to this level even once during the season. Furthermore, whatever the level of filling with water, almost all ponds were characterized by quick drainoff through percolation from the sidewalls and the bottom of the ponds. Indeed, 7 of the 20 ponds were drained of all the stored water within 2 to 3 days of their filling; 4 of these had filled to the required level. These were, therefore, of no use to the farmers for supplementary irrigation. In the others the percolation was somewhat slower but not insignificant. Moreover, water in two of the thirteen ponds, filling fully at least once, was too saline for irrigation. Thus 9 of the 20 farmponds constructed were useless for supplementary irrigation. Another 3 ponds, including one which filled to the required level, could not be used for the purpose because the farmers did not possess, and could not rent

the necessary waterlifting/pumping devices. Therefore, in effect only 8 farmponds were used for supplementary irrigation (Table 6.1). Therefore, it is clear that in at least half or more of the cases, the purpose for which the farmponds had been constructed could not be fulfilled.

Can it at least be said that in the 8 cases in which the ponds could be used for the intended purpose, the returns were worth the costs? We examine this question below.

In Table 6.1 the data regarding the cropwise area irrigated by the farmponds and the number of irrigations by the ponds for the year 1976-77 is presented. The total area irrigated by the 8 farmponds in all seasons came to 22.00 acres in the reference year. The crops irrigated by these farmponds were bajra (3.00 acres), jowar (12.00 acres), wheat (6.00 acres) and gram (1.00 acre). The number of irrigations given to three acres of bajra was one, and one acre of gram were two. In the case of 12 acres of jowar, 11 acres were given only one irrigation and one acre was given three irrigations. In the case of 6 acres of wheat, 3 acres were given three irrigations, 2 acres two irrigations, and 1 acre one irrigation. Of the 8 farmponds which were used for supplementary irrigation, 7 farmponds have given more than one irrigations to one or more crops. Only one pond has given one irrigation, which was given to one acre wheat. The reason for this farmpond not being able to give more than one irrigation,

**Table 6.1: Details about the Farmponds (Farmponds Scheme)**

Sr. No.	Case No.	Survey No.	Water-table (in metres) September to November	Cropwise total area irrigated by these farmponds in different seasons					Supplementary number of irrigations given from pond	Total of all seasons (acres)
				Kharif	Area (acres)	Rabi	Area (acres)			
1.	16	383	3.00	*	-	*	-	-	-	
2.	17	419	3.00	⊙	-	⊙	-	-	-	
3.	20	439	1.50	**	-	**	-	-	-	
4.	23	6	2.00	-	-	Jowar	1.00	Three	1.00	
5.	24	440	3.00	**	-	**	-	-	-	
6.	25	419/B	3.00	**	-	**	-	-	-	
7.	26	478	3.00	-	-	Wheat	1.00	One	1.00	
8.	26	479	3.00	-	-	Wheat	1.00	Two	1.00	
9.	29	146	3.00	-	-	Jowar	10.00	One	10.00	
10.	33	438	2.00	*	-	*	-	-	-	
11.	34	444	3.00	Bajra	3.00	Wheat	2.00	Bajra - One Wheat - Three	5.00	
12.	35	323/4	2.00	-	-	Wheat	1.00	Three	1.00	
13.	37	470	3.00	**	-	**	-	-	-	
14.	38	310/2	3.00	**	-	**	-	-	-	
15.	39	310	2.00	*	-	*	-	-	-	
16.	42	443	2.00	**	-	**	-	-	-	
17.	44	1040/A	3.00	-	-	Jowar	1.00	One	2.00	
						Wheat	1.00	Two		
18.	44	1040/B	3.00	-	-	Gram	1.00	Two	1.00	
19.	46	22	-	**	-	**	-	-	-	
20.	47	420	3.00	⊙	-	⊙	-	-	-	
<b>Total</b>					<b>3.00</b>		<b>19.00</b>		<b>22.00</b>	

- \* - Water from farmpond was not used due to unavailability of water lifting devices.
- ⊙ - Water from farmpond was saline and as such not used for irrigation.
- \*\* - Water from farmpond gets quickly (within 3 days) percolated due to the sub-soil layer of murum and as such unable to use it for irrigation as and when need arises.

though it had reached its full capacity and did not suffer the problem of quick percolation acutely, was the non-availability of water-lifting device with the farmer at the crucial time. One more farmpond gave only one irrigation, but to a sizable amount of land, i.e., 10 acres of jowar. It is reported that this particular pond had struck the natural underground water source.

An incidental benefit of the farmpond scheme is the availability of additional water for irrigation from the old wells. In Table 6.2 the data regarding watertable of the old wells and the cropwise area irrigated by these wells in different seasons is presented. The watertable of the wells at the beginning of the three seasons, viz., kharif, rabi and summer, were measured. In all, 7 old wells were situated adjacent to the ponds. Out of these 7 old wells, data relating to the past could be obtained for 5 wells.<sup>3</sup>

From the Table 6.2 it is seen that the watertable of all the remaining five wells increased, particularly at the end of the kharif and beginning of rabi season (October-November) and quite significantly in some of them.

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3. The date of past position for two old wells was not available because in the case of one well the plot of land on which the well is located had just been purchased by the respondent at the time of our investigation and the earlier owner was not available for enquiry, and in the second case the well was not in use before the implementation of the scheme.

Table 6.2: Details About the Old Wells: Farmwells Scheme

Sr. No.	Case No.	Survey No.	Material of the wells (in feet)						Cropwise Total Area Irrigated by These Wells in Different Seasons														
			Present Position			Past Position			Present Position				Past Position				Total of all Seasons (acres)	Total of all seasons (acres)					
			Jun/Oct	Apr/May	Jul/Nov	Kharif Crops	Rabi Crops	Summer Crops	Kharif Crops	Rabi Crops	Summer Crops	Kharif Crops	Rabi Crops	Summer Crops									
1.	23	6	Nil	10	4	*	*	*	-	-	Jowar	4.00	-	-	4.00	*	*	*	*	*	*	*	*
2.	24	446	1	15	5	1	10	2	-	-	Wheat	5.00	-	-	5.00	-	-	Wheat	3.00	-	-	3.00	
3.	25	419/A	4	24	10	4	22	10	Jowar(H)	0.50	-	-	-	-	-	Chi- llies	1.00	Wheat	1.00	Veg.	1.00	3.00	
									Sugarcane	1.00	Sugarcane	1.00	Sugarcane	1.00	3.50								
4.	25	419/B	5	25	10	5	22	8	Sugarcane	1.00	Sugarcane	1.00	Sugarcane	1.00	6.50	Onion	2.00	Jowar	3.00	Veg.	1.00	6.00	
									Chillies	0.50	Wheat	1.00	-	-									
									Groundnut	2.00	-	-	-	-									
5.	35	323	10	18	10	⊙	⊙	⊙	-	-	Veg.	1.50	-	-	1.50	⊙	⊙	⊙	⊙	⊙	⊙	⊙	
6.	44	1040	10	20	10	5	10	5	Maize	1.00	Wheat	2.00	-	-	5.00	Chi- llies	1.00	Wheat	1.00	-	-	2.00	
									Chillies	1.00	Jowar	1.00	-	-									
7.	46	22	5	35	5	5	25	5	-	-	Jowar	1.00	-	-	1.00	-	-	Jowar	1.00	-	-	1.00	
<b>Total</b>									<b>7.00</b>	<b>17.50</b>	<b>2.00</b>	<b>26.50</b>	<b>4.00</b>	<b>9.00</b>	<b>2.00</b>	<b>15.00</b>							

\* - Newly purchased farm and as such unable to give past information.

⊙ - Well was not in use before the implementation of the scheme.

We further observe from the same Table that the total area irrigated by these old wells in all seasons, i.e., the gross irrigated area, increased by 11.50 acres. As explained in the earlier chapter relating to the nala-training scheme, while calculating gross irrigated area we have added the area under sugarcane thrice - in all the three seasons. Even if we take it into account only once, which is the common way of calculating the gross irrigated area, it can be seen that the irrigated area increased by 7.50 acres. Thus, we find that as a result of the farmponds scheme the gross irrigated area under old wells had increased almost by 77 per cent.

In Table 6.3 the data regarding the watertable of the new wells and the cropwise area irrigated by these wells in different seasons are presented. It should be noted here that though these two new wells were sunk by the farmers during the years 1971-72 and 1972-73, it has been reported by the respective well owners that these wells had stuck more water only after the implementation of the farmpond scheme, adjacent to these two new wells. The water from these wells was used for irrigation only after the implementation of the scheme, when the beneficiaries became sure about availability of sufficient water in these wells. We observe from the same Table that the total area irrigated by these new wells in all seasons (i.e., the gross irrigated area) came to 11.50 acres, in

the reference year.

Thus, as a result of the implementation of the farmpond scheme the gross irrigated area from all the three sources, i.e., old wells, new wells and farmponds, establish a substantial addition (i.e., 11.50, 11.50, 22.00 acres from old wells, new wells and farmponds respectively) of 45 acres, in the reference year.

In the earlier chapter relating to the male-training scheme, we have discussed in detail the methodological concepts concerning the benefit-cost analysis. We have adopted the same methodological exercise for working out the benefit-cost analysis of the farmpond scheme. For the purpose of estimating the benefits and costs of the farmpond scheme the items of costs considered are:

(A) Capital Cost on Farmpond Scheme

The distribution of capital cost incurred on farmpond scheme was reported from the year 1973-74 to 1975-76, i.e., in three years period and the cost reported was at respective years' prices.

(B) Capital Cost Incurred by the Beneficiaries on Sinking New Wells and Energizing Them

It has been reported that the investment on sinking two new wells was incurred during the years 1971-72 and 1972-73. While the investment incurred for energizing these new wells was made in the year 1974-75. The reported cost in sinking new wells was also at the respective years prices.

**Table 6.3: Details About the New Wells (Faraponds Scheme)**

Sr. No.	Case No.	Survey No.	Watertable (in ft.)			Cropwise total area irrigated by these wells in different seasons						
			June/July	Oct./Nov.	April/May	Kharif Area (acres)	Rabi Area (acres)	Summer Area (acres)	Total of all seasons (acres)			
1.	16	382	3	20	3	-	-	Wheat	3.00	Groundnut	1.00	4.00
2.	37	470	3	15	5	Sugarcane	1.50		1.50		1.50	7.50
						Bajra	2.00	Wheat	1.00	-	-	
<b>Total</b>							3.50		5.50		2.50	11.50



The capital cost of the farapond scheme and well sinking, etc., carried out over two to five years were adjusted to 1976 prices by using price indices.<sup>4</sup> The prices of electric motors used in the computation are those of 1976 and are net of excise duties and taxes. These were obtained from some major manufacturers of such equipment.

(C) Repairs and Maintenance Cost

The project authorities have to incur some repairs and maintenance cost for keeping the pond at its proper depth by way of desilting it every year and repairing any damages to the side-walls and the wastewair, i.e., outlet. It has been decided to consider the annual maintenance cost as equivalent to 5 per cent of the total capital cost.

(D) Cost of Cultivation of Crops

As discussed in the earlier chapter relating to the nala-training scheme, only the incremental cost of cultivation of crops, from the irrigated area under new wells, old wells and faraponds, has been taken into account.

