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REVIEW OF OILSEED PRODUCTION TECHNOLOGY

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The views and recommendations expressed in this report are those of the authors and should not be attributed to the U.S. Agency for International Development.

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SUMMARY AND CONCLUSIONS

1. Edible oilseeds are grown in India in both kharif (rainy) and rabi (post-rainy)/summer seasons over an area of about 16.7 million hectares. Kharif crops (groundnut, sesame, soybean, niger and sunflower) cover about 64% of this area and are relatively more important. Rapeseed/mustard, safflower and some groundnut are grown in rabi/summer and account for about 36% of the area under oilseed. Aggregate oilseed output thus depends primarily on the production of kharif oilseed and, most importantly, on the output of groundnut which occupies more than 59% of the area under kharif oilseeds.

2. Over the last decade some changes have occurred in the relative importance of different kharif crops.The area under groundnut, sesame and niger declined while that under soybean and sunflower, two relatively new crops, increased. Taking both kharif and rabi crops together, the most important change has been in soybean. If crops are ranked by area, soybean would now be fourth (compared to seventh in 1971-74). Despite these shifts in area, the relative importance of kharif crops and groundnut among all edible oilseed crops remains almost unchanged. Groundnut contributes more than 57% to the total edible oilseed output.

3. Yield levels of oilseed crops are generally very poor in comparison with average yields in other countries and fluctuate from year to year within a wide range. The trend rates of yield growth for all crops except safflower have been poor and indifferent between trienniums 1970-73 and 1982-85.

4. About 12-14% of the area under edible oilseeds is irrigated. Almost all kharif oilseed crops are grown under rainfed conditions. About a million hectares under rabi/summer groundnut and about 24.5% of the land under rapeseed/mustard are irrigated. Though the levels of yield of these two irrigated crops are higher than the rainfed crops, they are unstable and highly variable from year to year.

5. Poor and indifferent yields are due to a variety of factors: crop characteristics, soil and regional climate. Oilseeds are highly susceptible to attacks by insects and pests and to a variety of diseases. More than 84% of the kharif oilseed area is located in the "oilseeds belt" of India - Rajasthan, Gujarat, Maharashtra, western Madhya Pradesh, Andhra Pradesh, Karnataka and Tamil Nadu. Despite great diversity, the quality of soils is generally poor in this belt. Over a large part of the area rainfall during the southwest monsoon is highly erratic and averages less than 500 mm. Drought of varying degrees of severity is frequent. Rainfall in most years cannot meet the minimum moisture requirement of crops of average duration. Irrigation facilities are few and dependent upon unreliable monsoon rainfall. A production technology appropriate to this harsh physical milieu must have varieties that are short duration and drought resistant. Additionally, these varieties should have built-in resistance to pests and diseases.

6. Multi-locational and multidisciplinary research on all oilseeds except soybean is organized and carried out by the All India Coordinated Research Project on Oilseeds (AICORPO). Soybean has a separate coordinated project outside AICORPO. The International Crop Research Institute for the Semi-Arid Tropics (ICRISAT) located in Patancheru, Andhra Pradesh, is also involved in research in post-rainy season (rabi)-groundnut. There is close cooperation between AICORPO and ICRISAT insofar as groundnut research is concerned. The major focus of research in the AICORPO System is on breeding to break the present yield barrier and for special characteristics, such as earliness, high oil content etc.

7. It takes six to eight years to develop a variety, to complete all the tests and trials in different centers and to release it for commercial cultivation. It takes another two to three years to organize certified seed production on an adequate scale. One weakness of the AICORPO System is insufficient pre-release testing of varieties under field conditions. Results of farm adaptive trials often do not reach scientists for evaluation.

8. Since AICORPO was established about 38 new varieties of groundnut, 37 new varieties of rapeseed/mustard, 27 varieties of sesame and about 22 varieties of soybean have been released. Packages of practices for different oilseed crops have been developed. These crops have three common attributes. First, they all require some irrigation. Second, most of the recommended varieties are medium to long-duration varieties. Third, they are all vulnerable to pests and diseases. The available technology therefore is applicable to the irrigated land, but it is being used in dryland areas because a technology appropriate to the oilseed belt has not been developed yet.

9. Unlike the high yielding varieties of cereals, the new oilseed varieties do not respond to nitrogen (one exception being some mustard varieties) nor do they have varietal plasticity. Yields are highly unstable over time and location.

10. Transfer of available technology has been impeded by poor extension and scarcity of new seeds. Farm level demonstrations have been few and far between and certified seeds of many of the new varieties are not available. But the main problem could be that in the absence of technology adapted to dryland agriculture, short growing period and pest and disease resistance, it is difficult to build an effective extension program on what David Hopper calls small differences in averages.

11. The Seventh Plan has set a 1989-90 target of 16.78 million tons of edible oilseed output. Sources of output increase are yield and area. Yields are unlikely to increase substantially in the short run. Varieties that may be developed in the next four years will have no impact on yields and aggregate output. With the varieties now available yield improvement is unlikely to be a source of growth except, perhaps, in the case of rapeseed/mustard. To meet the Plan target therefore, the area under oilseeds needs to expand by about seven million hectares. This is not a task that can be accomplished easily. About 40% of the

increased area must be under groundnut but kharif groundnut area has been declining since the early seventies. The additional area that can be planted to rabi/summer groundnut is about a million hectares. The end of the oilseed problem does not seem to be in sight.

1. INTRODUCTION

1.1 Statement of the Problem

The vegetable oil sector of the Indian economy has changed a great deal over the last decade. Although traditional types of edible oil such as, groundnut and mustard oil still predominate, the importance of edible oil from nontraditional sources such as cotton seed and soybean seems to have increased. Recent technological developments suggest that yet another oil from a nontraditional source, rice bran oil, might become an important component of the edible oil sector in another 10 years.[1/] A qualitative change seems to have occurred in the structure of the vegetable oil market as well. New entreprenuers have entered the industry and a spate of new processing firms with modern plants and machinery have gone into production. The vegetable oil market appears to have become somewhat more competitive than before which might, in course of time, induce a qualitative change in the structure and efficiency of the industry.

The oilseed sector, however, presents a different picture and remains one of the gray areas of the economy. Domestic production and availability of edible oilseeds have been very erratic over the last

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[1/] Recent reports suggest that scientists at the Central Food Technological Research Institute, Mysore, have developed a process to extract edible grade oil from rice bran. Commercial use of the process might take some time since it could entail modernization of the rice milling industry. Scientists estimate the production potential of edible grade rice bran oil at about 0.7 million tons.

decade, raising serious problems of capacity utilization in processing units and increasing the gap between the demand for and the supply of oilseeds. Annual imports of edible oil have increased substantially over the years.[2/] Growth of oilseed production has become a matter of concern to the Government of India, and out of this concern has emerged the National Oilseeds Development Project (NODP) and, still more recently, the Technology Mission for oilseeds.

