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COSTS AND RETURNS OF CONVERTING DRY LANDS INTO IRRIGATED AREAS

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SUMMARY

Conversion of dry land into wet land is made possible by irrigation under canals, tanks, tube-wells and wells. This paper confines itself to canal irrigation only. At macro level the problem consists of tangible costs like expenditure incurred on the construction of dam, digging canals and distributaries, maintenance staff for extension work and research, and provision of loans for developing ayacut. The primary direct benefits consist of increased area under irrigation and increased revenue to the State exchequer. It has primary indirect benefits also in the form of higher land values, greater capital formation covering increased investment on farm and other assets; better wages paid to human and bullock labour; and greater consumption of agricultural inputs. At the micro level the costs and yields of cultivating irrigated and unirrigated holdings reflect the expenditure involved in converting dry land into irrigated area. Facts available about flow irrigation through canals, however, point to the difficulties faced by the authorities in terms of organization, extension and research for developing ayacut. The story of all irrigation projects is essentially a human problem where the local cultivator has to change from his traditional dry cultivation to the cultivation of crops under irrigated conditions. The problem is extremely difficult and delicate for him to adjust to conditions of providing light irrigation judiciously to dry crops. If the Department of Agriculture does not provide a suitable pest-resistant variety that responds admirably to light irrigation, the struggle of the cultivator increases. Experience in Hirakud and elsewhere had shown that the ryot who adopted irrigation of dry crops had run into losses which he could compensate only by raising perennial or wet crops. Thus except for area on which irrigated dry crops had to be raised, the ayacut under wet and perennial crops developed substantially since, despite their higher costs of cultivation, wet crops, sugarcane and cash crops provided very high profits to the ryot.

DIVERSIFICATION OF CROPPING TO REDUCE INSTABILITY IN DRY FARMING AREAS OF MAHARASHTRA

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SUMMARY

About 92 per cent of the cropped area in the State is dependent on rainfall. Instability in weather conditions from year to year gives rise to instability in crop output, which in turn affects the prices and finally the income of farmers. Crop diversification as a measure of security against unfavourable weather conditions is an age-old agronomic practice. Diversification apart from reducing instability of crop output permits better utilization of resources, maintenance of soil fertility and aids in controlling weeds. The idea underlying crop diversification is 'if one crop suffers other will be better.'

Diversification model described below has been employed to determine the pattern of resource allocation between two different crops. The efficacy of diversification depends on the associations between two crops. Hence correlation coefficients of yields, prices and gross income for the principal crops grown in the State have been determined. Diversification model employed to determine the coefficient of variation (CV) is :

$$CV = \sqrt{\frac{q^2V_A + (1-q)^2 V_B + 2rq\,(1-q)\,S_A S_B}{[qI_A + (1-q)\,I_B.]^2}}$$

Where

CV = Coefficient of variation due to combination of two crops A and B.
q = Resources allocated to crop A.
l—q = Resources allocated to crop B.
V_A = Variance of crop A.
V_B = Variance of crop B.
r = Correlation coefficient of gross income between crop A and crop B.
S_A = Standard deviation of crop A.
S_B = Standard deviation of crop B.
I_A = Gross income from crop A.
I_B = Gross income from crop B.

In the ultimate analysis it was observed that the combination of cotton and jowar in the proportion of (0·2) : (0·8) gives maximum stability which is achieved by sacrificing higher income. The combination of cotton and groundnut in the proportion of (0·7) : (0·3) assures maximum stability of income. The two crops being complementary, income also increases. More allocation of resources to groundnut increases income but also instability. A similar phenomenon is also observed in the case of cotton-wheat combination when resources are allocated in the proportion of (0·6): (0·4). A detailed analysis has been undertaken in respect of all the important crop combinations grown in the State.

Obviously there are limitations in the application of this result. The State is comprised of large number of districts each with different climatic conditions and different pattern of crop yields. Therefore it is necessary to conduct similar studies based on district level information. The evolution of high-yielding varieties will also change the inter-crop relationship.

DEVELOPMENT OF ARID AGRICULTURE — NEED FOR A NEW APPROACH

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SUMMARY

Mainly owing to its peculiar agro-climatic conditions, the development problems of agriculture in the arid zone of Rajasthan are vastly different from the problems of other dry areas in the country. In the absence of any development programmes specifically evolved for arid agriculture and non-applicability of programmes evolved for well-watered areas, extension of plough on sub-marginal lands (which constitute nearly 79 per cent of the total lands and are suitable only for pasture development), has been the main plank of development strategy of the government in the arid region. This process of transfer of lands from extensive type of use (*e.g.*, grazing, etc.) to intensive type of use (*e.g.*, ploughing) has been accentuated during the plan era.

But this approach to agricultural development has proved self-defeating. By violating the natural principles of land use (*i.e.*, using the land beyond their use capability), the delicate ecological equilibrium of nature has been disturbed. This phenomenon, in terms of economics, has given rise to the operation of secular law of diminishing returns as indicated by (*i*) declining trend in crop yields accompanying the increasing trend of acreage under the crops, and (*ii*) reduced physical availability of usable land, vegetation and water resources in the region, as shown by various micro-level investigations.

This calls for a new approach to development of arid agriculture which can ensure higher farm production on a sustained basis without depleting the resource base. The conservation technology as incorporated in different conservation measures experimented by the Central Arid Zone Research Institute and adopted by some farmers too, offers a solution to the problem. If the limited evidence is considered as any indicator of the effectiveness of conservation measures, there is a clear case for making the same as king-pin of development strategy of arid agriculture.