(E) Loss of Income from the Land Now Under the Faraponds

Prior to the construction of the faraponds, the land under eight ponds out of the 20 faraponds considered (1.5 acres out of 3.0 acres) was under cultivation. With the construction of these faraponds the cultivation had to

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4. The method used to make the capital cost comparable at 1976 prices, is already discussed in the earlier chapter relating to the nala-training scheme.

be given up. The annual income which had been accruing from that cultivation must be included as cost item in the farmpond scheme. This income was imputed by considering the type of crops that were being cultivated; the gross receipts from such cultivation minus the cost of cultivation of those crops over this acreage of land (i.e. 1.5 acres) was calculated and the resulting figure taken as an imputed cost item in the farmpond schemes.

The items of benefits were as follows:

- (a) Incremental crop production from the farms under new wells irrigation.
- (b) Incremental crop production from additional irrigation under old wells.
- (c) Incremental crop production from the farms under irrigation directly from the farmponds.

The method for calculating the incremental benefits/costs, adopted in the earlier chapter (i.e., chapter on nala-training scheme) holds good in the farmpond scheme also.

## 6.2 Appraisal of the Farmpond Scheme

As said in the earlier part of this chapter, of the 20 farmponds the stored water used for protective irrigation was only from 8 ponds. Of the total 8 wells, 3 are adjacent to these 8 farmponds. The remaining 5 wells are adjacent to five farmponds which could not be used for protective irrigation for the reasons stated

earlier in this chapter. It was observed that, although these five ponds could not be used for protective irrigation, the watertable in the five adjacent wells had increased. We have calculated the benefit-cost ratio considering the capital investment in the eight faraponds and the benefits accrued due to protective irrigation given from these eight ponds and the adjacent three wells. We have also calculated the benefit-cost ratio taking into consideration the benefits accrued due to increase in the watertable of the five wells adjacent to the five faraponds only.

We have conducted the above exercises (we shall refer to the former as exercise-I and latter as exercise-II) for the following reasons. It was observed that the water from most of the faraponds could not be utilized because of the problem of quick percolation which is directly related to the soil-type. In future if the soil type is thoroughly examined before constructing a farapond and/or the measures are taken to minimize the problem of quick percolation, though it will add to costs, the problem of quick percolation can be minimized<sup>making</sup> it possible to utilize the stored water efficiently. Considering this, we have conducted exercise-I. The exercise-II was conducted taking into consideration our observation that although the water from the five faraponds could not be directly utilized due to quick percolation, it

has resulted in increasing the watertable of the wells adjacent to these five ponds <sup>and</sup> which has made possible additional irrigation. We have made an attempt to find out whether the benefits from additional irrigation cover the cost of the farmponds.

The benefit-cost ratio of the farmpond scheme has been calculated by using the same method adopted while calculating the benefit-cost ratio of the nala-training scheme. In the cases of both the exercise I and II, the benefit-cost ratio, even without considering the labour cost, both family and hired, in the total cost of cultivation of crops, comes out to be very much less than one, 0.57 and 0.45 respectively. If the cost of labour at the going wage rate is taken into consideration while calculating total cost of production of crops the scheme turn out to be economically unjustifiability<sup>le</sup> (refer to Tables 6.4 to 6.9). In view of these, it is clear that, like the drainage scheme investment in the farmpond scheme examined here are socially unproductive investments. Even if the Government considers of implementing the scheme and bears the capital cost, the scheme will still be a failure because of its huge capital and maintenance cost as compared to the benefits from this scheme.

Even if we consider the performance of the schemes in totality (i.e., 20 farmponds) the results are no different. The benefit-cost ratio of the farmpond schemes

(20 farmponds) comes out to be less than one (0.12) at 10 per cent rate of discount, assuming the opportunity cost of labour (both family and hired) to be zero. If the cost of labour at the going wage rate is taken into consideration the scheme turn out to be economically unjustifiable (refer to the Tables 6.10 to 6.12).

The tract under study was found to be unsuitable for the purpose of farmponds because of its soil type and rainfall conditions. Firstly, the rainfall in the region is scarce. Secondly, it was found that the problem of quick percolation of stored water affected seven farmponds out of twenty, thereby aggravating the unfeasibility of the scheme. This finding of ours, concerning the tract under study (i.e., Sholapur region) has been affirmed by the finding of Biswanger et al.

"..... On all deep and medium-deep vertisols (like Sholapur region), storing water for supplementary irrigation of the rainy season crop has little potential. Relative to the deep and medium deep vertisols situations, we can rule out small scale watershed-based runoff collection for supplementary irrigation of rainy season crops. For post-rainy season crops such a system will not be attractive in the Sholapur situation, but it may be attractive as one moves to higher rainfall zones."<sup>5</sup>

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5. Biswanger H.P., Virmani S.M. and Kempen J.  
Op.cit., pp. 19, 22, 24.

**Table 6.4: Farmpond: Benefit-Cost Analysis (With Labour Cost): Eight Farmponds from Which Protective Irrigation Was Given and Three Adjacent Wells Wherein the Watertable Has Increased due to Percolation from Farmponds**

Sr. No.	Period	Maintenance cost (5% of the capital investment on 8 farm-ponds)	Net increase in the production cost		Gross costs	Net increase in the crop production		Gross benefit	Net benefit
			Old wells	Farm-ponds		Old wells	Farm-ponds		
1.	1971-72	-	407.72	-	407.72	546.67	-	546.67	138.95
2.	1972-73	-	815.44	-	815.44	1093.34	-	1093.34	277.90
3.	1973-74	-	1223.16	-	1223.16	1640.01	-	1640.01	416.85
4.	1974-75	832.30	1630.88	850.00	3313.18	2186.68	1205.10	3391.78	78.60
5.	1975-76	1356.10	2038.60	2126.63	5521.33	2733.35	3012.75	5746.10	224.77
6.	1976-77	2193.50	2446.30	2835.50	7475.30	3280.00	4016.72	7296.72	-178.58

**Table 6.5: Farmpond: Benefit-Cost Analysis (Without Labour Cost): Eight Farmponds from Which Protective Irrigation Was Given and Three Adjacent Wells wherein the Watertable Has Increased due to Percolation from Farmponds**

Sr. No.	Period	Maintenance cost (5% of the capital investment on 8 farm-ponds)	Net increase in the production cost		Gross costs	Net increase in the crop production		Gross benefit	Net benefit
			Old wells	Farm-ponds		Old wells	Farm-ponds		
1.	1971-72	-	183.17	-	183.17	546.67	-	546.67	363.50
2.	1972-73	-	366.34	-	366.34	1093.34	-	1093.34	727.00
3.	1973-74	-	549.51	-	549.51	1640.01	-	1640.01	1090.50
4.	1974-75	832.30	732.68	398.70	1963.68	2186.68	1205.10	3391.78	1428.10
5.	1975-76	1356.10	915.85	996.75	3268.70	2733.35	3012.75	5746.10	2477.40
6.	1976-77	2193.50	1099.00	1329.30	4621.80	3280.00	4016.72	7296.72	2674.92*

\* The same figure will continue upto 50th year.

**Note:** The present worth at 10% social rate of discount at the end of 50th year = Rs.20643.39.

**Table 6.6: Farmpond: Benefit-Cost Analysis: Eight Farmponds from which Protective Irrigation was Given and the Three Adjacent Wells wherein the Watertable Has Increased due to Percolation from Farmponds**

Sr. No.	Period	Capital Investment on farmpond scheme	Discount Factor (10%)	Present Worth (10%)
1.	1973-74	16646.15	.909	15131.21
2.	1974-75	10475.64	.826	8653.18
3.	1975-76	16747.81	.751	12577.75
TOTAL				36362.14

1. Benefit-Cost Ratio (without labour cost)  $\frac{20643.39}{36362.14} = 0.57$   
 (Eight farmponds with 3 adjacent wells)



**Table 6.7: Farmpond: Benefit-Cost Analysis (With Labour Cost): Five Ponds from Which Water Was Not Used for Protective Irrigation but due to Its Percolation 5 Adjacent Wells (2 New + 3 Old) Have Increased Their Watertable**

Sr. No.	Period	Investment on water lifting devices	Maintenance cost (5% of the capital investment on these 5 ponds)	Net increase in the production costs		Gross costs	Net increase in the crop production		Gross benefit	Net Benefit/Loss
				New Wells	Old Wells		New Wells	Old Wells		
1.	1971-72	-	-	-	509.46	509.46	-	503.33	503.33	-6.13
2.	1972-73	-	-	-	1018.92	1018.92	-	1006.67	1006.67	-12.25
3.	1973-74	-	-	-	1528.38	1528.38	-	1510.00	1510.00	-18.38
4.	1974-75	759.80	36.40	3303.50	2037.84	6137.54	5038.96	2013.33	7052.29	914.75
5.	1975-76	759.80	760.80	3303.50	2547.30	7371.40	5038.96	2516.66	7555.62	184.22
6.	1976-77	759.80	1126.50	3303.50	3056.74	8246.54	5038.96	3020.00	8058.96	-187.58

**Table 6.8: Farmpond: Benefit-Cost Analysis (Without Labour Cost): Five Ponds from Which Water Was Not Used for Protective Irrigation but due to Its Percolation 5 Adjacent Wells Have Increased Their Watertable**

Sr. No.	Period	Investment on water lifting devices	Maintenance cost (5% of the capital investment on these 5 ponds)	Net increase in the production costs		Gross costs	Net increase in the crop production		Gross benefit	Net Benefit/Loss
				New Wells	Old Wells		New Wells	Old Wells		
1.	1971-72	-	-	-	299.61	299.61	-	503.33	503.33	203.72
2.	1972-73	-	-	-	599.22	599.22	-	1006.67	1006.67	407.45
3.	1973-74	-	-	-	898.83	898.83	-	1510.00	1510.00	611.17
4.	1974-75	759.80	36.40	2398.83	1198.44	4393.47	5038.96	2013.33	7052.29	2658.82
5.	1975-76	759.80	760.80	2398.83	1498.05	5417.48	5038.96	2516.66	7555.62	2138.14
6.	1976-77	759.80	1126.50	2398.83	1797.67	6082.80	5038.96	3020.00	8058.96	1976.14*

\* The same figure will continue upto 50th year.

**Note:** The present worth at 10% social rate of discount at the end of 50th year is Rs.16223.28.

**Table 6.9: Farmponds: Benefit-Cost Analysis: Five Farmponds from Which Water Was Not Used for Protective Irrigation but due to Its Percolation 5 Adjacent Wells (2 New and 3 Old) Have Increased Their Watertable**

Sr. No.	Period	Capital investment on farmpond scheme (Rs.)	Capital investment on new wells sinking (Rs.)	Total (Rs.)	Discount factor (10%)	Present worth (10%)
1.	1971-72	-	13086.90	13086.90	.909	11896.08
2.	1972-73	-	11102.40	11102.40	.826	9170.25
3.	1973-74	728.04	-	728.04	.751	546.73
4.	1974-75	14487.99	-	14487.99	.683	9895.30
5.	1975-76	7313.59	-	7313.59	.621	4541.99
<b>TOTAL</b>						<b>36050.35</b>

Benefit-Cost Ratio (without labour cost)  $\frac{16223.28}{36050.35} = 0.45$   
(Five wells adjacent to 5 ponds)

**Table 6.10: Faraponda Scheme: Benefit-Cost Analysis: Considering Labour (Family + Hired) Cost in the Total Cost of Cultivation of Crops**

Sr. No.	Period	Investment on water lifting devices	Maintenance cost (5% of the investment on farmpond scheme)	Net loss of income from the land now under the farmponds	Net increase in the production costs			Gross costs	Net increase in the crop production			Gross benefit	Net Benefit/ Loss
					Irrigation from New Wells	Irrigation from Old Wells	Irrigation from Farmponds		New wells	Old wells	Farm-ponds		
1.	1971-72	-	.	-	-	917.00	-	917.00	-	1050.00	-	1050.00	133.00
2.	1972-73	-	-	-	-	1834.00	-	1834.00	-	2100.00	-	2100.00	266.00
3.	1973-74	-	-	118.05	-	2751.00	-	2869.05	-	3150.00	-	3150.00	280.95
4.	1974-75	759.80	2293.20	296.25	3303.50	3668.00	850.00	11170.75	5038.96	4200.00	1205.10	10444.06	-726.69
5.	1975-76	759.80	4021.95	395.00	3303.50	4585.00	2126.63	15191.88	5038.96	5250.00	3012.75	13301.71	-1890.17
6.	1976-77	759.80	5798.75	395.00	3303.50	5502.00	2835.50	18594.55*	5038.96	6300.00	4016.72	15355.68*	-3238.87*

\* The same figure will continue upto 50th year.