It is a matter of concern to USAID as well. Since 1979 USAID has been supporting the National Dairy Development Board's (NDDB) oilseeds project - Oilseed Growers' Cooperative Project (OGCP) - through the free supply of PL 480 Title II Vegetable Oil. Modernizing oilseed processing and expanding oilseed production is the goal. While progress in setting up cooperatives and processing plants has been fairly consistent with project plans, the achievement of the objective of expanding edible oilseed production in project areas has fallen far short of expectations. A major assumption of the project was that by transferring the available oilseed production technology to farmers through demonstrations and the supply of improved seeds and other inputs, it would be possible to raise oilseed output substantially in the project areas. Now it appears that a close look at available technology is needed. The important questions are: what kind of oilseed production technology is available; is it appropriate to the conditions under which oilseeds are grown in most parts of the country, or is its applicability limited to specific areas; is a superior technology likely to come out of research centers in the near future? And finally, what are the prospects for rapid growth of edible oilseeds production in India?

1.2 Objectives

This report surveys a number of issues that deal with the above questions. It is concerned with the status of research, development and

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[2/] In 1984-85, India imported about 1.4 million tons of vegetable oil worth about Rs. 11 billion.

diffusion of edible oilseed production technology that would, on the one hand, increase production, yield and income of oilseed growers in India and, on the other, ensure an increasing and dependable supply of oilseeds to the Indian processing industry. More specifically, its objectives are to provide a critical assessment of the currently available technology and its performance. It will also review, to the extent possible, the new directions and thrusts of research and their likely impact on yields, aggregate production and farm income. Out of seven edible cultivated oilseeds,[3/] this report is focussed on three: groundnut, rape and mustard, and soybean. It does not cover tree crops that also yield edible oil. It does not go into the issues of oilseed prices nor the adequacy of the input supply mechanism, such as fertilizer credit, that might influence adoption behavior. The above issues are excluded primarily by the limited frame of reference established for this study.

1.3 Methodology and Data Source

This report is based on data from secondary sources, a large number of published and unpublished materials.[4/] Various publications of the Directorate of Economics and Statistics, Ministry of Agriculture, Government of India, provided the basic data on area and production of oilseed crops. Annual Progress Reports of the All India Coordinated Research Project on Oilseeds (AICOPPO), proceedings of annual workshops on oilseeds, provided material on the state of research, research accomplishment, varietal trials and other research programs. Special technical bulletins and other reports brought out by the Indian Council of Agricultural Research (ICAR) Directorate of Oilseeds Research, All

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[3/] The focus of this report is on "edible oilseeds". Hereafter the term 'oilseeds' in this paper should be taken to mean only the edible oilseeds.

[4/] The material used in this study, published and unpublished, is included in the "List of References".

India Coordinated Project on Dryland Agriculture, yielded a mass of material on various aspects of oilseed production practices and recommendations to farmers. Technical papers in various journals provided data on those aspects which are not generally reported in official reports. Studies made by other organizations, such as the National Council for Applied Economic Research (NCAER), the Program Evaluation Organization (PEO) of the Planning Commission, reported useful material on farm level performance of modern and traditional oilseed varieties. Some useful farm level data were also available in research reports of private sector organizations such as the Vanaspati Manufacturers Association's (VMA) Oilseeds Research and Development Institute.

The study has also benefited from discussions and interviews with a cross-section of people knowledgeable about various aspects of oilseed production, research and trade - experts, scientists and executives in research establishments, government departments dealing with oilseed production and development programs, private sector research establishments and trade associations. These discussions provided useful insights into different views and perceptions of the problems of oilseed production and technology.

1.4 Plan of the Report

Evaluation of a technology involves, first, an examination of the problem in response to which the technology is developed, and an examination of the technology's effects in relation to the objectives it is supposed to achieve. There can be several levels at which the effect of the technology is assessed. One obvious level is, of course, at the research/experiment station. The mean of the crop yields together with the standard error of that mean would provide a basis for the evaluation of a new variety of seed. The statistics at this level of analysis are important, and they do form an important part of this report. But an assessment based on these measures alone would be partial and incomplete,

besides being of limited utility. The yardstick for assessing oilseed production technology, as with any crop production technology, is the yield at the farm level. These elementary considerations have guided the plan of this report.

The next section (Section 2) of this report deals with the environment of oilseed production in India. It summarizes crop characteristics, the management and physical environment in which production is implemented, reports on the trends in area and yields, and their impact on aggregate oilseed production. It also identifies and defines the problems to which a new technology should respond and generally sets the stage for analysis in later sections. Section 3 describes the research infrastructure, various research projects, and the role and place of different public and private agencies in the infrastructure. Section 4 reviews the currently available technologies for groundnut, rape and mustard, and soybean - their characteristics, yield potential and the agronomic practices and inputs required for the realization of this potential. Section 5 takes a close look at the technologies and examines the yield differences between experiment stations and between different treatments. It examines the available data relating to yields of new varieties at the farm level and compares them with those on experiment stations. It includes a review of the data on the impact of new technology on farm income. Section 6 looks at the problem of seed supply and transfer of technology. The final section of this report discusses the outlook for oilseed production in the medium term.

2. PRESENT SITUATION

2.1 Relative Importance of Different Oilseeds

Each of the seven edible oilseed crops grown in India has its own place in the total edible oilseed basket, its own set of characteristics and a fairly well defined domain of relevance and problems. Together they cover about 16.6 million hectares. Groundnut is by far the most important of these crops occupying about 44.6 % of the total area under edible oilseeds. Next in importance are rape and mustard with a share of 24.9 %, and sesame with 15.1 %. Other crops are relatively less important. Areas planted to safflower, soybean, niger and sunflower add up to only 15.34 % (See Table 2.1). Soybean and sunflower are relatively new nontraditional crops. Soybean was introduced in a limited area of Madhya Pradesh in the late sixties with varieties imported from the United States, while commercial cultivation of sunflower began only in 1972-73 with a few varieties imported from Canada and the USSR.

Oilseeds are grown both in kharif (rainy) and in rabi (post-rainy)/summer seasons, but those in kharif are relatively more important. Five kharif oilseed crops - groundnut, sesame, soybean, niger and sunflower - occupy 63.67 % of all land planted annually to edible oilseeds while rabi crops - groundnut, safflower, rape and mustard - occupy 36.33 %. Aggregate edible oilseed output in any year thus depends heavily on the performance of the kharif crops, particularly on that of groundnut which has a share of more than 59.4 % in the kharif oilseed area. In rabi season, rape and mustard are the more important crops occupying 68.6 % of rabi oilseed land while groundnut occupies 18.56 % of the area.

2.2 Recent Changes

There has been substantial growth of area under edible oilseeds during the period 1970-71 to 1984-85 with a yearly growth rate of 1.54 %.

In fact, area growth for these oilseeds has been substantially larger than the growth of foodgrain area. However, areas under individual oilseed crops show a mixed picture (Table 2.2). While total area under groundnut grew at a rate of only 0.4%, sesame area grew at 0.75 % during the period. Area under rape and mustard, and niger grew at a rate of 1.94 and 0.88 % respectively. Safflower area increased at a rate of 3.35 %. Area under the two new oilseeds, soybean and sunflower, increased at a faster pace, that under soybean at 35.8 % and that under sunflower at 6.7 %. Both of these crops had very small areas planted to them at the start of the period. A large growth rate from a small base level is not always comparable to a small growth rate from a high base but, in the case of soybean, the gain in area in absolute terms has almost been equal to that under rape and mustard (about a million hectares) during this period.