The measures suggested tend to further strengthen the foundation of livestock enterprises, in which the region has comparative advantage vis-a-vis other regions. This will not only pave the path for regional specialization in livestock farming along with restricted crop cultivation but will improve the competitive position of arid region in the inter-regional investment priorities.

COST-BENEFIT STUDIES OF LIFT IRRIGATION UNDER DRY FARMING SITUATION IN ORISSA

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SUMMARY

Though the State of Orissa has been receiving an average annual rainfall of 1302 mms., drought and scarcity conditions are quite frequent due to its uncertain and uneven distribution. Its rigour is pronounced on uplands being located at a higher elevation. Greater degree of slope of this upland results in higher surface run off and washing away of fine particles of soils. The resulting lighter soil allows for greater percolation rate and considerable reduction in the water holding capacity. The State has 42 per cent of cultivated area under this type of land. Thus the area under dry farming constitutes a sizable proportion of the total land resources of the State. A lift irrigation scheme was initiated in the year 1963 in the State to provide assured water resource to the uplands. The objectives of this study were (1) to estimate the cost of converting dry areas into irrigated areas, and (2) to estimate the income benefits derived through the project. Three centres were selected for the purpose of this study. The total annual cost varied from Rs. 1,862 to Rs. 4,877 depending upon the nature of installation, horse power of the engines, the working hours and the area irrigated in different centres. The cost of irrigation was observed to be varying from Rs. 384 to Rs. 473 per hectare in the present situation. However, it was estimated that about 30 per cent to 50 per cent reduction in its cost could be attained with fuller utilization of pumps by bringing larger area under the projects. With respect to the benefits derived from the projects it has been observed that the intensity of cropping was raised from approximately 140 to 278 per cent with greater percentage of labour and capital intensive crops. The gross margin or, in other words, the return over variable costs was significantly higher (nearly six times) on lands provided with irrigation facilities.

NATURE OF INSTABILITY AND RESOURCE PRODUCTIVITY IN DRY LAND AGRICULTURE

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SUMMARY

The study pertains to the Indore district of Madhya Pradesh. Out of the total number of 180 months during the period of 1953-54 to 1967-68, 24 months were abnormal months. Nearly 83 per cent of the abnormal months were found between October to May. About 47 per cent of the total number of months were drought months. The drought concentrated generally in the month of October. There is wide fluctuation in the yield of principal crops leading to a high degree of instability to the economy of the region. The variations in physical yields and in farm harvest prices lead to fluctuations in gross returns to the farm from principal crops.

The values of R^2 for dry and partially irrigated farms indicate that the included variables explain between 66 per cent and 54 per cent of the variations in the logarithm of the gross value of crop output. The coefficients of land and labour are positive and are significant at 1 per cent level in both the equations. The coefficient for manures and fertilizers is positive but not significant. The elasticity of bullock labour has been found to be negative in both the equations. Regression coefficients in respect of various input factors indicate that land and human labour are the important inputs to which output is highly responsive. The sum of the elasticities is 1·8642 for dry farms while the corresponding figure for partially irrigated farms stand at 1·9681 showing thereby increasing returns to scale. The marginal value product of land is the highest on small farms and tends to decrease with an increase in the farm size. The marginal value product of human labour on dry and partial irrigated farms on an average tends to be higher than the prevailing wage rates in the selected area. The marginal value product of human labour on partially irrigated farms is more than double that of the dry farms. The marginal value product of bullock labour, on an average, is negative on the two groups of farms. The marginal value products of other inputs are positive in both the cases.

AN APPROACH TO OPTIMUM CROP COMBINATIONS FOR DRY LAND FARMS OF BANDA DISTRICT, U.P.

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SUMMARY

The present study was undertaken in Baberu block with the following objectives : (1) to examine the existing cropping pattern and crop combinations and to work out costs and returns in different size-groups; (2) to find out the economics of major crop rotations and crop combinations; and (3) to suggest profitable crop rotations and more remunerative crop combinations. In district Banda, one block, namely, Baberu was selected purposively having the lowest area under irrigation and having precarious monsoon and following water conservation practices. A sample of 100 cultivators was selected randomly from 10 villages, grouped under 0-2, 2-4, 4-6, 6-8 and 8 and above hectares size-groups of holdings. Survey method was used in the collection of data.

The average size of holding in the study area came to 5·29 hectares and the percentage area under irrigation averaged to 8·61 which showed a declining trend with the increase in farm size. The area under irrigation ranged between 10·51 to 7·13 per cent in the lowest and largest size-groups respectively.

The cropping pattern of the tract revealed that maximum area is devoted to the cultivation of jowar + arhar + *urid* followed by wheat + gram, barley + gram, wheat, bajra + arhar + *urid* and gram as these crops and crop combinations occupied, on an average, 23·41, 19·40, 17·00, 15·32, 9·41 and 8·40 per cent of the total cropped area. The rest of the crops of the tract, *viz.*, linseed, lentil, mustard and others covered only 7·06 per cent of the total cropped area. The percentage area under jowar + *arhar* + *urid*, bajra + *arhar* + *urid*, linseed, lentil and mustard decreased with the increase in farm size while the percentage area under wheat + gram, barley + gram, wheat and gram increased with the increase in the size of holding.

A marked feature of the study is that mixed crops covered more than half of the cropped area, *i.e.*, 69·22 per cent which is an indication of the consciousness of the farmers against risks and uncertainty of monsoon. Mostly, traditional varieties of the above crops are sown in the tract.