Note: The present worth at 10 per cent social rate of discount at the end of 50th year is Rs. -20950.98.

**Table 6.11: Farmponds Scheme: Benefit-Cost Analysis: Without Considering Labour (Family + Hired)  
Cost in the Total Cost of Cultivation of Crops**

Sr. No.	Period	Investment on water lifting device	Maintenance cost	Net loss of income from the land new under the farmponds	Net increase in the production costs			Gross costs	Net increase in the crop production			Gross benefits	Net benefit
					Irrigation from new wells	Irrigation from old wells	Irrigation from farmponds		New wells	Old wells	Farm-ponds		
1.	1971-72	-	-	-	-	482.67	-	482.67	-	1050.00	-	1050.00	567.33
2.	1972-73	-	-	-	-	965.34	-	965.34	-	2100.00	-	2100.00	1134.66
3.	1973-74	-	-	283.68	-	1448.01	-	1731.69	-	3150.00	-	3150.00	1418.31
4.	1974-75	759.80	2293.20	709.20	2398.83	1930.68	398.70	8490.41	5038.96	4200.00	1205.10	10444.06	1953.65
5.	1975-76	759.80	4021.95	945.60	2398.83	2413.35	996.75	11536.28	5038.96	5250.00	3012.75	13301.71	1765.43
6.	1976-77	759.80	5798.75	945.60	2398.83	2895.83	1329.30	14128.11*	5038.96	6300.00	4016.72	15355.68*	1227.57*

\* The same figures will continue upto 50th year.

Note: The present worth at 10 per cent social rate of discount at the end of 50th year is Rs.12467.52.

**Table 6.12: Faraponds Scheme: Benefit-Cost Analysis**

Sr. No.	Period	Capital investment on faraponds scheme	Capital investment on new wells sinking	Total	Discount factor (10%)	Present worth (10%)
1.	1971-72	-	13086.90	13086.90	.909	11896.08
2.	1972-73	-	11102.40	11102.40	.826	9170.25
3.	1973-74	45864.09	-	45864.09	.751	34443.86
4.	1974-75	34575.17	-	34575.17	.683	23614.73
5.	1975-76	35536.15	-	35536.15	.621	22067.86
TOTAL						101192.78

- (1) Benefit-Cost ratio (without considering labour (Family + Hired) cost in the total cost of cultivation of crops)  $\frac{\text{Rs. } 12467.52}{\text{Rs. } 101192.78} = 0.12$
- (2) Benefit-Cost ratio (considering labour (family + hired) cost in the total cost of cultivation of crops)  $\frac{\text{Rs. } -20950.98}{\text{Rs. } 101192.78} = -0.20$

CHAPTER VIIIMPROVED AGRONOMIC PRACTICES  
ON DRYLANDS - AN ASSESSMENT

The discussion in Chapter I suggested that the agricultural development of dryfarming areas requires a three pronged strategy to counteract the twin problems of very low and uncertain rainfall. The strategy consists of:

- (A) Integrated programme of soil conservation, land management and water harvesting practices.
- (B) Adoption of crops which would suit the type of soil and withstand moisture stress.
- (C) Reorientation of methods of cultivation so as to conserve the moisture in the cultivated land.

The techniques relating to the first strategy, i.e., soil conservation, land development and water harvesting practices, developed and extended in the area under study, have been examined in Chapters III to VI. These are nala-training, nala-check, drainage and farmponds. By their very nature these measures can affect only specific agricultural land depending upon their topography and location. The second and third strategies mentioned earlier may very well be clubbed together under the heading 'improved agronomic practices'.

Unlike the land improvement measures, measures to achieve increased production per acre under unirrigated

conditions, can be expected to affect almost the entire area under dryland farming. These include new crops, crop rotations and cropping practices. The research stations have suggested such crops and cropping practices and the extension agencies have begun extending these to select farming areas.

In view of this, it was felt necessary to examine the various improved agronomic practices recommended specially for the Mandrup project areas. The improved agronomic practices consist of:

1. Use of high yielding, drought resistant and short duration varieties of crops.
2. Use of manures and fertilizers according to the recommended doses for different crops.
3. Use of plant protection measures.
4. Use of improved implements and machinery.
5. Early sowing of rabi crops, particularly jowar, in this region.
6. Mid-season correction, if necessary.
7. Use of mulching practices.

Let us look at these recommended improved agronomical practices one by one.

#### 7.1 Use of High Yielding Varieties of Crops Recommended for the Tract

The cropwise details regarding the existing local varieties and the recommended HYV/improved varieties for the general cultivation in the tract under study are



presented in Table 7.1. The characteristic features of these recommended HYV/improved varieties of crops over the local varieties are varying in nature. The HYV/improved varieties of crops recommended specially for this dryfarming tract are drought resistant, early maturing, fertilizer responsive and high yielding type. It should also be noted here that all these HYV/improved varieties are advocated under unirrigated condition. While adopting these HYV/improved varieties of crops it is of prime importance to follow the various agronomic practices as have been advocated by the Department of Agriculture. The various agronomic practices consist of improved tillage practices, time of sowing, optimum seed rate, proper spacing, various inputs, e.g., chemical fertilizers, etc., and other necessary interculturing operations. The details of these agronomic practices, advocated for major crops are presented in Table 7.2. In order to work out the adoption exercise we have taken into consideration the major crops grown in the tract in kharif and rabi season during the year 1976-77. The crops considered for discussion are bajra and groundnut in kharif and jowar and wheat in rabi season. The details regarding the adoption of HYV/improved varieties of these crops are presented in Table 7.3.

1. Bajra

Growing of a crop during the kharif season in this tract is risky due to the uncertainty of rainfall which

**Table 7.1: Cropwise Details of Recommended HYV/Improved Varieties as Against the Existing Local Varieties of Crops**

Sr. No.	Crop	Recommended HYV/Improved varieties	Existing local varieties
<b><u>Kharif</u></b>			
1.	Bajra	HB-3	N-28-15, Sajguri
2.	Groundnut	K.4-11 (Spreading), K-1 (Semi-spreading) and S.B.11 (Bunch type)	Ghungru
3.	Sunflower	EC-68413, EC-68414, EC-68415 and Sunrise	No crop
4.	Green gram	HY.45	Jalgaon-781
5.	Black gram	No. 55	Local
6.	Red gram	No. 148	T.84
7.	Grass	Marvel-8 and Blue panic	Local
<b><u>Rabi</u></b>			
1.	Jowar	O1.35-1 (improved), R-16, GSH-1 and GSH-5 (Hybrid)	ND.15
2.	Safflower	H62-8, 7-13-3, A-300, No. 80	Local
3.	Gram	M.59, Chafa, Annegiri	Local
4.	Wheat	Kalyan Sona, N-59, NI-747-19	Local i.e. Khepali, etc.
5.	Cotton	Laxmi (no change)	Laxmi

**Source:** Chief Scientist, All India Coordinated Research Project for Dryland Agriculture, Sholapur and Project Officer, Integrated Dryland Agricultural Development Project, Mandrup, Dist. Sholapur, "Blue Print for Action and Vision for the Future," Department of Agriculture, Maharashtra State, pp.15, 16.

**Table 7.2: Package of Practices Recommended for Different Crops in the Integrated Dryland Agricultural Development Project, Mandrup, Dist. Sholepur**

Sr. No.	Item of Work	Bajra	Groundnut	Jowar
1.	Sowing time	Upto the mid-July	Upto the mid-July	First fortnight of September
2.	Variety	HB-3	SB-XI and K-4-11	M-35-1, CSH-7 and CSH-8
3.	Seed treatment	20% salt solution for control of 'arget'	Fungicidal seed treatment, Rhizobium culture	Carbofuran for CSH-7) CSH-8) 1:10 Seed treatment with sulphur for smut control
4.	Spacing (cm)	45 x 15	SB-XI : 30 x 15 K-4-11 : 45 x 15	45 x 20
5.	Seed rate (kg/ha)	2.5 kg	80 to 100 kg	8 to 10 kg
6.	Plant population per hectare	1.5 lakhs	SB-XI: 1.25 lakhs K-4-11:1.50 lakhs	1 lakh
7.	Fertilizer (kg):			
	N - ha.	50	12.5	50
	P - ha.	25	25	-
8.	Plant protection measures	BHC 10% 20 kg/ha	BHC 10% 20 kg/ha	BHC 10% 20 kg/ha. Second application after 15 days if necessary
9.	Any other item	Keep the plot clean for 30 days	-	Use surface mulch or protective irrigation if available

**Source:** Project Officer, "Annual Progress Report", Integrated Dryland Agricultural Development Project, Mandrup, Dist. Sholepur, 1975-76, Department of Agriculture, Maharashtra State, pp. 13, 14.

**Table 7.3: Adoption of HYV/Improved Varieties of Major Crops by the Sample Farmers**

Sr. No.	Items	(Area in acres)			
		Kharif		Rabi	
		Bajra	Ground-nut	Jowar	Wheat
1.	Total number of sample farmers	19	27	56	35
2.	Number of farmers using HYV/Improved varieties of crops	17	8	54	22
3.	Number of farmers using local varieties of crops	2	19	2	13
4.	Total area under the crop (acres)	60.50	177.00	1079.75	82.00
	1) Irrigated	11.00	4.00	29.50	54.00
	ii) Unirrigated	49.50	173.00	1050.25	28.00
5.	Area under unirrigated hybrid/improved varieties (acres)	40.50	24.00	1007.25	8.50
6.	Area under irrigated hybrid/improved varieties (acres)	11.00	3.00	29.50	45.00
7.	Area under local varieties of crops (acres)	9.00	150.00	43.00	28.50
8.	Percent of (6) above to total	18.18	1.70	2.73	54.88
9.	Percent of (5) above to total	66.94	13.55	93.29	10.36
10.	Percent of (7) above to total	14.88	84.75	3.98	34.76

affect crop growth adversely. Likewise, the bajra crop is generally grown on the light to medium soils and as such the problem of moisture stress is acute due to the low waterholding capacity of such soils. Considering these limitations of the tract, scientists advocated 'HB-3' hybrid variety of bajra for general cultivation in the tract. This variety stands well under frequent dry spells and the yield of this variety is found to be spectacularly more (almost four and half times on the demonstration plot and more than three and half times on the sample farmers' plots) than the local varieties like Sajguri and N.28-15-1 (for details, refer to Table 4).