In a sense the growth rates are arbitrary since the period was chosen arbitrarily. They need to be viewed in a long-term perspective. Chart 2.1 shows the long-term movements in area under groundnut, sesame, and rape and mustard. The small growth rate of area under groundnut (kharif and rabi combined) turns out to be illusory. About 7.698 million hectares were planted to groundnut in 1965-66. Since then this record has been exceeded only once - 7.754 million hectares in 1984-85. For this reason it may be more accurate to describe the area under groundnut as having stagnated since 1965-66. The reason for this stagnation is the decline in area under kharif groundnut. In contrast the area under rabi groundnut has increased substantially over the years. Chart 2.1 shows that the sesame area has never equaled its record of 2.794 million hectares achieved in 1966-67. It may be more accurate to describe the crop as consistently losing land. Area under rape and mustard has increased consistently both over the short and the long haul, and so have the areas under safflower and soybean since 1970-71. (Chart 2.2). Sunflower had a setback in the late seventies, but seems to have revived in recent years. Some shifts are taking place in area planted to oilseed

crops. Kharif groundnut and sesame are losing out while other crops gain land in kharif, and the area under safflower, rape and mustard, and rabi groundnut is expanding.

2.3 Geographic Distribution of Crops

Traditionally, groundnut has been grown as a kharif, rainy season crop, and more than 80 % of the kharif groundnut area is accounted for by five states. Together, these states cover a vast tract - from northwest to the southern plateau - most of the area being semi-arid with very low and very uncertain rainfall. The traditional groundnut area is Gujarat with 31 %, Andhra Pradesh with 19.54 %, Tamil Nadu with about 12 %, Karnataka with 11.87 % and Maharashtra with 10.06 % of the land planted to kharif groundnut. (Table 2.3) The share of other states in kharif-groundnut area is small - Madhya Pradesh, Uttar Pradesh and Rajasthan add up to only 12 %. Orissa, a relative new comer in groundnut cultivation, accounts for 2.15 % of the area. Rabi groundnut is grown in six states, Andhra Pradesh leading with 26 % of land, followed by Tamil Nadu - 24 %, Gujarat - 15.74 %, Maharashtra - 14.70 %, Orissa - 10 % and Karnataka - 9.53 %. The area under kharif groundnut has been on the decline during the last decade and a half in all states except in Gujarat and the nontraditional state, Orissa, while area under rabi groundnut has been on the increase in five out of six states where it is grown, the exception being Tamil Nadu.

The area under rapeseed and mustard is distributed mostly over the north and northeastern states. Five states among themselves account for 83 % of total area under the crop, with Uttar Pradesh in the lead at 52.9%, and Rajasthan, Madhya Pradesh, Haryana and Assam following with 12.75 %, 6.19 %, 5.55 % and 5.20 % land respectively. West Bengal and two relatively new producers, Gujarat and Orissa, account for another 11% of the land. Over the last 15 years area under rape and mustard has been increasing in all states except in Uttar Pradesh and Punjab.

Sesame is grown in 10 states, six of which fall in the semi-arid zone covering about 47 % of the area under the crop. These states are Andhra Pradesh - 6.60 %, Gujarat - 4.14 %, Karnataka - 4.27 % Maharashtra - 7.24 %, Rajasthan - 16.75 and Tamil Nadu - 4.65 %. Uttar Pradesh - 30.82 %, Madhya Pradesh - 9.74 %, Orissa - 7.95 % and West Bengal - 4.5 % make up the rest.[5/]

Three states account for the entire land planted to safflower. Maharashtra has the largest share of this cropland - 72.37 %, and Karnataka and Andhra Pradesh have 21.52 % and 5.25 % respectively. Niger land is distributed primarily among four states. The share of Madhya Pradesh in this crop land is 39.7 % while those of Maharashtra, Orissa and Karnataka are 17 %, 25 % and 9.4 % respectively.

Commercial cultivation of soybean began in the late sixties in Madhya Pradesh and Uttar Pradesh in land left as fallow in the rainy season. More than 96 % of the area under the crop today is accounted for by these two states. Over the last five years some land (1.65 %) in Gujarat has been planted to soybean. Sunflower cultivation, like that of soybean, is localized in Maharashtra - 48 % of total area, Karnataka - 34.37 % and Tamil Nadu - 11.86 %. It is grown mainly as a mixed crop or inter-crop.

All the kharif oilseed crops are grown under rainfed conditions. About a million hectares of rabi/summer groundnut and about 24.5 % of the land under rapeseed and mustard are irrigated. This total dependence of kharif oilseed crops on rainfall is the most important factor adversely

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5/ See also Charts 2.3, 2.4 and 2.5.

affecting yield levels and stability in yields and production. In the areas in which oilseed crops are grown in the kharif season availability of irrigation water is poor and, where available, is unreliable because it also depends upon erratic and unreliable rainfall. In the Saurashtra region of Gujarat, for example, where much of the area under kharif groundnut is concentrated, there are virtually no facilities for either surface irrigation or well irrigation. The crop is totally dependent on a variable and uncertain monsoon. It is interesting to note that where farmers can irrigate kharif oilseed crops, that is, within irrigated commands, they seldom cultivate oilseeds in kharif, preferring to grow other competing crops. In irrigated command areas in Gujarat they prefer to grow groundnut in rabi/summer [6/].

2.4 Yield Levels

Given the geographic distribution of oilseed crops and the absence of irrigation, yield levels of oilseeds are understandably poor. Present average yields of kharif groundnut, soybean and sunflower are

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[6/] This observation is based on a quick look at the pre-and post-project cropping patterns in the command areas of several new surface irrigation projects in Gujarat. It appears that other irrigated crops in kharif season give the farmers a better return than oilseeds. This is merely a hypothesis at this stage. It cannot be tested here for lack of relevant data.

respectively 770, 706 and 547 kilograms per hectare with those of niger and sesame at 248 and 230 kg/ha respectively. Rabi groundnut yield is about twice that of kharif - 1560 kg/ha - while safflower, and rapeseed and mustard yields are respectively 506 and 601 kg/ha. Growth rates of yield per hectare of oilseed crops between the triennium ending 1972-73 and the triennium ending 1984-85 are shown in Table 2.2. Of all oilseeds, safflower yields alone have grown at an impressive rate, 7.33 % per year. Yields of rape and mustard have grown at a rate of 1.15 %, though the upturn in yields seems to have taken place only since the1983/84 season. Yields of groundnut, soybean and sesame have grown at 1.05, 0.23 and 0.76 % respectively, while sunflower yields have declined at 2.9 % per year.

Oilseed yields are unstable and highly variable from year to year. Available data indicate (Tables 2.4 and 2.5) that groundnut yields are more variable than rape and mustard, and variability also depends on the region in which the crop is grown. Kharif rainfed groundnut yields vary as much as by 54.2 % in Gujarat while the variation in rainfed rapeseed and mustard in Rajasthan is 35.7 %. Though, in general, variation in irrigated yield is less, groundnut (irrigated) yield in Rajasthan varies by as much as 39.8 % and rapeseed and mustard yield in Bihar by 17.3 %. This seems to suggest that irrigation might not solve the problem of yield variability in all regions.