The investment in fixed capital decreased with the increase in the farm size as average investment in fixed capital under 0-2 hectare size-group was Rs. 4,107·48 while it came to Rs. 3,685·69 per hectare in the largest size-group and averaged to Rs. 3,822·79 per hectare.

The intensity of cropping decreased with the increase in the farm size and ranged between 110·87 to 100·05 per cent, the average being 103·57 per cent. The per hectare figures of input, output and net income were Rs. 481·92, Rs. 920·46 and Rs. 438·54 in the lowest size-group while in the case of largest size-group the corresponding figures were Rs. 429·75, Rs. 786·44 and Rs. 356·69. Thus, input, output and net income also decreased with the increase in the farm size.

As far as the economics of major crop rotations is concerned, fallow—bajra + *arhar* + *urid* was found most profitable, hence maximum area should be diverted to this rotation followed by fallow—

jowar + *arhar* + *urid*, fallow—wheat, fallow—wheat + gram, and fallow—gram as net returns from the respective crop rotations came to Rs. 496·52, Rs. 464·38, Rs. 401·37, Rs. 382·55 and Rs. 373·48, respectively. In other dry tracts, fallow—gram is observed to be more profitable than fallow—wheat, but in the Baberu block due to water conservation practices conducted by the Soil Conservation Department (under the Dry Farming Scheme) and follow-up by farmers, fallow—wheat crop rotation is found to be more remunerative than fallow—gram as the latter yields less in water conserved soils.

Thus, it can be suggested that in addition to improved varieties of crops and application of recommended doses of fertilizers with recommended practices, crop rotations should be followed in the following order: fallow—bajra + *arhar* + *urid* (60 kg. N, 30 kg. P, 30 kg. K), fallow—jowar + *arhar* + *urid* (50 kg.N, 25 kg.P, 25 kg.K), fallow—wheat (80 kg.N, 40 kg.P, 40 kg.K), fallow—wheat + gram (50 kg.N, 25 kg.P, 25 kg.K), fallow—gram (25 kg.N, 50 kg.P, 25 kg.K) and fallow—barley + gram (40 kg.N, 20 kg.P, 20 kg.K). The recommended varieties of different crops are bajra H.B. 1, H. B. 4, *arhar* T·21, AS·5 and AS. 8, wheat Kalyan H.D. 1467, H.I. 6—23 and A. 7-30, gram T.87, *urid* T.9 and barley RS 6 and HP. 13. The fertilizer mixture should be placed 5—8 cm. deep in furrows at the sowing time and 5 per cent B.H.C. at 20 kg. per hectare should be mixed in the soil before sowing as a precautionary measure against the serious problem posed by termites in the dry land.

The net income has increased by 74·07 per cent in bajra + *arhar* + *urid*, 55 per cent in jowar + *arhar* + *urid*, 62·16 per cent in fallow—wheat, 57·79 per cent in fallow—wheat + gram, 48·87 per cent in fallow—gram and 65·84 per cent in fallow—barley + gram. It is, thus clear that by introducing improved and high-yielding crop varieties, manure and fertilizer along with the adoption of improved cultural practices involving soil-water conservation, some benefits of modern technology can be reaped towards profit maximization.

FARM SIZE AND ITS RELATION TO VOLUME OF CAPITAL INVESTMENT, OPERATING COSTS AND RETURNS ON DRY LAND FARMS OF SHOLAPUR DISTRICT OF MAHARASHTRA

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SUMMARY

This paper attempts to study the volume of capital investment, farm expenditure, farm income and income from subsidiary occupations and the input-output relationships based on data collected from a sample of 55 holdings having no irrigation facilities, selected from 11 villages in Malshiras tehsil of Sholapur district of Maharashtra according to stratified random sampling method. The selected holdings were grouped under small (below 14 acres), medium (14-30 acres) and large (above 30 acres), numbering 22, 20, and 13 holdings respectively. The data collected by survey method refer to the period April 1, 1963 to March 31, 1964.

In regard to capital investment a closer association was noticed between maintenance of draft animals and milch animals and the size of holdings. The average number of draft animals possessed by farmers under each of the size-groups were 1·14 animals in small size, 1·45 in medium size and 1·85 animals in large size holdings. The trend of capital investment in the form of land, farm buildings, livestock, implements for different sizes of farms showed that the average value of different items of capital investment per farm increased with the size of holding. Per acre investment on different items of capital such as land, farm buildings, livestock and implements decreased with the size of the farms.

The trend in expenditure on the dry farms showed that on an average 52·23 per cent to 58·70 per cent of the cost was on items like seeds, manures, feeds and land taxes. Cost on hired labour was highest (33·01 per cent) in the case of large sized holdings.

High correlation was observed between the farm size and the value of the crop production on small sized dry farms, while low correlation was observed in the case of the other two size-groups of dry farms. This indicated that increasing returns to scale exist on small holdings and there exists a scope for increasing the size of such holdings till they achieve optimum returns whereas on large sized holdings diminishing returns to scale exist indicating the necessity of reduction in the present size of holding to achieve the optimum stage of production in the present conditions.

Out of the total income from the farm business of different sized dry farms, income from crop production was highest (62·94 per cent) on large sized farms, and lowest (46·60 per cent) on small sized farms, while income from subsidiary occupation was highest (53·40 per cent) on small sized dry farms and lowest (37·06 per cent) on large sized dry farms.