From the same Table it may be seen that the yield of bajra crop (HB-3) was poor (4.20 q/ha) on the farmers' plots as compared to demonstration plots (10.53 q/ha). The probable reasons for the poorer yield on the farmers plot are that these farmers had not followed all the package of practices, viz., use of optimum doses of fertilizers, seed treatment, use of improved seed-drill, etc., recommended by the research station. However, on the demonstration plots these recommended package of practices were followed by the extension agency. The detailed discussion regarding the use of improved seeddrill and the use of manures and fertilizers by the sample farmers is presented in the sections two and three of this chapter respectively. Nevertheless, the yield of the hybrid variety 'HB-3' was

**Table 7.4: Yield of Crops (Unirrigated) with Improved/HYV and Local Varieties on Demonstration Plots and on Sample Plots**

(Yield - Qtls/ha)						
Sr. No.	Details	Wheat	Jowar Grain Fodder	Bajra	Ground- nut	
<b>1. <u>Demonstration Plots (1974-75)</u></b>						
A.	Improved/HYV varieties	7.75*	14.46	70.60	10.53	12.05
B.	Local varieties	4.42*			2.37	2.11
C.	Percentage increase of (A) over (B)	175			444	571
<b>2. <u>On Plots of Sample Farmers (1976-77)</u></b>						
A.	Improved/HYV varieties	3.55	3.53	42.00	4.20	5.33
B.	Local varieties	2.30			1.10	2.93
C.	Percentage increase of (A) over (B)	154			382	182

\* These figures are taken from the "Report on Research Work Done during 1973-74", Agricultural Research Committee, M.P.K.V., Rahuri and ICAR, New Delhi, p.47.

**Source:** Directorate of Agriculture, "Dry Farming in Maharashtra," Department of Agriculture (Maharashtra State), Information Bulletin No. 577 (Marathi), November 1975, pp. 13 and 17.

about 3.5 times that of the traditional variety.

Therefore, the farmers felt persuaded to grow this variety.

The level of adoption of the HB-3 variety of bajra on the sample plots is presented in Table 7.3. In all 19 of the sample farmers cultivated the bajra crop, out of which 17 farmers (nearly 90 per cent) had adopted the recommended variety (HB-3) on their farms. All these farmers were growing the local variety of bajra viz., Sajgari, before they were advised to grow the new hybrid variety.

Thus, so far as bajra is concerned, the new variety has substituted the old, and the yield rate under unirrigated condition has increased at least three-fold.

## 2. Groundnut

The other major crop grown in the tract in kharif season is groundnut. Considering the limitations of the tract, i.e., frequent dry spells, etc., dryland scientists have recommended the SB-XI improved variety of groundnut crop for cultivation instead of the prevailing local variety like 'Ghungru' or C-148. The recommended improved variety (SB-XI) has certain distinguishing agronomic characteristics compared to the local variety. The variety is a bunch type and is well resistant to the 'Tikka' disease. Moreover, this is high yielding, drought resistant and can be grown under unirrigated condition. This variety is earlier maturing (105 days) than the local strains like C-148 (144

days).<sup>1</sup> The results of the demonstration plots and sample plots showed around six times and around two times increased yields respectively of this improved variety over the local one (Table 7.4). However, from the same Table it is also clear that the yield of groundnut crop was very poor (5.33 q/ha) on the farmers plot as compared to demonstration plots (around 12 q/ha). The most likely reason for this is very poor application of phosphatic fertilizers by the sample farmers. On demonstration plots the recommended doses of these fertilizer along with the necessary package of practices have followed. The details regarding the use of fertilizers by these sample farmers is discussed in the section three of this chapter.

Table 7.3 shows the level of adoption of the recommended improved strain, viz., SB-XI on the sample farms. It is seen from the Table that only 8 out of 27 farmers (approximately 30 per cent) adopted the recommended improved variety. The remaining 19 farmers cultivated local variety particularly 'Chungru' on their farms. Areawise, only 16 per cent of the total land under groundnut, of which 14 per cent was unirrigated and 2 per cent irrigated, was under the improved variety.

The sole reason, reported by the sample farmers and confirmed from the project officials, for the very limited adoption of the improved variety of groundnut was lack of

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1. Chief Scientist, "Agricultural Research Committee, 1974.", op.cit., p. 29.



availability of certified seeds of SB-XI strain in time during the reference year, though the project farmers were convinced about the superiority of this variety over the local strains. Therefore, it was fairly clear that this new variety of groundnut will completely replace the local varieties at an early date depending of course on the availability of the new seeds.

### 3. Jowar

Jowar is the most important rabi crop in the scarcity zone of Maharashtra. This crop occupied almost 77 per cent of the total cultivated area under the Mandrup Project. The variety M.35-1, locally known as 'Maldandi', is still the ruling variety in the tract. It was observed on the sample plots that almost 92 per cent of the total area under jowar was occupied by this variety (Table 7.3).

Although M.35-1 is a variety with an excellent grain and gives better yield (almost double in the case of grains) as compared to other traditional varieties like N.D-15, etc., the drawbacks of this variety are that it has a longer duration (135 days), has a tendency to lodge and is not highly fertilizer responsive. This variety also does not perform well at a high population density. The moisture extraction pattern of M.35-1 indicates two peaks, one at the grand growth stage and the other at grain formation. If moisture stress is developed at the latter stage, grain formation is affected considerably.<sup>2</sup>

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2. Indian Council of Agricultural Research, "Crop Life Saving Research," ICAR, New Delhi, February 1976, p.100.

The crop rabi jowar, is grown entirely on receding soil moisture, which puts limitations on the available soil moisture for plant growth, as no assured showers are generally expected after sowing. In order to exploit the available moisture to the fullest possible extent the new variety of jowar to be recommended to this tract should be deep rooted, drought resistant and early maturing. An ideal strain of jowar should fulfil the above requirements along with being a high yielding, fertilizer responsive and a stable variety.

Unfortunately, however, research to develop better varieties with the above characteristic, to substitute Maldandi (M.35-1) on dryland, has not yet been rewarding. The hybrid varieties of jowar, particularly CSH-1, proved useful on irrigated lands. But these were not successful under unirrigated condition in the rabi season, because of their poor moisture extraction capacity which leads to their inability to stand frequent dry spells. The only new strain which had at least, some of the required characteristics, is "R-16". It is early maturing (110 days), has bold grains, and is suitable to high population density. But in terms of yield rate, it is even less (12.46 q/ha) compared to the M.35-1 (15.21 q/ha).<sup>3</sup>

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3. Chief Scientist, "A Report of the Research work done during 1973-74," op.cit., p. 75.

Moreover, it is susceptible to the disease "Charcoalrot" if the sowing is delayed to October, which is frequent in these dry tracts.<sup>4</sup> Thus, despite its advocacy by the extension agency under early sowing, it has not caught on, and is not likely to. Therefore, the scientists concerned were firmly agreed that "none of the stable and newly evolved varieties of rabi jowar had statistically out-yielding the traditional variety M.35-1."<sup>5</sup>

Thus, M.35-1 (Maldandi) continues to be the best available variety of rabi jowar and no improvement in it is in sight. With its dominant position in the dryland agriculture of this region, the varietal position of rabi jowar continues to be "the weakest link in production."<sup>6</sup> Nor is there any possibility of it being substituted by any other crop under existing technical and economic conditions.

#### 4. Wheat

It has been generally observed that the yields of wheat crop are low in this dry region. The studies conducted at Dry Farming Research Station, Sholapur attribute the poor yields of wheat locally grown to its

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4. Directorate of Agriculture, Maharashtra. "Dry Farming in Maharashtra," op.cit., p. 29.

5. Chief Scientist, "A report of the research work done during 1973-74," op.cit., p. 76.

6. Indian Council of Agriculture Research, "Crop Life Saving Research", op.cit., p. 100.

poor moisture extraction. Wheat was observed to extract only 65 per cent of available moisture.<sup>7</sup> It was, therefore, believed that a variety of wheat capable of extracting more percentage of moisture would do better under these conditions.

Considering this aspect the Department of Agriculture, Maharashtra advocated the HYV varieties like Kalyan Sona, N-59, NI-747-19 and NI-5439, for this dry region. These varieties can give better yields under unirrigated conditions. It was also observed at the Dry Farming Research Station, Sholapur that the moisture use efficiency per day was the highest in the case of Kalyan-sona and NI-5439. The yield performance of these varieties was also encouraging as compared to local varieties (Table 7.4).

Though these HYV varieties of wheat gave better yields as compared its local varieties, the dryland scientists observed that the yields of wheat crop, in general, are significantly lower (both under irrigated and unirrigated conditions) in this dry region as compared to rabi jowar (M.35-1), due to the poor moisture extraction capacity of the former and other climatic reasons. On demonstration plots it is observed that the yield of unirrigated jowar (M.35-1) is almost double the yield of HYV wheat (Kalyansona).<sup>8</sup> We have calculated the gross

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7. Chief Scientist, "Report on the research work done during 1974-75", op.cit., p. 20.

8. Chief Scientist, "Report of the research work done during 1973-74", op.cit., pp. 48, 76.

income from jowar and wheat (both unirrigated), as the farmers will ultimately consider the income aspect while deciding which crop to grow. The data show that on demonstration plots jowar (M.35-1), if grown instead of wheat (Kalyansona), would give an extra gross income of Rs. 1151/hectare (Table 7.5). Taking into consideration this aspect the Department of Agriculture, Maharashtra strongly advocated jowar instead of wheat crop for this dry land tract.

Our calculations about the extra income that farmers may get in cultivation of jowar (M.35-1) rather than wheat (Kalyansona) on the basis of data from sample farmers is less decisive. It was found that sample farmers by shifting to jowar rather than wheat would get an extra income of Rs. 240/hectare (Table 7.5). The potential increase on the basis of sample farms is much less than similar calculations based on the data from demonstration plots. This may have resulted from the differences in the package of practices used for jowar cultivation on demonstration plots and the sample farms. Moreover, the small sample size of unirrigated wheat (only 4 farmers) compared to unirrigated jowar (52 cultivators) can be the another reason for this.

Furthermore, with respect to adoption of HYV wheat, in our sample 35 farmers cultivated wheat crop, out of which 22 farmers adopted recommended HYV wheat, especially

**Table 7.5: Gross Income from Jowar (M.35-1)  
and HYV Wheat**

Sr. No.	Details	Jowar		Wheat		Difference in gross income (J-W) Rs.
		Yield Q/ha	Value (Rs.)	Yield Q/ha	Value (Rs.)	
<b>1. Demonstration Plots</b>						
A.	Grain	14.46	1807.50	7.75	1356.25	
B.	Fodder	70.00	700.00		Nil	
C.	Total		2507.50		1356.25	1151.25
<b>2. On plots of sample farmers:</b>						
A.	Grain	3.53	441.25	3.55	621.25	
B.	Fodder	42.00	420.00		Nil	
C.	Total		861.50		621.25	240.25

Rates used - Wheat @ Rs. 175/Q.

Jowar @ Rs. 125/Q.

Jowar fodder @ Rs. 10/Q.

Kalyansona, on their farms. Areewise, 65 per cent of the land was under HYV wheat out of which 55 per cent was under irrigated wheat and only 10 per cent was under unirrigated wheat, which again confirms that farmers have preferred to take these HYV wheat especially on irrigated land because of its poor moisture extraction capacity. On the remaining 35 per cent of land local varieties like Bansi, Khapli, etc.,

were cultivated. It was observed at the time of personal interview with these farmers, that they prefer to cultivate local varieties only for home consumption, as they find the quality and taste of these local strains better than of HYV wheat.