The data in Tables 2.4 and 2.5, compiled from limited information from crop cutting sample surveys also indicates yield differences of about 50%, on the average, between rainfed and irrigated crops with important variations at the state level. These data, averaged over a varying number of years, however, do not provide an adequate assessment of the yield levels that can be reached in weather normal years. For

instance, groundnut yields in kharif season have been as high as 1240 kg/ha and 1335 kg/ha in Gujarat and Orissa respectively in some years. Similarly, rainfed groundnut yield in Tamil Nadu reached the level of 1125 kg/ha in 1977/78. In rabi season the highest average yields attained so far are 2365 kg/ha in Gujarat, 1737 kg/ha in Karnataka, 2033 kg/ha in Maharashtra and 2073 kg/ha in Orissa. Since these are state-wide average yields it is fair to conclude that there were dispersions around these means and that a large number of farmers had obtained yields that were significantly higher.[7/]

2.5 Crop Characteristics

To understand the reasons for poor average yield levels of oilseed crops one needs to closely examine their characteristics since, by and large, these are fastidious crops requiring delicate tending and care. Groundnut, for instance, is not tolerant of frost, drought or waterlogging. It requires 14°-15°C temperature for germination and initial growth. (50)[8/] Adequate moisture availability is critical at fertilization. Without it soil turns hard and cakes, the pegs fail to penetrate the soil with the fertilized embryos and heavy yield loss results. But wet spells at harvest time make it difficult to dry the produce leading frequently to fungus infestation and to aflatoxin

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[7/] This has some implications for research to which we shall return in Section 5.

[8/] Underscored figures in parentheses refer to material cited in List of References.

problems. Seed viability is reduced if seed is stored under ordinary conditions for a long period.[9/] It appears to be best grown in the dry season with controlled irrigation when it has fewer problems. Rapeseed and mustard tolerate neither frost nor hail. The spines in safflower interfere with interculturing, harvesting and threshing. The hard seedcoat makes oil extraction by village ghanis difficult. Shattering of sesame pods is common and leads to post-harvest losses. Sunflower has the problem of low seed-filling and pollination.

One of the crucial attributes of oilseeds is their vulnerability to pest attacks and susceptibility to diseases. Rapeseed and mustard are highly vulnerable to a number of insects/pests such as leaf blight, white rust, painted bug, mustard sawfly, leaf miner and, most importantly, to aphid. Aphid multiplies rapidly and approaches epidemic proportions very fast. Its effect is almost total destruction of a crop. Yield losses due to aphid at different locations have been variously estimated at between 24 and 90 %. (51) No variety is immune to aphid attack. Annual loss of mustard output due to aphid could be as high as 0.4 million tons and the money value of this loss about Rs 1668 million. (51) Mustard sawfly and painted bug damage the crop at early stages of growth, though painted bug often returns to damage further at pod formation and harvesting stages. White rust was a relatively minor disease until recently but with the introduction of high yielding varieties susceptible

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[9/] This is a problem in many regions where groundnut is cultivated with residual moisture in the post-rainy season. For a brilliant summary of the crop characteristics, regional production conditions and constraints, see (62) (63).

to white rust and with the change in cultivation practices, it has become a major problem in many areas.[10/]

Sesame yields are affected by a number of insects/pests attacks and by various diseases which take a heavy toll.[11/] The crop is vulnerable to about 38 different insects/pests, the most common being leaf roller, capsule borer, midge and gall fly. Though chemicals are available to control many of these pests, they are seldom used since the use of pesticides is not economic from the farmers' viewpoint given the very low yield of the crop. Some of the common diseases are powdery mildew, stem and root rot, and bacterial leaf blight. Phyllody occurs in years of heavy rainfall and stem rot is common when there is moisture stress. Chemicals available for controlling or preventing diseases are not very effective.[12/] Early varieties of soybean (Bragg, Clark 63) were highly susceptible to yellow mosaic disease in the northern plains, particularly in Uttar Pradesh. Other diseases are aerial blight and bacterial pustules. Soybean is also vulnerable to girdle beetle, pea steenfly, white fly, thrips and hairy caterpillar. Safflower is affected by aphid and blight disease. Sunflower, as a new crop, is relatively free from major pests and diseases, although in some regions it is reported to have been attacked by alternaria, rust, selerotania and heliothis diseases.

10/ See (15).

11/ See (68).

12/ See (38).

Insect and pest attacks take a heavy toll of groundnut. More than 90 species of insects and mites are attracted to groundnut, although only about nine of them are reported to be important over large areas. (66) Two pests - leaf miner and white grubs - are considered to be of national importance. Other common pests are jassid, thrips, aphid, tobacco and gram caterpillar, red hairy caterpillar and termites. (66) Continuous cropping of the same crop in the same tract appears to have made aphid a major pest during the last two decades. Annual loss of groundnut output due to pest attack is estimated to be as high as Rs 1500 million.[13/] More than 55 pathogens including viruses have been reported to affect groundnut with about eight of them of major importance. (30) Recently, rust has become one of the major groundnut diseases. This is attributed to weather conditions, monoculture of the crop, year-round cultivation and absence of resistance in cultivated varieties. (15)

Incidence of some pests and diseases and consequent yield loss can be reduced, though not eliminated, by timely application of agrochemicals. However, chemicals either to control pests or to prevent diseases are seldom used on oilseed fields. In fact, the use of all modern inputs, not chemicals alone, is limited to a small proportion of oilseed land.

2.6 Management Environment

Since 1967 a number of improved varieties of oilseeds has been released for commercial cultivation. There is, however, no official data about the proportion of oilseed area that has been covered by these varieties. Estimates that are available relate to the early seventies

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13/ Quoted in (66).

when they were prepared in response to the needs of the National Commission on Agriculture. (48) (29)

Some scientists maintain that the oilseed area has never been saturated with improved varieties. Those released in the fifties and the sixties still occupy much of the oilseed land. As for groundnut, the National Commission on Agriculture (48) estimated that at 5 % replacement rate, about 36 thousand tons of seeds need to be produced annually. However the production of certified seeds in 1982-83 was only 16 thousand tons. (64)[14/]

As with seeds so with plant nutrition, thus fertilizer recommendations, naturally, vary from crop to crop and from state to state. Taking groundnut as an illustration, recommended N varies from 8 to 20 kg/ha, P from 16 to 80 kg/ha and K from 0 to 45 kg/ha for the rainfed crop. Corresponding quantities for the irrigated crop are 8-30 kg/ha for N, 10-75 kg/ha for P and 0-75 kg/ha for K. In addition, gypsum application at the rate of 500 kg/ha is recommended at the flowering stage. These recommendations are seldom followed by farmers. This limited adoption of modern inputs has given rise to the view that oilseed farmers are subsistence oriented.