From the study of output-input ratio, the notable conclusion that emerged was the low ratio of output to input. The average ratio varied from 0·6792 on large sized farms to 0·8234 on small sized dry farms. It was obvious that the farmers of the dry tract work on a very low margin of profits. This indicated the need for adoption of all possible measures to improve the output-input ratio. It was further observed that the output-input ratio increased a little after the inclusion of the income from subsidiary occupations in the crop production income. The situation explained the need for developing and combining in proper proportion, occupational activities such as poultry keeping, sheep and cattle breeding, dairying and off-farm services, etc., so as to help improving and balancing the economy on dry farms. The study revealed that it is necessary to convert dry farms into economic units. They may either be encouraged to sink wells or to combine such units with suitable subsidiary enterprises mentioned in the study.

IMPACT OF IRRIGATION AND TECHNOLOGICAL CHANGES ON INCOME LEVELS OF FARMS IN JABALPUR DISTRICT OF MADHYA PRADESH

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SUMMARY

This paper seeks to assess the economics of traditional agriculture under existing resources and to explore the possibilities of improving farm incomes in traditional agriculture through irrigation and technological changes. For the purpose of study, a sample of 172 farms was randomly selected from the villages falling within the vicinity of Jabalpur town. This sample was sub-divided into traditional and advanced technology, *i.e.*, farms which were not using fertilizer and other improved farm practices and those which were using fertilizers and other advanced farming practices respectively. The sample farms were grouped into four categories based on the availability of irrigation and level of technology, namely, (*i*) unirrigated traditional farms with less than 25 per cent of the land receiving fertilizer, (*ii*) irrigated traditional farms, (*iii*) unirrigated advanced farms with at least 25 per cent of the area receiving fertilizer, and (*iv*) irrigated advanced farms. The number of farms in these categories was 69, 27, 21 and 55 respectively. The data pertained to the year 1967-68. The synthetic model farm for each category of farms was developed and programmed for optimal solutions, Irrigation has proved to be a crucial factor in raising the farm productivity which is evident from the marginal value product of irrigation on traditional and advanced farms. The programming results have shown that the marginal returns from irrigation on the advanced farms are 76 per cent higher than on the traditional farms. On the basis of average returns, both traditional and advanced farms under irrigated conditions had per acre income with irrigation which was 150 per cent higher than that on the unirrigated farms. The irrigated farms using advanced technology showed a net income of Rs. 1,130 per acre against Rs. 249 per acre of unirrigated traditional farms. Considering the mode of irrigation, a nine per cent return from irrigation with an oil pump was found which is not attractive enough to cause rapid expansion of irrigation. If electricity were made available to the farms, electric pumps would be more attractive with a 22 per cent rate of return. The present allocation of resources was found to be very close to optimality as the income gains due to programming were from 10 to 12 per cent more on traditional farms and from 13 to 22 per cent more on advanced farms. Introduction of technology on traditional farms resulted in an increase of income ranging from 32 to 48 per cent on unirrigated and irrigated farms of the traditional category respectively. The expansion of cash inputs showed tremendous increase in farm income of all categories. For example, the increase in income due to expanded cash expenses in the four categories was 134, 103, 59, 33 per cent respectively. Thus the traditional farms in Jabalpur district have very high potential for raising income through introducing more new inputs like irrigation and technology and allowing greater use of operating capital.

ECONOMICS OF WATER RESOURCES AND PUMPING UNITS FOR IRRIGATION

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SUMMARY

For irrigation of crops water is obtained either from canals or is lifted from open wells, tube-wells and perennial streams. In most of the cases, however, farmers prefer to develop their own sources of water and install lifting devices. It thus becomes important for a farmer to know the unit cost of source and unit cost of pumping so that he can make a decision as to what type of source of water supply and pumping unit will be economical to him. In Tarai of district Nainital in general and U.P. Agricultural University in particular, there has been increased emphasis on irrigation in past few years. A large number of different kind of wells, open wells, shallow tube-wells, medium and deep artisan wells have been constructed and different types of pumping units have been installed, which have made available information regarding development and utilization of water resources in the regions.

The analysis of the economics of the water resources and pumping unit was done according to the existing procedures and compact algebraic expressions to the variable parameters were obtained. The hourly costs of water sources and pumping units and for different combination of the sources and pumping units were analysed.

Among the artificially constructed sources, consisting of wells tapping first aquifer, cost of shallow tube-well 50 to 70 feet deep was found to be lowest equal to Re. 0·25 per hour. The cost of collar well and perforated pipe well 25 to 30 feet deep was found to be Re. 0·30 per hour. This is slightly higher than the unit cost of shallow tube-well. The cost of masonary well 25 to 30 feet deep was found to be Re. 0·60 per hour, which is highest among all the wells. The collar and perforated pipe wells however have not been found successful in areas predominant with fine aquifer material because of the frequent heaving of the sand from bottom or entry from the sides.

The cost of tube-wells 300 ft., 500 ft. and 700 ft. deep was Re. 0·87, Rs. 1·63 and Rs. 2·47 per hour respectively. Generally these wells are advantageous because they yield free flowing water, a common phenomenon in Tarai conditions which may not be applicable to other places. The cost of pumping of water per hour with 5 H.P. electric and diesel pumping set was Rs. 1·79 and Rs. 2·44 respectively. The diesel pumping set is 36 per cent costlier than the electric pumping set. In 10 H.P. range the cost of pumping with electric pumping set was Rs. 2·27 and diesel pumping set was Rs. 2·80, about 23 per cent costlier than the electric pumping set.