Summing up:

We may now sum up the observed results of the new varietal improvements suggested by the Research Station and the extension agency in the unirrigated lands. The varietal improvements suggested in regard to the two major kharif crops in the area, namely Bajra and Groundnut have proved significantly superior and have been well received by the farmers. The hybrid bajra variety gives at least three fold increase in yield rate on the farmers' fields and by 1976 most farmers had switched over to this variety. It is by now the accepted variety and the gross as well as net income from bajra may be said to have increased by at least 300 per cent.

In regard to the new groundnut variety in kharif season the experience on the farmers' fields is very satisfactory and there is a 100 per cent increase in gross and net income from this. The adoption of this variety was slow merely because of inadequate availability of seed, and it is reasonable to conclude that the switch over to the new variety will be complete at an early date.

Besides a 300 and 100 per cent increase in production

and income from bajra and groundnut respectively, the new varieties are expected to reduce the year to year fluctuations in the production and income from these two kharif crops due to their greater ability to stand adverse rainfall conditions. While it has not been possible for us to measure this on the farmers' fields, it is necessary to keep this added advantage in view.

Turning to Rabi crops in these dry agricultural regions, we, however, find no visible improvements in the agricultural production and income position. Indeed, the research scientists have not been able to develop any better varieties for the major rabi crops of the region than<sup>v</sup> what were already being grown by the farmers. Rabi jowar which is the dominant crop not only in rabi season but in the total crop system of the region, is under the well-established variety Maldandi (M.35-1), and no better varieties than this were available and could be advocated. The same was the position in regard to wheat under unirrigated condition, where the new HYVs were not particularly superior to the traditional varieties, and therefore had no chance of extensive adoption. The new HYVs in case of wheat proved superior only under irrigated condition and adoption was quite fast. But both existing and potential irrigation in these dry lands is extremely limited and wheat is not the most important crop under irrigation. Thus, in the rabi season there was little



improvement in production and income possible in this dry agricultural region.

There were a few other newer crops, like sunflower, etc., advocated by the research scientists and extension workers, but the adoption of these and the experience with such crops by farmers was meagre.

In terms of varietal improvement therefore only two kharif crops, bajra and groundnut, showed significant increase in production and income and therefore their rapid adoption. A question may then arise: what is the possibility that due to significant increases in the returns per acre from these two kharif crops, and somewhat greater seasonal stability in their yields, some land now put to other kharif or even rabi crops may be transferred to one or other of these two kharif crops? A careful examination of this question suggests very little such possibility. The reasons are mainly two. In the first place, jowar is the main rabi crop. The yield rate of rabi jowar (Maldandi) is at least as high as, or somewhat higher than that of the hybrid bajra variety now accepted by farmers. Pricewise also jowar fetches a higher price than bajra. This leaves little incentive for farmers to switch land from under rabi jowar to kharif hybrid bajra. Secondly, groundnut requires light or light-medium soil to facilitate harvesting by uprooting the plants. Most lands under rabi crops like jowar and wheat are not of such type.

This severely limits the possibility of any significant increase in acreage under groundnut at the cost of some rabi crops. Of course, year to year fluctuations in proportion of area under kharif and rabi crops due to fluctuations in rainfall is normal in this region. But a long term systematic shift of acreage to kharif crops due to improvement in yields of the kharif crops does not appear promising.

Under these circumstances, the total expected impact on farm production of the new varieties introduced with dry agricultural region appears rather small. Kharif bajra and groundnut occupy 5.35 per cent and 9.66 per cent respectively of the gross cropped area of the project.<sup>9</sup> A 300 per cent increase in production and income from bajra and 100 per cent increase in those of groundnut will lead to about 28 per cent increase in total agricultural production in the region (assuming that the total production/income from various unirrigated crops is in proportion to the area under these crops). While for a poor agricultural region any such definite improvement is useful, it is very small, particularly when compared to the spectacular increases in the green revolution tract. One finds that the technological improvements in dryfarming regions hold small though positive possibilities.

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9. Project Officer, IRLAT, Mandrup. "Annual Progress Report for the year 1975-76", Department of Agriculture, Maharashtra, p. 5.

## 2. Use of improved implements and machinery

One of the reasons for the low yields of crops (Jowar in the case of this region) is inadequate plant population. Ensuring adequate plant population and its uniform distribution on the field is not easy under dry farming condition. One possible reason for this is the insufficient contact of seed with soil particles resulting in failure of germination. Another reason is the improper distribution of seed sown with the help of indigenous (local) seed drills. Indigenous seeding devices (locally known as Teephan, Moghur, etc.) are not capable of providing uniform depth of sowing and proper distribution of seed. This results in gappy plant stand ultimately resulting in poor yields. Similarly, with the local seeding devices the seed and fertilizer cannot be drilled at the same time with desired placement.

By using improved seeding device, the question of uniform distribution of seed and its placement at appropriate depth can be solved; at the same time fertilizer can be placed along with seed. By compacting the row with specially devised mechanism, such as packer wheels or blade behind the seed drill, it would be possible to induce better contact between seed and soil. Moreover, almost all the improved seeddrills were helpful in minimizing the cost of sowing, as a result of simultaneous seeding, fertilization and covering

operations.

The experiments on the usefulness of these improved seeding devices over local seeddrills had been carried out at the 'Dry Farming Research Station, Sholapur'. The results of sowing of rabi jowar with the improved and local seeddrills are presented in Table 7.6. The results show that use of 'Maharashtra Token Yantra' resulted in increased grain yield over indigenous seeddrills to the extent of about 19 per cent.

The data regarding the adoption of the improved seeddrills and other improved implements and machinery by the sample farmers is presented in Table 7.7. It should be noted here that though the improved implements and machinery advocated by the research and extension agencies consisted of various devices like duster, sprayer, ploughs, chaf cutter, etc., the project cultivators put more emphasis on the improved seeddrills, as it is the implement of basic necessity for improving the yields of the crops.

It is seen from Table <sup>7.7</sup> that, of the total sample farmers, i.e. 57, as many as 34 (60 per cent) had used the improved seeddrills specially designed for dry land cultivation. Among those who used these improved seeddrills 29 (approximately 85 per cent) felt benefitted from it and the remaining 5 farmers (nearly 15 per cent) stated that they had not benefitted from the use of improved seed drills. It is also observed that a sizable

number of sample farmers, i.e., 23 (nearly 40 per cent) were unable to use the improved seedrills though several of them were convinced about the potential benefits of these improved seedrills vis-a-vis the local ones. It is also clear from the Table 7.8, that, out of the 29 farmers benefitted from the improved seedrill as many as 23 had purchased the improved seedrill '18" Ferti-Seeder' from the project at a subsidised rate (the extent of subsidy was 50 per cent). Of the remaining, two farmers had hired it from neighbours - and four farmers had hired it from the project store.

In the case of other improved implements and machinery, viz., ploughs, sprayer, chaff cutter, etc., out of the 29 farmers benefitted, only 2 had hired these improved implements and machinery from the project store. Of the remaining 27 farmers 18 had purchased one or the other improved implements from the project store at subsidised rate and 9 farmers had purchased these implements, on their own, i.e., without any subsidy from the project. Of the five farmers who used one or the other improved implements, but failed to derive any benefit from it two had purchased these implements from the project store at subsidised rate, and the remaining 3 farmers had purchased these, particularly ploughs, on their own.

All but one of the sample farmers who had purchased the improved seedrill were large and medium farmers (with

more than 10 acres of cultivated land). Indeed two-thirds of the large farmers and one-third of the medium farmers in the sample had already purchased this seed-drill. The same was the case in regard to the other improved implements advocated by the research-cum-extension agency. Similarly, ~~one~~ of the farmers who hired in these implements, most were large and medium farmers. The small farmers in the sample were not very much in the picture, though one of them had also purchased a seed-drill and found it useful.

Most of the farmers who owned or hired and used the new seed drill and other implements found them useful. If more people had not purchased it so far, it was partly due to the very high price of the new seed drill. It cost Rs.450/- a piece, as against Rs.100/- for the local seed-drill. The state gave a 50 per cent subsidy on purchase of the new implements. This is sure to persuade all large farmers and even many medium farmers to purchase it. Indeed, some had already purchased without the subsidy. However, most small farmers and even some medium farmers may find the price too high, even with the subsidy. They would prefer to rent it if they can; for many of those who had not used it were nevertheless persuaded about its usefulness. The difficulty with revising was two fold. The farmers who had already purchased the implement were reluctant to hire it out for fear of mis-use and damage. The extension agency was the only source of

renting; and the data show that again large and medium farmers made greater use of this facility. The real problem here was the small number of new seed-drills available with the agency - only 15. No wonder their use would be limited and that too to the larger farmers. In view of the high cost, it would be necessary to have larger number of such implements available on hire with the extension agency/village cooperative/gram panchayat so that small and medium farmers may use it regularly. Financially it may not cost the Government more than the subsidy programme.

Furthermore, it was the general complaint of all the beneficiary farmers that improved seedrills in particular as well as the ploughs are too heavy to operate with the help of a pair of bullocks. They would desire these implements to be somewhat lighter. Secondly, the distance between two rows in the case of the improved seeder is 45 cms., particularly in the case of the jowar crop. Though this facilitates easy interculturing operations, it results in less fodder yield and hence is not popular among these cultivators who were more interested in fodder yield, for their dairy and/or animal husbandry business.

The net results of the enquiry into the adoption of the new implements is that these implements have proved useful and sooner than later most large and many medium

farmers will own and use these. The use of the implements by the small farmers will depend largely on hiring facility at the community level. The experimental data had shown a 19 per cent improvement in the yield of jowar as a result of the use of these implements. We have attempted to measure the impact of improved seeddrills on jowar yield, by comparing yields on the farms who had used these with those who had not used. It was observed that the yield of jowar was found to be 19 per cent higher on the sample farms using improved seeddrills as compared to those who had not used it. The incremental yield observed on the sample farms appear to be almost equal with the results of the experimental plots. It should, however, be noted that the entire increase on experimental plots could be ascribed to the use of improved seeddrills while the observed increase on sample farms denote the impact of improved seeddrills along with other agronomic practices. We were not in a position to measure this impact on the farmers' fields, but at least a 5 to 10 per cent improvement in yield may be presumed in view of the favourable response of the farmers to the rather costly implements.



(A)  
**Table 7.6: Yield of jowar as effected by improved seeding methods during the year 1972/73**

Sr. No.	Type of seed drill used	Yield (Qtls/ha)	
		Grains	Fodder
1.	Indigenous seed drill	12.14	41.32
2.	Swastik seed drill	13.88	48.33
3.	Agricultural Engineer's drill	12.84	48.08
4.	Maharashtra Token Yentra	14.47	45.42
5.	International seed drill	12.66	48.26
6.	Indigenous seed drill with plant population adjusted to 72000/ha after 3 weeks from sowing	12.76	31.42
7.	Noble seed drill	12.57	14.79

Source: "A report on the research work done (1973/74)", Chief Scientist, All India Co-ordinated Research Project for Dry Land Agriculture, Sholapur. Agricultural Research Committee, Mahatma Phule Krishi Vidyapeeth, Rahuri and Indian Council of Agricultural Research, New Delhi, p.87.