According to this perception, oilseed crops are grown in most parts of India "under subsistent levels of economy with poor soil conditions", (60) and with poor crop management. (73) Most farmers operate small and

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14/ It appears that farmers cannot be criticized for not taking to the new varieties since the seeds of the new varieties have not been available in sufficient quantity. There have been other limitations as well. For instance, the supply of institutional credit to oilseed farmers is reported to have been insufficient. These issues are appropriate subjects of investigation in adoption/diffusion studies. We have not examined them in this report.

marginal holdings with a poor resource base. (16) (17) (73). They do not attach the same importance to oilseed crops as they do to cereal crops. This subsistence orientation of farmers leads them to deny oilseed crops the inputs that are needed to realize high yields. They do not use new productive seeds, use little or no fertilizer and pesticides, and use very few of the recommended agronomic practices. Because of their subsistence orientation, they are averse to taking risks and to investing in modern inputs for risky crops such as oilseeds.

This perception appears to be based on a misreading of data on oilseed area and operational holdings. While the proportion of small and marginal farmers among oilseed growers is large, the proportion of oilseed area cultivated by them is very small. This is illustrated in Table 2.6. The oilseed area operated by farmers with holdings up to two hectares in size - the conventionally defined small and marginal farmers - forms only about 20 % of the total. Relatively larger farmers with holdings over two hectares in size account for 80 % of the area under oilseeds. It follows that even if small and marginal farmers had high risk-aversion or subsistence orientation, traditional oilseed farming (that is, without modern inputs) should be confined to only 20 % of the oilseed area. It also follows, by implication, that on the other 80 % of oilseed land - the overwhelmingly large proportion of oilseed area - oilseed farming should be on modern lines, with modern inputs and high yields. But evidence, such as it is, suggests that oilseed farming is overwhelmingly traditional.

The myth that small and marginal farmers have a high degree of risk aversion or that they are subsistence oriented and consequently do not adopt new technologies was exploded long ago when high yielding foodgrain technology came on the scene. Studies on adoption of oilseed technology have been few, but there is evidence that the adoption behavior of different groups of oilseed farmers is no different from that of foodgrain farmers.

Of relevance here is a study conducted by the Programme Evaluation Organization of the Planning Commission to evaluate the oilseed development program (1976-80) covering 34 districts in 13 states. (53) It found almost total adoption of the recommended varieties of groundnut, rape and mustard, soybean and sunflower among sample farmers irrespective of size.[15/] In the case of sesame, however, only 58 % of the sample farmers used the recommended varieties.[16/] When it came to the question of the adoption of other elements of the recommended package, the picture was different. Adoption of the recommended seed rate by sample farmers varied a great deal. The proportions of farmers adopting the recommended seed rate was 43.5 % for groundnut, 80.2 % for rapeseed/mustard, 94 % for sunflower, 48 % for soybean and only 15 % for sesame. Adoption of recommended practices relating to fertilizer and plant protection was extremely poor. Insofar as yields are concerned, the small and marginal farmers had a slight edge over other farmers, but, by and large, the differences in yield were not substantial.

This study demonstrates that it is not the subsistence orientation, nor is it the risk aversion of farmers that is at the root of poor input use and of poor yields of oilseed crops. It is not even the high cost of inputs that deters farmers.[17/] The fact is, a large proportion of non-adopters are not convinced of the superiority of the recommended

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[15/] There was some deviation from this trend in a couple of districts.

[16/] It is not possible to breakdown the figures for adopters/nonadopters by size - group of farms.

[17/] A varying, but small proportion of nonadopters did indicate costs as a factor for deviation from the recommended package.

package of practices.[18/] This is interesting. While the scientists and administrators hold poor management environment responsible for poor oilseed output, the farmers seem to hold a different view altogether. A close look at the harsh realities of the physical environment of oilseed cultivation may explain why.

2.7 Physical Environment

Five oilseed crops - groundnut, sesame, safflower, niger and sunflower - occupy about 11.8 million hectares, out of a total 16.6 million hectares under oilseeds. About 84 % of this land is distributed over seven contiguous states - Rajasthan, Gujarat, Madhya Pradesh (West), Maharashtra, Andhra Pradesh, Karnataka and Tamil Nadu. This is virtually the oilseed belt of India but also the formidable dryland zone of Indian agriculture. Its distinguishing features are poor quality soil, scanty and highly variable precipitation, high climatic water demand and a short growing season.

Though soils in this great belt are by and large of low fertility, there is a wide qualitative variation even within districts. Generally the soils are characterized by high erodibility, shallow depth, low moisture retention capacity, high crusting that leads to poor crop stands and high moisture storage capacity in Vertisol areas which makes it difficult to cultivate when soil is dry or wet. (40) These soils, together with scanty and erratic rainfall, pose a severe problem for plant growth.

[18/] This is the reason given by nonadopters in the sample for not adopting the recommended package of inputs and practices.

Customarily, India is divided into three zones in terms of rainfall: assured, medium and dry. (Chart 2.6) Normal annual rainfall of 1150 mm and above defines the assured rainfall zone, of between 750 mm and 1150 mm the medium rainfall zone, and of below 750 mm the dry zone. Much of this rainfall is received during the southwest monsoon. (Table 2.7) The definition of dry zone is somewhat unsatisfactory for it obscures the important fact that over almost the entire cultivable area in this zone, monsoon rainfall ranges from only 300 to about 500 mm. Neither the chart nor the table quite manage to bring out this point clearly, nor are these able to show the distribution of monsoon rainfall over the growing season which is an equally important factor affecting plant growth. Surface irrigation in the dry zone is limited and unreliable, as is groundwater, dependent as it is on monsoon rainfall.

Table 2.7 shows that the variability of monsoon rainfall is the least in the case of assured rainfall zone and the greatest in the dry zone. It also indicates that the probability of drought occurring is very high in the dry zone. There are at least four important aspects of this rainfall pattern that affect oilseed crops. First, the totally inadequate rainfall reduces the length of the crop season. It cannot sustain long or medium-duration crops by meeting their water requirement. Assuming evapotranspiration loss to be about 6.25 mm/day, generally assumed in semi-arid areas, the rainfall requirement of groundnut crop, say of 120 days duration, would be 750 mm (54) which cannot be met by rainfall over much of the dry zone. Second, the variability of rainfall is such that the onset of rains may be quite early or considerably late. Timely sowing which is so important for reasonable yields of oilseed becomes a matter of chance. Third, there are prolonged "breaks" in rainfall over the growing season which often makes it difficult for crops to survive. Fourth, the retreat of monsoon may be either quite early or considerably late, again adversely affecting

crop yields .[19/] (18) (19)

Given this physical milieu it would seem that no recommended package of practices would ever inspire farmer confidence unless it included a variety that is both short duration and, at the same time, drought resistant. The importance of short duration varieties may be illustrated with the actual rainfall data of groundnut-producing Bhavnagar District of Gujarat. (54) Normal monsoon rainfall in Bhavnagar is about 542 mm. In only two years between 1971 and 1983 did rainfall exceed 750 mm - in four crop years it was between 221 and 361 mm, and in seven years it was between 563 and 610 mm. With the usual assumption about evapotranspiration losses, the moisture requirement of groundnut varieties of 110 days duration was met in only two years out of 13. In seven years there were various degrees of moisture stress - moisture shortfall ranging from 77 mm to 124 mm - resulting in varying reduction in yields. In four years there was total crop failure. Rainfall, however, was sufficient to meet the full water requirement of a variety with maturity of 80 days in nine out of 13 years. Given the rainfall pattern, a short duration variety would not eliminate crop failures altogether, but it would reduce the number of years of dismal production substantially and generally raise yields and production to higher levels. The additional attribute of drought resistance in a variety will have obvious consequences in terms of yield and production in the dry zone.[20/] These then are the required attributes of an oilseed

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[19/] Conditions within the oilseed belt or the dry zone vary a good deal. There are pockets here and there, sometimes quite large, where rainfed cropping has a better chance of success. For instance, Hyderabad and Sholapur have comparable rainfall, but different rainfall probabilities and patterns of distribution. Consequently, cropping is generally successful in Hyderabad but risky in Sholapur. (40)

[20/] A third desirable attribute of a technology relevant to the dry zone would be built-in resistance to pests and diseases.

production technology over the large part of the oilseed growing area. Without this technology, the use of modern inputs will continue to be rare, and yield levels will remain where they are, fluctuating widely from year to year around a small average.