The total cost of water including the cost of pumping of water and the cost of the source from the shallow tube-well with 5 to 10 H.P. electric pumping set was found to be the lowest as compared to other combinations of pumping units and sources tapping first aquifer. The cost of pumping of water from 300 ft., 500 ft. and 700 ft. deep tube-wells was Rs. 2·79, Rs. 3·24 and Rs. 4 respectively. The total cost of water including the cost of pumping per unit volume (10,000 gallons) per 500 ft. and 700 ft. deep tube-wells was Re. 0·72 and for 300 ft. deep tube-wells was Re. 0·82, which is about 10 per cent costlier than the cost of unit volume of water from 500 to 700 ft. deep tube-wells. The cost of pumping of water from river with a tractor depends upon the size of pump and the number of pumps operated by the tractor and the H.P. of the tractor used for pumping.

On an overall basis, the tube-wells of 300 ft. deep or more are economical than shallow tube-wells, though the cost of the source per unit volume of water is higher and the initial investment is also heavy in comparison to shallow tube-wells. Pumping from the first aquifer is important in keeping a balance of groundwater table, where there are chances of rise of groundwater table. The shallow tube-wells do not involve heavy investment and can be constructed by local know-how and are economical. Next to shallow tube-wells are 300 ft. deep tube-wells which an average farmer can afford. The deep tube-wells of 500 to 700 ft. deep require an investment, that can be afforded by larger farmers only. Whenever feasible large farmers or co-operative societies should be encouraged to get such wells constructed for balanced tapping of all the aquifers. Whenever

free flowing stream water is available it would be most economical to pump from the stream for irrigation. Attempts should be made to avoid the use of tractor power or diesel engine for pumping water for irrigation. The use of tractor power is not only uneconomical but it may also dislocate other farming operations. In any case if tractor power is to be utilized then more than one pump may be used depending upon the H.P. of the tractor so that as much of the power as practicable may be utilized.

VIABILITY OF AVAILABLE DRY FARMING TECHNOLOGY AND SOME FINANCIAL ASPECTS OF ITS ADOPTION IN SELECTED VILLAGES IN MYSORE STATE

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SUMMARY

This paper is based on the study of the sample of 120 farmers from six predominantly dry farm villages of Bellary district in Mysore State. The paper aims at (*i*) identifying the known dry farming technology and studying its viability and (*ii*) measuring the level of adoption of the technology, its components and the magnitude of finance for its wider adoption. The analysis centres around the hyphothesis that there is a viable dry farm technology relevant to the tract, but that it has not been fully adopted by the farmers and that the more important of the probable economic reasons for it is the lack of institutional arrangement for meeting the farmers' credit requirements.

The officially recommended package of available dry farm technology for the tract includes the use of improved and hybrid varieties of seeds, chemical fertilizers and plant protection measures, improved implements and the adoption of soil conservation measures especially contour bunding. With a view to determining the level of adoption of the available technology, an index of progressiveness was prepared taking into account the use of hybrid and improved seeds and fertilizers as basic criteria. Based on the score obtained according to the use of these inputs, the farmers were divided into three different levels of adoption, the average score of the I, II and III levels of adopters being 6, 22 and 40 respectively, giving an overall score of 22 points.

The detailed analysis of adoption of various components of technology highlighted two important facts, *viz.*, (*i*) looking to the number of farmers, the various components of available technology have been found acceptable among a cross-section of them, irrespective of their land holdings, (*ii*) nonetheless, the level of adoption is very low and unevenly distributed among them.

Examined from different aspects of viability, it was found that the available technology meets the viability criteria of simplicity, acceptability, feasibility in terms of input availability and profitability. The net returns per acre (after making allowance for family labour at the going wage rate and before allowing for interest on investment and depreciation on farm assets, are positively correlated with the levels of adoption, the respective returns being Rs. 26, Rs. 73 and Rs. 87 per acre, for the three different levels of adopters.

The overall low adoption of available technology tends it desirable to enable the low adopters to attain the level of high adopters. The financial implications of raising these levels have been worked out with the assumption that, given the components of technology, the level of expenditure incurred both on investment and on working expenses is a fair enough indication of the level of technology attained. On this assumption, it is found that, for raising the farmers from the lowest level to the highest level of adoption, it requires an average of Rs. 721, Rs. 395 of medium-term finance and Rs. 326 for current expenses. The corresponding figures for raising level II to level III are Rs. 435, Rs. 223 and

Rs. 212 respectively. As against this, the net family incomes (both farm and non-farm) for I and II level adopters are Rs. 111 and Rs. 668 per annum. The average additional financial requirement per farmer for attaining the complete adoption of available technology amounts to Rs. 3,421, composed of Rs. 2,082 for the purpose of investment of a medium nature and Rs. 1,339 for operational expenses. Looking to the unimpressive performance of institutional credit agencies, this further reinforces the need for strengthening the institutional credit structure aimed at bringing about technological break-through in this depressed sector of Indian agriculture.

MAXIMIZING RETURNS FROM DRY FARMING IN HARYANA STATE

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SUMMARY

Technological changes in agriculture has so far been confined to selected regions with favourable agro-climatic conditions and assured sources of irrigation. Hence dry farming regions have been excluded from the purview of the new technology. Although the problem of increasing output from these areas is difficult, the challenge can be met with the application of modern science and technology. In this study an attempt has been made to examine the existing dry farming practices on cultivators' farms and the improved technology as has been developed and used on the Haryana Agricultural University farm. The present study is confined to the Hissar district of the Haryana State.

The important crops grown in this area are bajra, *guara* and jowar in the *kharif* season and gram and barley during the *rabi* season. On the experimental farm, however, a large assortment of crops, such as *arhar*, bajra, cowpea, *guara*, groundnut and *moong* were successfully grown during the *kharif* season.