(B)  
**Table 7.6: Yield of unirrigated lower as affected by improved seeding method on sample farms**

Sr. No.	Type of seed drill	Yield (Q/ha)
1.	Improved seeddrills*	3.85
2.	Local seed drills	3.23
3.	Percentage increase of (1) above over (2)	19.19

\* Five farmers had used 'Maharashtra Token Yantra' and the remaining 24 farmers had used the '18" Ferti-seeder'.

**Table 7.7: Adoption of the technique of improved seeddrills and improved implements and machinery by the sample farmers (size groupwise)**

Sr. No.	Size group classification	Used the improved implements and found better	Used the improved implements but not found better	Not used the improved implements at all	Total
1.	0.01 to 10.00 acres	1 (12.50)	1 (12.50)	6 (75.00)	8 (100.00)
2.	11.00 to 25.00 acres	10 (45.45)	2 (9.10)	10 (45.45)	22 (100.00)
3.	26.00 acres and above	18 (66.67)	2 (7.41)	7 (25.92)	27 (100.00)
Total		29 (50.88)	5 (8.77)	23 (40.35)	57 (100.00)

(Figures in the parentheses show percentage to the total)

**Table 7.8: Size groupwise details of the beneficiary farmers regarding the improved seeddrills and other improved implements**

Sr. No.	Size-groups classifications	Used the improved seed drills and benefitted from it			Used the improved seed drill but not benefitted			Grand Total (5+8)	Used the other improved implements and machinery and benefitted from it			Used the other improved implements and machinery but not benefitted			Grand Total (12+15)
		Owned	Hired	Total	Owned	Hired	Total		Owned	Hired	Total	Owned	Hired	Total	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
A.	0.01 to 10.00 acres	1	-	1	-	1	1	2	1	-	1	1	-	1	2
B.	11.00 to 25.00 acres	7	3	10	-	2	2	12	10	-	10	2	-	2	12
C.	26.00 acres and above	15	3	18	-	2	2	20	16	2	18	2	-	2	20
Total		23	6	29	-	5	5	34	27	2	29	5	-	5	34

### 3. Use of manures and fertilizers

All dry land soils are poor in nitrogen and some of them are also poor in phosphorus.<sup>1</sup> The soils of the tract under study are also deficient in nitrogen and in certain pockets phosphatic deficiency has also been observed. In order to correct these deficiencies, nitrogenous and phosphatic fertilizers were tried on various crops at the Dry Farming Research Station, Sholapur, which resulted in a substantial increase in crop yield of almost all crops. It was also observed that the yields of rabi jowar, safflower, cotton and bajra increased with 50 kg.N/ha under unirrigated cropping. The trials (experiments) conducted on research station showed that the increase in the dose of nitrogen beyond 50 kg/ha on soil depth between 30 to 60 cm is definitely uneconomic.<sup>2</sup>

The Research Station also discovered that the method of application of fertilizers is as important as the quantity of fertilizers applied. Since the moisture is the limiting factor, the fertilizers have to be applied, necessarily by proper placement. The fertilizers has

1. ICAR and IDRO, "Crop Life Saving Research",  
Op.cit. p.111.

2. Chief Scientist and Soil Specialist, "A brief note  
on the work done at the Dry Farming Research  
Station, Sholapur", op.cit. p.4, 5.

necessarily to be applied at the time of sowing when there is enough moisture in the soil.<sup>3</sup> Application of fertilizers at the time of sowing 10 cm. below the soil surface and preferably 5 cm. below the seed was found most effective.<sup>4</sup>

We undertook an exercise to find the objective factors behind the recommendation regarding nitrogen application (i.e. 50 kg.N/ha) made by the Research Station. We were some what handicapped as we failed to get the necessary soil typewise data about nitrogen application. Another difficulty we came across is about finding the effect of nitrogen application independently, because the observed yield improvements represent combined effect of nitrogen application and the use of improved seed drills.

In order to decompose the observed yield pertaining to 'N' application and the use of seed drills, the following method was used. As found in section - 2, the extent of increase in the yield of crops through the adoption of improved seed drills was 19%. In other words in the absence of the use of improved seed drills the extent of possible decline in yield would be 16%. We, therefore,

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3. Chief Scientist and Project Officer, "Blue Print for action and vision for the future". op.cit. p. 18.
  4. Chief Scientist and Soil Specialist, "A brief note on the work done at the Dry Farming Research Station, Sholapur", op.cit. p. 4.

deflected the observed yields at various 'N' treatment to that extent.

Such an exercise was undertaken for jowar and bajra crops by using the Research Station data. The total per hectare income was plotted against the cost involved in application of different 'N' levels. It was found that the jowar income was maximum at about 50 kg.N/ha which is close to the optimal 'N' dose recommended by the Research Station. In the case of bajra the optimum dose which could give maximum per hectare income is at a large variance from the recommended optima.

We have made an attempt to compare the recommended doses of fertilizers with the actual fertilizer consumption by the sample farmers. The comparison will be made cropwise. The data regarding the cropwise per acre plant nutrients (N.P.K.) consumption by the sample farmers is presented in Table 7.9.

Looking at the Table, the general observation is that the nitrogen consumption of almost all the major unirrigated crops was very poor as compared to the recommended dose of it (i.e. 20 kg.N/acre or 50 kg/ha. The actual consumption of nitrogen in the unirrigated bajra and jowar was 4.88 kg.N and 1.39 kg.N. per acre respectively. The nitrogen application in the case of all the remaining crops was almost nil. The lower average dose of nitrogenous fertilizers resulted from the fact that

a large number of farmers did not use chemical fertilizers at all. In the case of jowar, it was observed that out of 52 sample farmers, who had taken this crop on their farm, only 9 had applied fertilizers to some extent. The remaining 43 sample farmers had not at all applied chemical fertilizers to the jowar crop. The same thing had happened in the case of other crops also, as revealed from the above Table.

As regards the use of farm-yard manures (F.Y.M.) the situation is not very encouraging. The number of farmers who used F.Y.M. is not very different from those who used chemical fertilizers.

The reasons for meagre utilization of manures and fertilizers, reported by the sample cultivators were:

- (i) Use of chemical fertilizers is very risky in this dry farming region, due to the uncertainty of assured rainfall.
- (ii) Lack of technical knowledge about the selection of proper types of fertilizers and their appropriate (optimum) doses, and
- (iii) Financial constraints.

Of the three reasons - mentioned above by the sample farmers the first seems to be the most crucial as far increasing the use of fertilizers is concerned. Extension activities through propogating optimum doses of proper fertilizers and also provision of adequate credit



facilities will not be helpful beyond a limit. Extension activity may, however, be effective in making use of F.Y.M. more widespread which will go a long way in improving the crop yield on dry farms.

**Table 7.9: Per acre plant nutrient (N,P,K) consumption of the major unirrigated crops grown by the sample farmers**

Sr. No.	Crops		Total plant nutrient consumption			Number of farmers		(kg/acre)	
			Nitrogen (N)	Phosphorus (P)	Potash (K)	Using Fer-	Total	tilizers/	manures
1.	Bajra	1) Ferti.	3.04	1.39	1.20	2	15	4.08	
		11) F.Y.M.	1.84	1.51	2.98				
			4.88	2.90	4.08				
2.	Groundnut	1) Ferti.	0.20	0.20	0.20	1	26	0.69	
		11) F.Y.M.	0.30	0.25	0.49				
			0.50	0.45	0.69				
3.	Jowar	1) Ferti.	0.95	0.50	0.30	9	52	0.99	
		11) F.Y.M.	0.43	0.35	0.69				
			1.39	0.85	0.99				
4.	Wheat	1) Ferti.	0.92	-	-	1	4	3.92	
		11) F.Y.M.	2.42	1.99	3.92				
			3.34	1.99	3.92				

Note: The NPK percentage has been calculated by considering both manures (F.Y.M.) and chemical fertilizers and their composition. The data of the composition of these manures and fertilizers were taken from:

"Composition of important organic manures and fertilizers"  
 Department of Agriculture, Maharashtra State,  
 Research Bulletin No. 12, 1969, p.3.

4. Advancing sowing dates of rabi crops:

In the dry farming tract like Sholapur rabi crops are grown on receding soil moisture under traditional sowing time, i.e., in the second week of October. This puts limitation on the available moisture for plant growth as very few showers are generally expected after sowing. Secondly, the medium deep and deep soils of this region (generally occupied by rabi jowar) begin to crack 4 to 5 weeks after the cessation of rains, i.e. usually in the third or the last week of November. To minimise moisture stress, rabi crops should complete their flowering before cracks develop in the soil. Considering these limitations scientists felt that if rabi crops are sown about 3 to 4 weeks earlier than the usual (traditional) period, i.e., second fortnight of October, greater quantity of moisture may be available for crop growth, ultimately resulting in greater production.

Whether or not the objective conditions for successful adoption of this practice exist can be assessed from the distribution and the quantum of rainfall in the months of August, September and October. This data for the period 1958 to 1972 is presented in Table 7.10.

It is clear that barring a few exceptions (the years 1960, 1968 and 1972) the rainfall in August was sufficient to undertake sowing operations in the month of September. Moreover, a comparison of the total rainfall during the

months of September and October reveals that the September rains are more evenly distributed besides being larger in total quantum as compared to the October rains. Hence, it seems that it would be beneficial to undertake sowing in early September, as the rains in the rest of September and October will be helpful for plants in their early growth stage. Alternatively, if the rabi sowing is undertaken in early October which is also the traditional sowing time the crops are likely to be exposed to a low and unevenly distributed October rainfall.

The experiments conducted at the Dry Farming Research Station, Sholapur in the year 1971-72 showed that the suggested change in sowing time, i.e. 3 to 4 weeks earlier than the usual period, proved highly effective in increasing moisture use capacity and ultimately the yields of rabi crops (Table 7.11). It has also been observed that early sowing poses certain problems, such as attack of 'Shoot Fly' in jowar. However, it can be overcome by seed treatment with 'carbofuran'. Since moisture is the most limiting factor in dry land agriculture, any disadvantages incidental to advanced sowing are relatively less important.

The data regarding the adoption of this technique by the sample farmers is presented in Table 7.12. In regard to advanced date of sowing recommended particularly to the rabi jowar, 26 of the total sample farmers, i.e.

57 (almost 49%) stated that they had adopted the practice and also found it useful. The farmers who had adopted this practice but not found it useful were 12 farmers and the sizable number of farmers i.e., 17 stated that they do not know anything about this practice. When the advice of the extension agency was explained to them, at the time of our field investigation, they were firm that they will not use such practice as it is "against tradition and nature." These farmers attributed the incidence of pest attack to early sowing.

Table 7.12: Adoption of the practice "advanced date<sup>e</sup> of sowing" by the sample farmers.

Sr. No.	Details	Total number of farmers	As per cent of total
1.	Adopted the practice of early sowing and found it useful	28	49.12
2.	Adopted the practice of early sowing but not found useful	12	21.05
3.	Do not know anything about such practice	17	29.83 100.00
Total		57	100.00

To what extent <sup>did</sup> adoption of this technique benefited the farmers? It is not easy to answer this question, as we have data about sample farms pertaining to a single year 1976-77. However a rough estimate can be made by comparing this ~~and~~ data with the data for 1970-72, provided

by the research station from the experimental plots.

Table 7.13 presents the yield rates of jowar that were obtained on the sample farms and the experimental plots with early/late sowing dates. The yield difference between the early and the late sowing in the case of experimental plots is significantly large. It seems that by advancing the date of sowing by about 3 weeks farmers could get a distinctly improved yield.