TABLE 2.1 RELATIVE IMPORTANCE OF DIFFERENT OILSEEDS IN TERMS OF AREA

CROPS	AREA* (in 000 ha)	PERCENT of total area under oilseeds	of total area under kharif oilseeds	of total area under rabi oilseeds
Groundnut: Kharif	6312.9	37.86	59.46	
Groundnut: Rabi	1124.5	6.74		18.56
Groundnut: Total	7437.4	44.60		
Sesamum	2525.6	15.14	23.79	
Soybean	742.0	4.45	6.99	
Niger	567.9	3.41	5.35	
Sunflower	469.4	2.81	4.42	
Rape & Mustard	4155.6	24.92		68.59
Safflower	778.3	4.67		12.85
Total	16,676.2	100.00	100.00	100.00
Kharif Oilseeds		63.67		
Rabi Oilseeds		36.33		

*Average of three years: 1981-82 to 1983-84

SOURCE: Area and Production of Principal Crops in India, 1981-84, Directorate of Economics & Statistics, Department of Agriculture & Cooperation Ministry of Agriculture, Government of India, Delhi 1984.

TABLE 2.2 GROWTH RATES OF AREA, PRODUCTION AND YIELDS OF DIFFERENT EDIBLE OILSEEDS, 1970-71 TO 1984-85

CROPS	AREA	PRODUCTION	YIELD
		PERCENT	
Groundnut	0.43	1.48	1.05
Sesame	0.75	1.51	.76
Rapeseed and Mustard	1.94	3.12	1.15
Safflower	3.35	10.93	7.33
Niger	0.88	2.00	1.11
Sunflower	6.69	3.55	-2.94
Soybean	35.88	35.57	0.23
TOTAL EDIBLE OILSEEDS	1.54	2.70	1.14

NOTE: The growth rates in this table were derived from an exponential function, of the form $Y=AB^t$, fitted to three-year moving averages of area, production and yield data. The year 1977-78 was selected as "origin" in each case for computational purposes.

SOURCE: Agricultural Situation in India, relevant issues, and (23).

TABLE 2.3 GEOGRAPHIC DISTRIBUTION OF EDIBLE OILSEED CROPS

PERCENTAGE OF TOTAL AREA (AVERAGE OF 1980/81 - 1982-83)

STATES	GROUNDNUT KHARIF	GROUNDNUT RABI	SESAME	RAPE/ MUSTARD	SAFFLOWER	NIGER	SUN-FLOWER	SOYBEAN
Andhra Pradesh	19.54		26.06	6.60	5.25			
Assam				5.20				
Bihar				1.85		7.40		
Gujarat	31.07	15.74	4.14	3.70				1.65
Haryana				5.55				
Jammu & Kashmir				1.01				
Karnataka	11.87	9.53	4.27		21.52	9.41	34.37	
Madhya Pradesh	4.97		9.74	6.19		39.69		74.77
Maharashtra	10.06	14.70	7.24		72.37	17.02	48.03	
Orissa	2.15	10.13	7.95	3.52		25.66		
Punjab	1.20			2.67				
Rajasthan	2.78		16.75	12.75				
Tamil Nadu	11.94	23.80	4.65				11.86	
Uttar Pradesh	4.31		30.82	52.90				21.70
West Bengal			4.50	3.66				
All India	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

* Three year average: 1981/82 - 1983/84

SOURCE: Directorate of Economics and Statistics, Department of Agriculture & Cooperation, Ministry of Agriculture, Government of India, Area and Production of Principal Crops in India 1981 - 84.

TABLE 2.4 VARIATIONS IN IRRIGATED AND RAINFED GROUNDNUT YIELDS

STATE	NO. OF YEARS	PERIOD	MEAN YIELD (kg/ha)	VARIATION (%)
1	2	3	4	5
Irrigated				
Andhra Pradesh (K)*	7	1973-74 to 1979-80	1185.57	17.16
Andhra Pradesh (R)*	7	1973-74 to 1979-80	1397.57	8.91
Gujarat (K)	10	1972-73 to 1981-82	979.80	25.06
Karnataka (K)	5	1974-75 to 1978-79	942.40	23.83
Karnataka (R)	5	1974-75 to 1978-79	1560.00	10.31
Punjab	6	1976-77 to 1981-82	1023.50	15.52
Rajasthan	9	1973-74 to 1981-82	1016.11	39.81
Tamil Nadu	10	1972-73 to 1981-82	1635.70	10.95
All States	1	1981-82	1357.66	26.56
Rainfed				
Andhra Pradesh (K)	7	1973-74 to 1979-80	734.14	18.53
Andhra Pradesh (R)	7	1973-74 to 1979-80	1016.00	14.73
Gujarat (K)	10	1972-73 to 1981-82	666.30	54.20
Karnataka (K)	5	1974-75 to 1978-79	593.60	20.01
Karnataka (R)	5	1974-75 to 1978-79	1277.20	18.95
Maharashtra (K)	8	1974-75 to 1981-82	689.81	12.03
Punjab	6	1976-77 to 1981-82	912.16	15.19
Rajasthan	9	1973-74 to 1981-82	599.33	36.62
Tamil Nadu	10	1972-73 to 1981-82	869.30	16.50
All States	1	1981-82	913.75	28.62

Source on the following page

Table 2.4 (contd.)

*(K) = Kharif; (R) = Rabi

NOTE: Figures in Column 5 are coefficients of variation.

SOURCE: Consolidated results of crop estimation survey on principal crops issued by National Sample Survey Organization, and Reports on preliminary results of cropcutting experiments from state governments. Various issues of Area and Production of Principal Crops in India.