Net returns from the existing as well as from the suggested plan with improved technology were worked out for small, medium and large farms. The suggested plan showed an increase in income by 221, 148 and 194 per cent respectively, on small, medium and large farms. Similarly human and bullock labour utilization also increased with the adoption of improved technology. The study showed that with proper management of crops and rotations, the employment and net returns from dry farming could be increased several fold. But the success of new technology calls for an effective extension service, and suitable institutions to provide credit for meeting the increased capital requirements. Similarly the establishment of farm service units to perform timely operations and price stabilization programme through price supports or input subsidies (preferably the latter) are necessary pre-conditions for maximization of production and returns from dry farming.

STUDY OF THE ECONOMICS OF DRY FARMING AREAS IN ANDHRA PRADESH THROUGH RAINFALL SIMULATION

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SUMMARY

The history of other dry farming regions shows that the only definite ways to develop such areas are mainly through irrigation, extensive cultivation and animal husbandry. For Anantapur district in Andhra Pradesh having poor underground and surface water resources and a relatively high demographic pressure, yet another solution has to be sought for. The main limiting factor besides unpredictable rainfall, is the traditional attitude consisting of yearly trials and errors, to avoid the worst with existing rainfall. A rational approach will try to describe the probable future situations and consequences of the State's and farmers' choices, according to the rainfall though unpredictable but known through previous data. For the above reasons, the development of such a tract will only be obtained through the co-ordination and conjunction of all the State's efforts and no such planning can be made without submitting the possible actions to this terrible judge: rainfall.

Two ways are opened for this study : (*i*) use of previous data to work out the correlation between rainfall and yields, and apply it to main types of rainy years to see what will be the best strategy at micro and macro level for each type; (*ii*) begin now a fundamental research on the basic relation between daily rainfall and plant production (through the soil water stock) relying on research stations' study and on multi-located trials—so that after some 4 to 5 years it is possible to build up a regional rainfall simulation model being a very powerful tool to test every possible intervention.

The first approach is immediately possible but it will very soon reach its own limits as homogeneous data will not be available. The correlation may clearly be biased by uncontrolled factors ("external" perception of the phenomenon). Worst of all, the analysis cannot possibly distinguish more than 4 to 8 types of rainy years, which will not obviously be of great use in this region where rainfall vary from 100 to 900 mm. and where the same yearly total rainfall hides so many determinant differences.

The aim of this paper is to show that building up of this "Regional Rainfall Simulation" is possible and what information it can bring to the men in charge of this dry area's development. A list of the possible uses is attempted along with the explanation of the working of the model, and a list of the actions and the means to be worked up to be in a position to build up this model as soon as possible. The paper gives the statistical and physical part of the proposed model and a quick explanation of the part played by rainfall in 1970 on the yields of the crops at Reddipalli farm of the Indo-French Agricultural Project.

PROBLEMS OF DRY FARMING IN AGRA DISTRICT OF UTTAR PRADESH

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SUMMARY

Agriculture in an area which receives more than 1,200 mm. rainfall has the same production potential as the irrigated area. The problem area for dry farming is the area which receives rainfall in between 400 mm. to 1,000 mm. and has less than 25 per cent of the sown area under irrigation. Thus dry farming is a programme of good soil management and improved practices designed to consume all available water for crop production in the area of low, uncertain and variable rainfall.

Agra district of Uttar Pradesh falls under the problem area of dry farming. Out of the total 14 community development blocks in the district five have less than 25 per cent and only five have 50 per cent or more irrigated area. Wheat is the principal crop of the irrigated area and bajra, gram and oilseeds of the unirrigated area. Agriculture in the district is highly unstable due to the high degree of rainfall variability and the chances for recurrence of drought are rated high. Economic return on irrigated holdings in terms of total output, net income and farm business income is 133·7, 126·9 and 137·5 per cent respectively higher than that on unirrigated holdings. The following efforts are needed to achieve a break-through in agricultural productivity in dry farming area. (1) Every efforts must be made to utilize the available irrigation potential in the area. (2) Evolution of rain-fed high-yielding varieties of crops is highly desired. (3) Crop insurance practices should be introduced. (4) As yield potential of this area is low, efforts should be made to minimize the cost through judicious mechanization.

THE COSTS AND RETURNS OF CONVERTING DRY AREAS INTO IRRIGATED AREAS—A CASE STUDY IN UTTAR PRADESH

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SUMMARY

The impact of green revolution is a localized phenomenon in the pockets of irrigated areas. A substantial part of crop acreage is still under crops which are mainly rain-fed with inadequate rainfall. Therefore, not only the per acre yield but also the per acre per unit of time productivity is very low.

If assured irrigation facilities are developed in these areas and multiple cropping is followed, the task of attaining the goal of self-sufficiency in foodgrain production could be easily solved within the very near future. This study is an attempt to examine economically the prospects of converting the dry areas into irrigated areas in Budaun district of Uttar Pradesh. The analytical procedure involves the computation of command area for a specific size of electric tube-well on the basis of *rabi* crop requirements and an economic appraisal of cost and return per acre of high-yielding varieties wheat crop with the full package of practices is made. It was found that as a result of developing irrigation facilities in the form of installing an electric tube-well one can get Rs. 2·97 net return by making an investment of one rupee for irrigation. Therefore, emphasis should be laid from extension side to give all sort of encouragement not only to the large size farms but also to small size farms which by pooling their small holdings could have a joint electric tube-well and could improve their farming conditions.