The yield difference on sample farms, however, are not significant. By advancing the date of sowing farmers were able to improve the yield only marginally. The reason for the apparent success of early sowing on the experimental plots and lack of it on the sample farms may be explained in terms of the distribution of rainfall during September and October in these two years, i.e., 1970-71 and 1976-77.

It is noticed that during 1970-72 the October rains were in sufficient and uneven unlike in 1976-77, when they were sufficient and more evenly distributed. This would explain why the early sowing was not much beneficial during 1976-77 on the sample farms.

**Table 7.10: Weekly actual rainfall in millimetres: Raingauge St. Sholapur**

Sr. No.	Year	Total rainfall August	Weekly rainfall September				Total rainfall September	Weekly rainfall October				
			I week	II week	III week	IV week		I	II	III	IV	V
1.	1958	369	77	39	-	-	116	14	14	85	-	-
2.	1959	37	25	-	-	-	25	1	32	40	-	-
3.	1960	2	-	99	21	241	361	21	-	10	-	-
4.	1961	62	-	-	-	-	-	3	73	8	-	14
5.	1962	162	161	211	49	8	429	-	8	-	-	-
6.	1963	182	54	11	9	12	86	5	-	68	20	21
7.	1964	20	10	39	93	3	145	88	34	-	2	-
8.	1965	72	-	-	35	14	49	-	-	-	-	-
9.	1966	72	-	-	33	16	49	-	-	-	-	-
10.	1967	18	15	-	-	77	92	45	69	-	-	-
11.	1968	5	-	5	88	37	130	115	26	-	2	-
12.	1969	122	219	101	23	63	406	-	-	-	52	1
13.	1970	96	4	-	38	70	112	-	24	11	-	-
14.	1971	158	1	-	-	31	32	69	33	102	19	6
15.	1972	11	-	64	25	-	89	2	NA	NA	NA	NA

Source: Government of Maharashtra, "Drought Prone Areas Programme for Sholapur district" (Project for submission to the IBRD (World Bank), October 1973, p.35.

**Table 7.11: Yield and moisture use of different crops as influenced by advancing the sowing dates in 1970/71**

Sr. No.	Date of sowing	<u>Sorghum (Jowar)</u>		<u>Safflower</u>		<u>Gram</u>		<u>Wheat</u>	
		Yield A/ha.	Moisture use (mm)	Yield Q/ha	Moisture use (mm)	Yield Q/ha.	Moisture use (mm)	Yield Q/ha.	Moisture use (mm)
1.	8 September	8.83	235	12.43	251	8.36	237	4.70	179
2.	20 September	5.38	225	9.19	210	7.43	146	4.58	158
3.	7 October	4.20	146	7.20	143	4.36	141	2.11	113
4.	23 October	1.35	109	3.97	103	4.06	86	2.01	64

Source: "Crop Life Saving Research", (Information useful for the development of the Sholapur region), Proceedings of the travelling seminar on crop life saving research organised by the Indian Council of Agricultural Research during 1972/73, with support from the International Development Research Centre, Ottawa, Canada, p.55.



**Table 7.13: Yield of Jowar Crop as influenced  
by advancing the date of sowing**

(Yield - Qtls/ha)

Sr. No.	Details	Experimental plots	Sample plots
1.	Yield with early sowing	8.83	3.63
2.	Yield with late sowing	4.20	3.55

**Note:** The results of the experimental plots and the sample plots pertain to the year 1970-71 and 1976-77 respectively.

### 5. Use of Surface Mulching

Since rabi crops are grown on receding soil moisture in the tract under study, the use of mulch for preventing evaporation of soil moisture from the surface is necessary. The use of mulch can provide extra moisture for plant growth, and hence plant population and fertilizer use in dry land agriculture can be increased.<sup>1</sup> Surface mulch can effectively control evaporation particularly through cracks in the field surface. It also reduces the impact of rain drops and thus prevents soil erosion by splash. The conservation of rain-water becomes difficult in soils with very low rate of infiltration. The rain water under such conditions is subjected to run-off. Out of the several techniques employed to increase infiltration and to conserve run-off, mulching is very promising.<sup>2</sup> To increase the efficiency of mulching closer distance between the trenches is desirable. The mulch is required to be spread between the crop rows after the emergence of crops, i.e., after 15-20 days after sowing. After spreading the mulch in the field interculturing

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1. Indian Council of Agricultural Research and International Development Research Centre, "Crop Life Saving Research", Seminar proceedings. Basic Resources, Sholapur region, ICAR, New Delhi, Feb. 1976, p.101.
  2. Chief Scientist, AICRPDLA, Sholapur and Project Officer, IDLADP, Mandrup, "Blue Print For Action And Vision For The Future", op.cit., pp-12, 13.

operations are not needed.<sup>3</sup>

From the experiments conducted at the Dry Farming Research Station, Sholepur during the year 1970 to 1974, it has been observed that the organic mulch of any kind gives significantly more yield as compared to the control, i.e., without mulch (See Table 7.14). From the above experiments it has also been observed that the different organic mulches which can be available from farm waste (e.g. jowar stubble, tur stalk, wheat straw, dry grass, etc.) were found more or less equally efficient; however, dry grass mulch ranks first (See Table 7.14). This could be attributed to the greater bulkiness of the canopy of dry grass which conserve moisture to the maximum. In the case of rabi jowar (M-35-1), it was observed that the yield, both of grain and fodder, was increased substantially by spreading different mulch materials @ 5 tonnes per hectare on soil surface (Table 7.14).

The data regarding the adoption of this technique by the sample farmers is presented in Table 7.15.

In our sample, as many as 60 per cent of the total farmers (57) were not at all aware of the technique of mulching. Of the remaining 40 per cent of the farmers, those aware of the technique of mulching, hardly 4 per

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3. Chief Scientist and Soil Specialist, "A brief note on the work done at the Dry Farming Research Station, Sholapur". op.cit. p.6.

**Table 7.14: Effect of Surface Mulch on the Yield of Jowar (t/ha)**

Sr. No.	Type of mulch	1970-71		1971-72		1973-74		Average	
		Grain	Fodder	Grain	Fodder	Grain	Fodder	Grain	Fodder
1.	Control	2.70	20.4	6.94	28.6	12.19	54.0	7.28	34.3
2.	Jowar-stubble	5.63	32.8	6.64	25.8	18.80	83.0	10.35	47.2
3.	Wheat-straw	7.29	39.5	7.37	29.5	18.95	86.9	11.20	51.9
4.	Tur stalks	7.02	39.5	9.37	49.0	19.07	81.0	11.82	56.8
5.	Dry grass	7.71	39.5	8.22	51.3	22.03	96.4	12.65	62.4

The mulch material used @ 5 tonnes/hect.

Source: Soil specialist and chief scientist,  
AICRP for DLA Sholapur,  
"A Brief Note On The Work Done At The Dry Farming Research, Sholapur".  
Mahatma Phule Krishi Vidyapeeth, Rahuri, March 1975, p.7.

**Table 7.15: Details of the adoption of the Mulching Technique**

Sr. No.	Broad category of opinions	Total number of farmers	As per cent of total
1.	Aware, adopted and found useful	2	3.51
2.	Aware but not adopted	21	36.84
3.	Not aware of such technique	34	59.65
	Total	57	100.00

cent (only 2) farmers adopted the technique and were impressed with the same. Some of the reasons for meagre adoption of this technique as reported by the sample farmers at the time of our investigation were:

- (a) Lack of mulch material for large scale mulching.
- (b) High labour cost (approximately Rs.100/ha) for spreading the mulch in the field and
- (c) Difficulties in carrying out interculturing operations, whenever necessary.

It is the general opinion of the sample farmers that the adoption of this practice is possible only on a small scale. Farmers particularly from dry regions cannot afford to adopt such a costly technique, especially when there is great shortage of fodder for the animal.

While discussing with the scientists about the

views expressed by the sample farmers about the adoption of this practice, they opined that like the other measures of moisture conservation the practice of mulching also proved much promising on the research station. Yield differences with and without mulching indicated that the practice is economical. They also explained that the fear of greater pest incidence on the mulched farms is also unfounded because anyway in dry regions like Sholapur the possibility of pest attack (particularly on rabi crops) is very negligible. With this justification the basic problem that has been reported by the sample farmers remains unsolved. The main difficulty is that the non-availability of mulch material from farm produce.

Even the experimental data depicted in Table 1 shows that the additional production of fodder is at the most 25 to 30 quintals per hectare while the requirement of mulch material, as recommended by the research station is 50 quintals (5 tonnes) per hectare. (While assessing feasibility of the mulching practice it is observed that the cost of mulch material @ Rs.10/Qt for the total requirement (i.e. 5 tonnes/ha) comes to Rs.500/-. If we add to this Rs.100 as the cost of labour for spreading, a total cost becomes Rs.600/- for mulching one hectare of land. As against this the additional jowar grain yield is about 4 Qtls (Rs.500/-) plus some 25 Qtls fodder (Rs.250/-). Therefore, there is a surplus value product of Rs.150, which

is just one quintal of jowar grain. This is a meagre advantage at the cost of all fodder. The cattle will have to go without fodder, the price of fodder would consequently rise and, therefore, this marginal net additional income will also disappear and might become negative). It may, thus, be seen that even the experimental farms could not grow the mulch material in adequate quantities. Availability of mulch material will remain a hurdle in wider adoption of this practice. The project scientists notwithstanding the other points they have raised in favour of this practice have nothing to say about this crucial problem of availability of mulch material. Moreover, farmers particularly from this dry region may justifiably prefer to keep the fodder for their cattle instead of using it as mulch material. No wonder, the farmers thought this to be a method useful for use in a small scale.

Thus, unless a solution for the problem of adequate availability of mulch material is found, the likelihood of this practice becoming popular among the farmers are very remote. This technique though advocated by the Research Station, therefore, cannot be expected to make any significant impact on the production from dry land agriculture.

## 6. Mid-Season Correction

The technique of mid-season correction involves substitution of short duration crops in the place of unhealthy standing crops and other necessary corrective measures to improve the situation. In the event of a complete failure of rains in kharif season or a late start of rains the light to medium deep soils (upto 45 cms of depth) are generally diverted for rabi jowar. This not only affects the production of kharif crops in the region, especially pulses and oilseeds but also results in poor production of rabi jowar due to the low moisture holding capacity of such light soils. Apart from this, conversion of kharif area into rabi area poses the difficulty to the cultivators of coping up with ploughing an increased area for rabi crop with the limited bullock power that he has. As a result of this the practice of adding the kharif area into rabi area is neither sound nor paying.<sup>1</sup>

The Dry Farming Research Station, Sholapur have suggested the schedule for alternate crops under different rainfall situation (Table 7.17). The experiments conducted at the Research Station indicated that if kharif rains are delayed even upto August or September, crops like bajra, cowpea, redgram can successfully be sown during the first

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1. ICAR "Crop Life Saving Research", op.cit. pp.56-57.



week of September. The performance of these crops, sown in the first week of September, is given in the Table 7.16. Though these crops performed well even when the sowing was done during the first week of September, the difficulty of the farmers undertaking sowing work on all kharif area as well as Rabi areas (due to the advocacy of early rabi sowing also) will remain. In this situation the only benefit will be that the light soil will be used for kharif crops only and as such the yield of rabi crop will not be affected adversely.