TABLE 2.5 VARIATIONS IN IRRIGATED AND RAINFED YIELDS OF RAPESEED AND MUSTARD

STATE	NO. OF YEARS	PERIOD	MEAN YIELD (kg/ha)	VARIATION (%)
1	2	3	4	5
Irrigated				
Bihar	6	1974-75 to 1979-80	685.33	17.32
Haryana	8	1974-75 to 1981-82	682.37	12.41
Rajasthan	8	1974-75 to 1981-82	641.37	13.11
Punjab	5	1977-78 to 1981-82	653.00	14.19
West Bengal	5	1977-78 to 1981-82	601.80	11.93
All States	1	1981-82	721.80	9.81
Rainfed				
Assam	8	1974-75 to 1981-82	451.62	10.04
Bihar	6	1974-75 to 1979-80	461.33	12.11
Haryana	8	1974-75 to 1981-82	488.62	25.23
Rajasthan	8	1974-75 to 1981-82	472.25	35.71
Punjab	5	1977-78 to 1981-82	441.80	23.06
West Bengal	5	1977-78 to 1981-82	373.00	7.47
All States	1	1981-82	483.16	15.21

NOTE : Figures in Column 5 are coefficients of variation.

SOURCE: Same as in Table 2.4.

TABLE 2.6 PERCENTAGE DISTRIBUTION OF AREA UNDER OILSEEDS CULTIVATION BY SIZE GROUPS OF HOLDINGS, 1976-77

CATEGORY OF HOLDINGS AND SIZE GROUP	PERCENTAGE AREA UNDER OILSEEDS		
	Irrigated	Unirrigated	Total
	1	2	3
Marginal (Below 1.0 ha)	14.8	8.0	8.5
Small (1.0 to 2.0 ha)	16.7	11.3	11.7
Semi-medium (2.0 to 4.0 ha)	23.1	20.1	20.3
Medium (4.0 to 10.0 ha)	30.3	36.0	35.6
Large (10.0 ha and above)	15.1	24.6	23.9
All catagories	100.0	100.0	100.0

SOURCE: Bhapinder Singh Sarao, All India Report on Agricultural Census 1976-77, Department of Agriculture and Cooperation, Ministry of Agriculture, Govt. of India, New Delhi, 1983, p. 39.

TABLE 2.7 NORMAL RAINFALL FOR FOUR PRIMARY RAINFALL REPORTING PERIODS FOR MAJOR RAINFALL DIVISIONS

State	Division	Total Rainfall (mm)	Percentage Distribution (%) Monsoon	Post Monsoon	Pre-Winter	Mon-soon	Probability of Drought during South-west Mon-soon (-20% normal) 1 in x years	Coefficient of Variation of Monsoon Rainfall (Percent)
1	2	3	4	5	6	7	8	9
North								
Punjab	-	624.7	80.0	4.2	8.6	7.2	-	32
Rajasthan	west	311.1	89.1	2.4	3.6	4.9	2.5	49
	east	704.1	92.5	3.0	2.1	2.3	3	28
U.P.	west	964.2	87.0	4.0	5.1	3.9	3	24
	east	1007.7	88.2	5.6	3.4	3.0	4	22
East								
Assam		2516.4	65.3	7.3	2.3	25.1	15	9
Bihar	plains	1202.9	85.0	6.0	2.9	6.1	5	12
Orissa		1482.2	76.7	12.0	2.7	8.6	5	13
W. Bengal	Gengetic	1425.3	75.6	9.3	2.7	12.4	5	11
West								
Gujarat		976.5	95.2	3.2	0.4	1.0	3	30
Suaurashtra & Kutch		482.6	93.1	3.8	0.9	2.1	-	-
M.P.	west	1004.9	90.7	5.1	2.2	2.0	5	17
	east	1401.7	87.7	5.7	3.1	3.5	-	13
Maharashtra	Konken Goa	2872.0	93.9	4.8	0.1	1.2	5	27
	Mad. Mah	920.7	83.6	11.5	0.8	4.1	5	18
	Marath-wada	773.6	83.3	11.0	1.5	4.0	-	-
	Vidarbha	1099.6	87.0	7.0	2.9	3.1	4	24
Karnataka	Coastal	3264.8	87.7	7.8	0.1	4.4	-	27
	Int - N	675.0	65.2	19.1	0.9	12.7	-	20
	Int - S	1244.9	67.6	18.5	0.8	13.0	4	20

Table 2.7 contd.

1	2	3	4	5	6	7	8	9
South Andhra	Coastal	1008.3	56.6	32.3	2.3	8.8	5	18
	Telangana	926.5	81.7	10.0	2.1	6.1	3	21-24
	Rayal-seema	677.8	54.4	32.0	2.2	11.3	3	30
Kerala		2996.1	66.9	18.3	1.2	13.5	5	19
Tamil Nadu		1008.1	33.0	47.1	5.3	14.6	3	23

SOURCES: Columns 3-7: Based on data for the period 1901-50. P. Koteswaram, "Meteorological and Climatic Aspects of Dryland Farming in India". Paper presented at the I.C.A.R. workshop on Dryland Agricultural Research, Indian Agricultural Research Institute, New Delhi, September 28 - October 1, 1970.

Column 8 : S.R. Sen, "Growth and Instability in Indian Agriculture," Agricultural Situation in India, January 1967, pp. 827-839.

Column 9 : P.K. Das, The Monsoons. New Delhi: National Book Trust of India, 1968.