BENEFIT-COST RATIO AND PRODUCTIVITY ON DRY AND IRRIGATED FARMS IN DISTRICT UNNAO (A CASE STUDY)

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SUMMARY

The study was conducted on 50 cultivators' holdings (25 dry and 25 irrigated) selected randomly from three villages of district Unnao in Uttar Pradesh. The study revealed that though there was no significant difference in the average size of farms under dry and irrigated conditions but variation in irrigation facilities differentiated other characteristics of farms under the two conditions. The average irrigated area on irrigated and dry farms was observed as 79·45 and 5·26 per cent respectively. The investment on irrigation per hectare showed that the cost of converting the dry land into irrigated land varied from Rs. 1,470·73 to Rs. 1,683·87 with an average of Rs. 1,604·74. The study of the farm economy showed that the cropping intensity and the area under high-yielding varieties were significantly higher on irrigated farms than on dry farms. Though no significant difference was observed in the total area under foodgrains but the area under crops having high-yielding varieties like paddy, wheat and maize was significantly higher on irrigated farms whereas wheat + gram, barley and jowar+*arhar* dominated in the cropping pattern of dry farms.

Further analysis showed that the use of inputs like fertilizer, human and bullock labour per hectare was higher on irrigated farms as against dry farms. This resulted in higher yields of crop enterprises on irrigated farms than on dry farms. The productivity of *rabi* crops like wheat, barley and gram was observed as 69 per cent, 53 per cent and 54 per cent higher on irrigated farms than on dry farms. The productivity ratio of irrigated and dry farms was observed to be the highest for wheat being 1·69 and lowest for paddy being 1·16. The output-input ratio was also higher on irrigated farms with an average of 2·21 against 1·98 on dry farms. The output and net income on irrigated farms increased by 63·2 and 80·5 per cent respectively over dry farms with an increase in input by 46·2 per cent. The additional input-output analysis of irrigated farms over dry farms, showed that the benefit-cost ratio of irrigation was 2·69. The capital turnover on irrigation which varied from 49·36 to 57·30 per cent with an average of 54·15 per cent was significantly higher than the capital turnover in agriculture in general. This showed that the investment on irrigation helps in increasing the total output comparatively more than investment on other items like farm buildings and farm implements and machineries. The study suggested that the dry farms should be provided with credit facilities to the extent of about Rs. 1,600 and Rs. 400 as medium and short-term loan per hectare to convert the dry areas into irrigated one and to meet the additional production inputs of irrigated farms.

INCOME DISPARITY BETWEEN DRY LAND AND IRRIGATED FARMS IN DISTRICT KANPUR, UTTAR PRADESH

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SUMMARY

The study is based on the data obtained from 200 cultivators in 20 villages, out of which 100 cultivators were selected from 10 villages representing dry land farming in Ghatampur block and the remaining 100 cultivators were selected from 10 villages of Kalyanpur block, representing irrigated farming, in Kanpur district, Uttar Pradesh during 1970-71. The main objectives of the study were (*i*) to work out costs and returns on the existing cropping pattern on dry land and irrigated farms; and (*ii*) to suggest alternative plans for optimizing farm returns on dry land farms. A comparative study shows that the area under irrigation and cropping intensity came to 9·52 per cent and 104·23 per cent on dry land farms as against 82·21 per cent and 165·50 per cent on irrigated farms. The investment in fixed capital per hectare was higher on irrigated farms than on dry land farms. The calculated value of 't' between the investment in fixed capital of dry land and irrigated farms came to 18·02 which was highly significant at 5 per cent level, showing thereby that investment in fixed capital was significantly higher on irrigated farms.

On an average, the input, output and net income per hectare on dry land farms worked out at Rs. 503·57, Rs. 917·34 and Rs. 413·77 as against Rs. 1,393·39, Rs. 3,364·56 and Rs. 1,971·17 on irrigated farms respectively. The corresponding percentage increase on the above items on irrigated farms over the dry land farms came to 176·70 per cent, 266·77 per cent and 376·30 per cent. The calculated value of 't' between the input, output and net income on dry land and irrigated farms came to 14·28, 18·09 and 21·34 respectively. All were highly significant at 5 per cent level. Thus, it may be concluded that there exists a great disparity in income between the dry land and irrigated farms.

The input-output relationship on the whole as well as on all size-groups was higher on irrigated farms as compared to dry land farms. One rupee of investment on dry land farms yielded an output of Rs. 1·82 as against Rs. 2·41 on irrigated farms.

The main features of the alternative plans proposed in respect of each separate size-groups of dry land farms are briefly discussed as follows : The area under high-yielding varieties has been proposed to increase by 6·32 per cent, 6·55 per cent, 7·02 per cent, 7·55 per cent and 8·07 per cent for 0-1, 1-2, 2-3, 3-4 and 4 and above hectares size-groups respectively. Correspondingly, the cropping intensity be increased to 115·25 per cent, 115·98 per cent, 116·12 per cent 117·02 per cent and 117·38 per cent. The investment in fixed capital per farm has been proposed to increase by Rs. 349·17, Rs. 672·81, Rs. 869·24, Rs. 1,597·65 and Rs. 1,902·31 for the corresponding size-groups, mainly for the improvement of land, purchase of farm machinery and implements and pump-sets and construction of irrigation structure. The investment in working capital per farm be increased by Rs. 104·03, Rs. 341·85, Rs. 483·01, Rs. 514·59 and Rs. 1,191·48 with the increase in the farm size. This increased investment on working capital is associated with increased cost on dry farming practices, high-yielding seeds, manures and fertilizers and irrigation, etc. The gross return per farm with the adoption of alternative plans be increased by Rs. 267·68, Rs. 886·04, Rs. 1,284·95, Rs. 1,474·60 and Rs. 3,265·44 for the respective size-groups.