The data regarding the adoption of this practice by the sample farmers is presented in Table 7.18. From the Table it is clear that a majority of the farmers i.e., 46 out of 57, (81%) were totally unaware of such practice though most of them felt <sup>that they</sup> were in the need for such practice, particularly during the year 1972-73. As a result they have converted all the kharif land into rabi and obviously the yield was severely affected. Even after convincing them about the utility of this practice, at the time of our investigation, most of them firmly rejected this proposition on the grounds that it is against "tradition and also the nature". Of the remaining 11 farmers 10 had adopted this practice three years back and were convinced about the usefulness of this practice and only one whose field is adjacent to those of adopters was convinced about its utility but had not felt the need to

adopt it. As we have collected the data from sample farmers only for one year, i.e. 1976-77, it is not possible for us to measure the benefit that has been obtained through use of this practice by the above 10 adopters.

To sum up, it can be stated that there is a lot of scope to convince the farmers about the potential benefits of this practice either by actual demonstration on their farms or through extension agencies. In critical rainfall situation, which this dry land tract has to face on and often, a wider adoption, the implementation of this practice will be of great help.

**Table 7.16: Performance of rainy season crops during the early winter season of 1971.**

Sr. No.	Crops	Date of sowing	Life period	Average yield (Q/ha)	Maximum yield attained Q/ha
1.	Bajra	4 Sept.	85	5.30	-
2.	Cowpea	31 August	78	5.60	10.09
3.	Redgram	3 Sept.	154	4.89	5.61
4.	Green gram	4 Sept.	81	2.48	4.20
5.	Black gram	4 Sept.	82	3.88	5.21
6.	Sunflower	1 Sept.	101	9.00	10.33

Source: ICAR and IDRC,  
 "Crop Life Saving Research", (Seminar Proceedings)  
 Indian Council of Agricultural Research, New Delhi,  
 p.57.

**Table 7.17: Suggested schedule for alternate crops**

Sr. No.	Rainfall situation	Suggested cropping
1.	Normal rains	Hybrid bajra, Redgram, Green-gram, Black gram, Groundnut
2.	Failure of rains during June, but normal rains during July	Hybrid bajra, pulses, sunflower and groundnut
3.	No rains during June and July, but normal rains in August	Hybrid bajra, pulses and sunflower
4.	Failure of rains during kharif but rains in early September	Hybrid bajra, pulses and sunflower, rabi cotton
5.	Normal rabi season	Rabi jowar, cotton, gram and safflower
6.	No rains in September but good rains in mid-October	Jowar, Safflower and gram
7.	Late sowing in November	Safflower and gram
8.	Very late sowing in December	Safflower and gram

Source: Indian Council of Agriculture Research, "Crop Life Saving Research", (Seminar proceedings), I.C.A.R. and I.D.R.C., pp.56,57.

**Table 7.18: Adoption and opinion of the sample farmers regarding the practice of 'Mid-season correction'**

Sr. No.	Details	Total number of farmers	As per cent of total
1.	Adopted the practice and found it useful	10	17.55
2.	Aware of the practice but not adopted	1	1.75
3.	Not aware of such practice	46	80.70
<b>Total</b>		<b>57</b>	<b>100.00</b>

CHAPTER VIIICONCLUSIONS

Indian agriculture, which although depends largely on monsoon rains, is not uniformly affected by the monsoons. There are regions of high and medium rainfall which enable the farmers to achieve better crop yield with a comparatively greater stability from year to year. On the other hand, the low rainfall regions are characterized by both low seasonal precipitation and greater uncertainty. This affects agriculture in <sup>a</sup> more serious way. The low rainfall regions (receiving less than 750 mm of rainfall per annum) in India constitute 34 per cent of the net sown area of the country and account for 11 per cent of the population. Maharashtra is one of the states comprising major dry regions; 34 per cent of its total area comes in this category.

Considering the limitations of the Green Revolution technology (which is heavily dependent on assured, adequate moisture in the soil) and the limited irrigation potentiality in the dry agricultural regions, it was realized that the agricultural development in the dry regions has to have somewhat different strategy which is not dependent upon irrigation.

The agricultural development of dry farming areas require a two pronged strategy to counteract the twin

problems of very low and uncertain rainfall. The strategy consists of:

- A. Integrated programme of soil conservation, land development and water harvesting measures which will be helpful in reclaiming the uncultivated/eroded land for cultivation and also will help in recharging the watertable of the adjacent wells.
- B. Adoption of crops and cropping schemes suitable to the types of soil, and re-orientation of methods of cultivation, so as to conserve the moisture in the cultivated land leading to increased production per acre under unirrigated conditions.

The techniques relating to the first strategy, namely, soil conservation, land development and water harvesting, developed and extended in the area under study are contour bunding and terracing, nala training, nala checking, drainage and farm ponds. Of these, contour bunding and terracing affects practically all fields in the dry farming region. But this work had already been completed on all fields in almost the whole of the dry farming region of the State. Therefore it was not possible to study its impact on agricultural production in the villages under investigation. The other measures, by their very nature, can affect only specific agricultural

lands, depending on their location and topography.

Unlike the land improvement measures, improved agronomical practices to achieve increased production per acre under irrigated conditions can be expected to affect almost the entire area under dryland farming. These include new crops, crop rotations and cropping practices. The Research Station has suggested such crops and cropping practices and the extension agencies have begun extending these to the selected farming areas. Naturally, the specific measures for all types of dry agricultural regions cannot be the same, but will vary depending on terrain, soil and rainfall and other climatic conditions. The specific measures developed and advocated by the research and extension agencies at Mandrup in Solapur district of Maharashtra <sup>are</sup> ~~is~~ meant to be applicable to the famine and scarcity - liable tracts in Western Maharashtra as also parts of North Karnataka where similar conditions prevail. The present study examines the economic results of the measures extended to farmers and tried out by them on their fields in the neighbourhood of the research station at Mandrup. These findings should be relevant in judging the feasibility and worthwhileness of the methods advocated, and thereby give us some idea of the potentiality of development of dry land agriculture on the basis of techniques developed by the middle of the 1970's in this region.



A systematic examination of the land development and soil conservation measures adopted shows that most of them have been worthwhile. Nala training, nala checking and drainage have prevented soil erosion from affected lands and led to restoration of most of the affected land to cultivation.

Nearly 16.9% of the total cultivated land in the three villages studied, lay on either side of the nala (stream) passing through these villages. Our sample study suggests that over 15% of this land, had gone out of cultivation due to the erosion by this untrained nala. Nala training restored 96 per cent of this eroded land to cultivation, which comes to 2.5 per cent of the total cultivated land in the villages. Similar efforts in other villages can be expected to bring similar results, depending of course on the area affected by the nala or nalas passing through them.

The results of nala checking were of <sup>a</sup> similar dimension. We had made a complete survey of all land affected by nala checking measure. The land restored to cultivation as a result of this measure therefore came to about 0.75 per cent of the total area occupied for cultivation in the village. It is fair to assume that the results may be comparable in other villages, if the measure is adopted there.

As for drainage, we found 22 per cent of the land

in the affected plots from which we had drawn our sample was restored to cultivation. Since all fields affected by water logging had been taken up for drainage works by the time of our survey we may say that about 1.27 per cent of the total cultivated area in the villages was restored to cultivation as a result of the drainage.

The three together add upto 4.52 per cent of the total cultivated area of the surveyed villages. Though naturally not large, this is a significant contribution of these land development measures. Indeed it is necessary to remind ourselves of the extent of land under current fallow and culturable waste as a proportion of the total area occupied for cultivation in these dry farming regions, in order to assess the contribution of such land development measures on this phenomenon. In Sholapur district, the percentage of land under current fallow was 6.26% per cent and under culturable waste was 2.95% per cent of the total culturable area (net cropped area + current fallow + culturable waste) during 1975-76. If the type of land development measures carried out in our 3 sample villages is carried out extensively in the entire district, one will be reasonable in assuming that about 4 to 5 per cent of the total land or about 4612.50 acres of the culturable waste land can be restored to cultivation (assuming of course that the land gone out of cultivation due to sales and water logging is classified under

culturable waste).

Besides restoring damaged lands to cultivation, the nala training and nala checking measures were also responsible for recharging a number of wells in the village with rain water through greater seepage. This resulted in expansion of area irrigated by the wells. The net irrigated area under wells/farm-ponds increased by 390 per cent. Of course area irrigated by wells in the three surveyed villages constituted a small proportion (about 0.14 per cent) of the total cultivated area. Nevertheless, a 390 per cent increase in this area was another worthwhile result of the land development and water harvesting measures.

The estimation of the social benefit-cost of these investments carried out in the study show that while this was not very high, socially speaking the benefits were more or less commensurate with the costs and the investments in this sense were justified. It is however, questionable if the beneficiaries can pay the entire cost from the returns accruing to them; they may be in a position to pay only a part of the cost.

The only water harvesting measure tried out, which proved a failure by and large, was the scheme of constructing farm ponds to impound rain water. Whatever its possible success in other parts of the dry farming regions of India, it is quite clear that it is not a

worthwhile proposition in the Sholepur-type regions. We find the studies at ICRISAT also supporting this conclusion.

The other set of techniques advocated for the region related to adoption of new varieties of crops and agronomic practices. The detailed examination of the performance of the new varieties of crops show that both in terms of improvements in yield rate and economic returns, only two kharif crops; hybrid bajra and a new variety of groundnut proved successful, leading to a wide acceptance by farmers, subject ofcourse to availability of seed. The new HYV wheat was found economically successful only in irrigated lands, but irrigated lands are of very limited significance in this dry farming region.

No newer variety of Jowar than Malgandi (GHS-1) which farmers have been growing in these parts for the last 4-5 decades in the Rabi season, has been successfully developed or advocated. This dry region, characterised by uncertain kharif rains, particularly in the first half of the season, is a predominantly Rabi Jowar tract and there is as yet no possibility of any significant improvement in its yield rate through development of better varieties suitable under unirrigated condition.

The other new crops advocated by the extension agencies, like sunflower, castor, etc., had not yet been tried out by farmers in the village in any significant

measure to provide us with an empirical basis for judgement about their suitability.

Nor is it possible in these regions from lands normally put under Rabi Jowar, to be switched over to Kherif hybrid bajra or new groundnut, because of non-suitability of the soil of these lands for the Kherif crop, as we have examined in the study.

Thus the improvement in the crop yield through adoption of new crops can effect only about 15 per cent of the total cropped area in the surveyed region, since that is the area under bajra and groundnut. While this is useful, it is not very significant considering the dimension of the problem.

The other agronomical practices examined in detail were either of no relevance at the large scale or held out very small though positive benefits.

It is obvious that the package of technological practice advocated for improvement of dry farming is likely to result in recovery of 4 to 5 per cent land for cultivation and at most a 25 per cent increase in income from dry land farming. These are no doubt definite and positive benefits. But they are very small compared to the possibilities, as well as actual achievements under "green revolution" technology in irrigated areas. These small benefits, accruing over a period of years, will be swamped by the consequences of the steadily growing

pressure of population on land in these areas. The possibility of developing significantly higher yielding varieties of crops for these regions appears doubtful, in view of the inadequate moisture supply in the soils over crucial stages of plant growth in most parts of the year. Under these circumstances, the prospects of new dry farming technology making a significant contribution to increasing production and income of farmers in these regions appears poor.

The future, therefore, would depend on extending irrigation facilities to this region, wherever feasible, and alternative employment opportunities for the growing body of farmers and farm labourers. These are serious problems for planners to tackle.

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