DRY LAND AGRICULTURAL DEVELOPMENT—A CHALLENGE FOR COMMERCIAL BANKS

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SUMMARY

Emphasis has been rightly placed on dry land agricultural development in the Fourth Plan, which has a vital concern with dry land farming areas, particularly in the context of spreading out the benefits of agricultural development. As per estimates given in the Fourth Plan document, there are 128 districts in the country which have low to medium rainfall under 1,125 mm. annually with very limited irrigation facilities. These districts account for nearly 68 million hectares or about one-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 in Maharashtra and Mysore. Twenty-five districts fall in these areas accounting for about 18 million hectares of the net sown area. The proportion of cultivated area under irrigation is hardly 5 per cent and as such these areas are characterized by the maximum extent of instability in agricultural production, thus posing difficult problem. Out of the remaining districts, 12 districts already have irrigation covering about 30-50 per cent of the cropped area and hence, the problems of these districts are no longer acute. The remaining 91 districts spread out mainly in Andhra Pradesh, Gujarat, Punjab and Haryana, Madhya Pradesh, Maharashtra, Mysore, Tamil Nadu and Uttar Pradesh represent the typical dry land farming tracts.

Dry land agricultural development programme envisaged in the Fourth Plan is two-fold, *viz.*, research into improved dry farming technology and application of such technology to dry farming areas. The Indian Council of Agricultural Research has implemented an All-India Co-ordinated Research Project for dry areas with a Plan outlay of Rs. 147·50 lakhs at 24 research centres representing various agro-climatic and soil conservation conditions. The project includes in its scope various research aspects of dry farming, such as breeding drought resistant varieties, water harvesting, improved irrigation practices, new techniques of fertilizer application including foliar application and soil and moisture conservation.

The ambitious Fourth Plan programme of dry land agricultural development described above is undoubtedly a timely step in the right direction. It will, however, make heavy demands on the financial institutions operating in the agricultural sector. An attempt here is made to throw light on the role of commercial banks in financing dry land agricultural development.

Commercial banks will have to face following major problems in financing dry land agriculture. The suggested line of action is also discussed below :

(1) Dry land agriculture areas are comparatively backward with low population density. They are less monetized and have a low intensity of commercial activities. The branch expansion programme in such areas will have to be carefully chalked out.

(2) The business per unit of area or per farmer in dry land agriculture areas would be much smaller and the cost of management of bank credit—cost of distribution, recovery and supervision—would be considerably high for the branches of commercial banks operating in such areas. The saving propensity of the dry land farmers would also be quite low and as such the deposit mobilization activity of commercial banks in these areas would be at a low level. Suitable organizational devices will, therefore, have to be evolved for economizing the cost of distribution, recovery and supervision of bank credit to dry land farmers and to step up deposit mobilization activity in these areas.

(3) The tangible security that the dry land farmers would offer would be of much less value than that offered by the irrigated farmers. This may inhibit the credit expansion programme of commercial banks, unless they adopt the crop loan system and consider credit worthiness of the purpose, rather than that of the farmer.

(4) The success of dry land agriculture depends on the successful implementation of the measures of soil conservation, land shaping, land development and water harvesting. These measures, generally cannot be undertaken by individual farmers alone. As such, suitable procedures will have to be evolved for group financing. Certain legislative measures will also be necessary for the success of these schemes. The banks will have to obtain technical guidance from the technical cell which should be established by the Agricultural Finance Corporation for this purpose.

(5) The risk involved in financing dry land farmers would be much greater due to the fluctuating fortunes of agriculture in these areas and as such, the problem of overdues will be a great headache for the banks. The co-operatives have already a bitter experience in this field, in spite of certain measures, such as "the bad-debt reserve fund." The banks will also have to evolve suitable procedures to reduce the intensity of the problem of overdues. Possibility of linking bank credit with the procurement activities of the Food Corporation should be explored.

(6) Dry land farmers would be required to undertake soil conservation measures as well as measures for the development of irrigation resources. As such, their medium and long-term credit need in the initial period will be much higher. A suitable integrated plan of short-term, medium-term and long-term credit will, thus, have to be evolved. For this purpose, instead of depending on the Government agency or the private manufacturers of agricultural equipments, it would be better, if the Agricultural Finance Corporation creates its own extension agency with trained persons in dry land agriculture for the preparation of farm plans of the dry land farmers and their successful implementation. In this connection, it would be worthwhile to adopt the system of supervised credit, suitably modified depending on the local conditions in different dry land regions.

(7) The dry land farmers are more inclined to grow foodgrains than the more profitable commercial crops. In order to stabilize their incomes at higher levels, they would be required to adopt improved crop plans with profitable commercial crops. This would necessitate the creation of an efficient machinery to supply them the production requisites as well as marketing and processing services, required for the commercial crops. The existing co-operative institutions providing these services are inadequate in number and generally inefficient in their operations, mainly due to inadequate funds and lack of technical guidance. The commercial banks should step up their advances to co-operatives for marketing and processing activities, and should also make them available technical guidance, through the technical cell to be established in the Agricultural Finance Corporation.

The Agricultural Finance Corporation has already initiated schemes for the development of dry land agriculture in Tamil Nadu, Rajasthan and Bihar. To make them a success and to expand these activities on a substantial scale, the infra-structure support will have to come from the Government, particularly for necessary legislation, development of transport and storage as well as for crop and cattle insurance.