CHART 2.1: AREA UNDER GROUNDNUT, SESAME AND RAPESEED AND MUSTARD

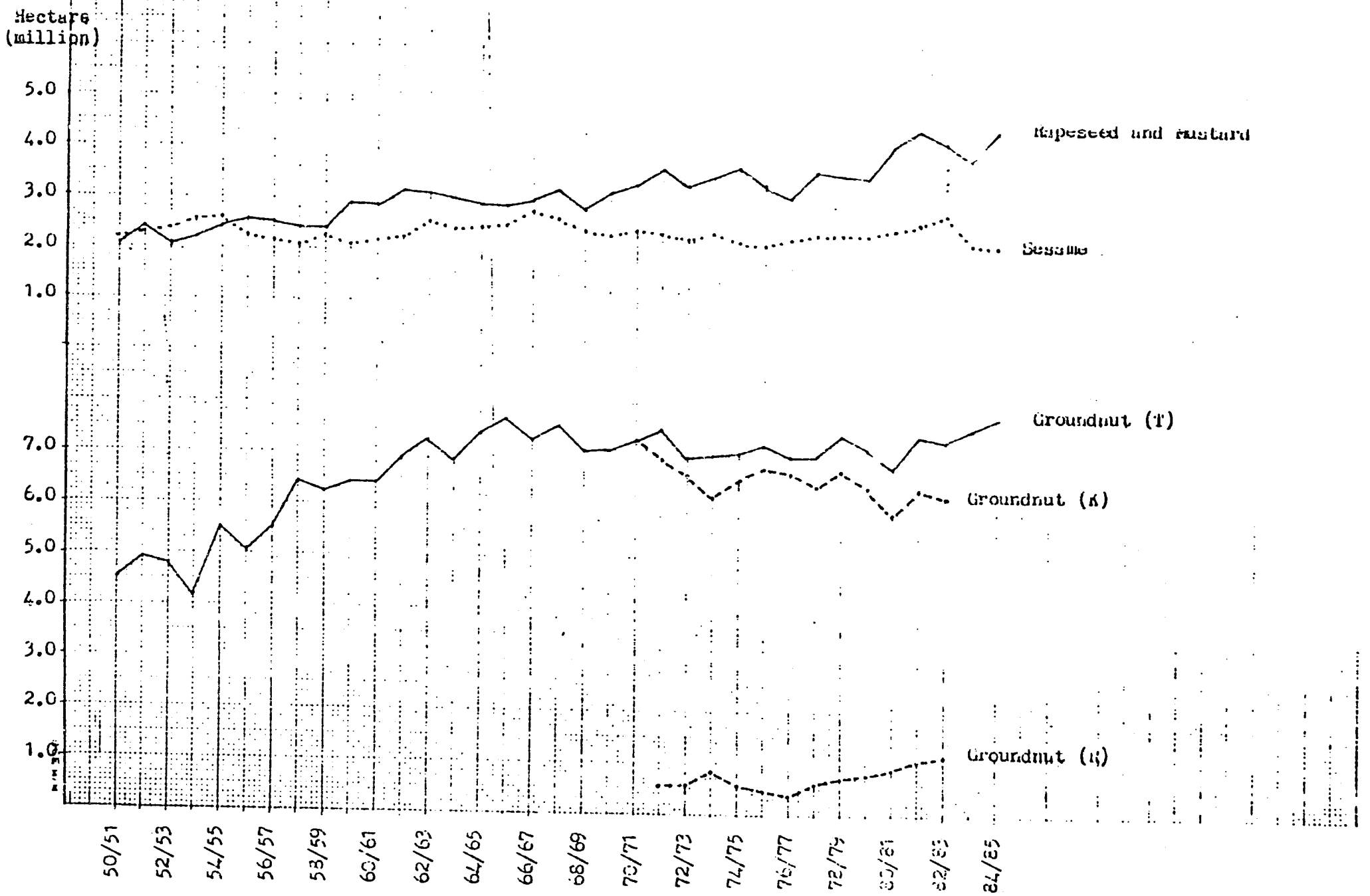
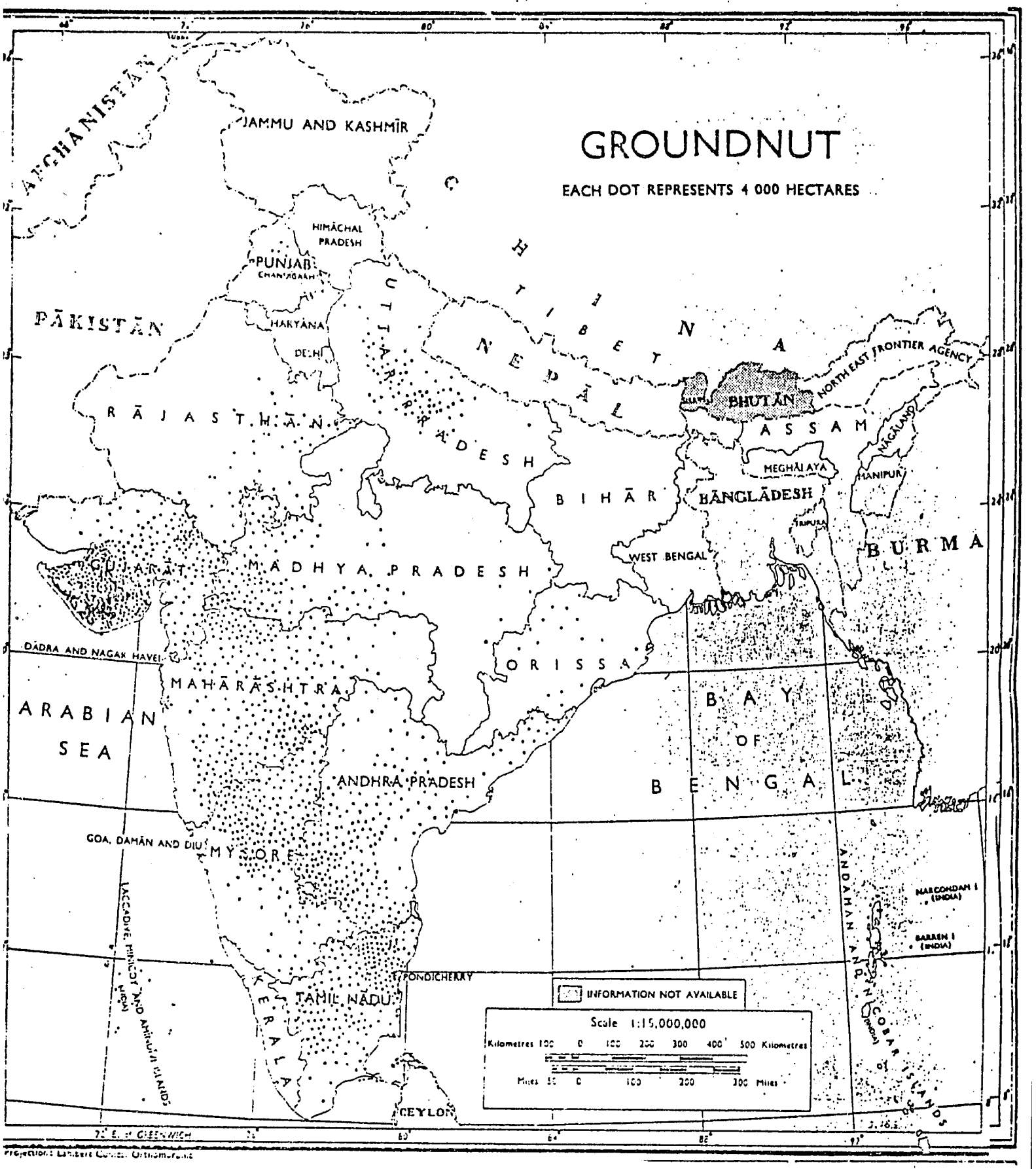


Chart 2.3


GROUNDNUT
EACH DOT REPRESENTS 4 000 HECTARES
AFGHĀNISTĀN
JAMMU AND KASHMĪR
HIMĀCHAL PRADESH
PUNJAB
CHANDIGARH
HARYĀNA
DELHI
PĀKISTĀN
RĀJASTHĀN
UTTAR PRADESH
NEPĀL
TIBET
BHUTĀN
NORTH EAST FRONTIER AGENCY
ASSAM
NAGALAND
MEGHĀLAYA
MANIPUR
BIHĀR
BĀNGLĀDESH
TRIPURA
WEST BENGAL
BURMA
GUJARAT
MADHYA PRADESH
DĀDRA AND NAGAR HAVELI
ORISSA
MAHĀRĀSHTRA
ARABIAN SEA
BAY OF BENGAL
ANDHRA PRADESH
GOA, DAMĀN AND DIU
MYSORE
LACCADIVE, MINICOY AND AMINDIVI ISLANDS
ANDAMAN AND NICOBAR ISLANDS
NARCONDAM I (INDIA)
BARREN I (INDIA)
PONDICHERRY
TAMIL NĀDU
KERALA
INFORMATION NOT AVAILABLE
Scale 1:15,000,000
Kilometres 100 0 100 200 300 400 500 Kilometres
Miles 50 0 100 200 300 Miles
CEYLON
72° E. of GREENWICH
Projection: Lambert Conic Orthomorphic

b

Chart 2.4
INDIA

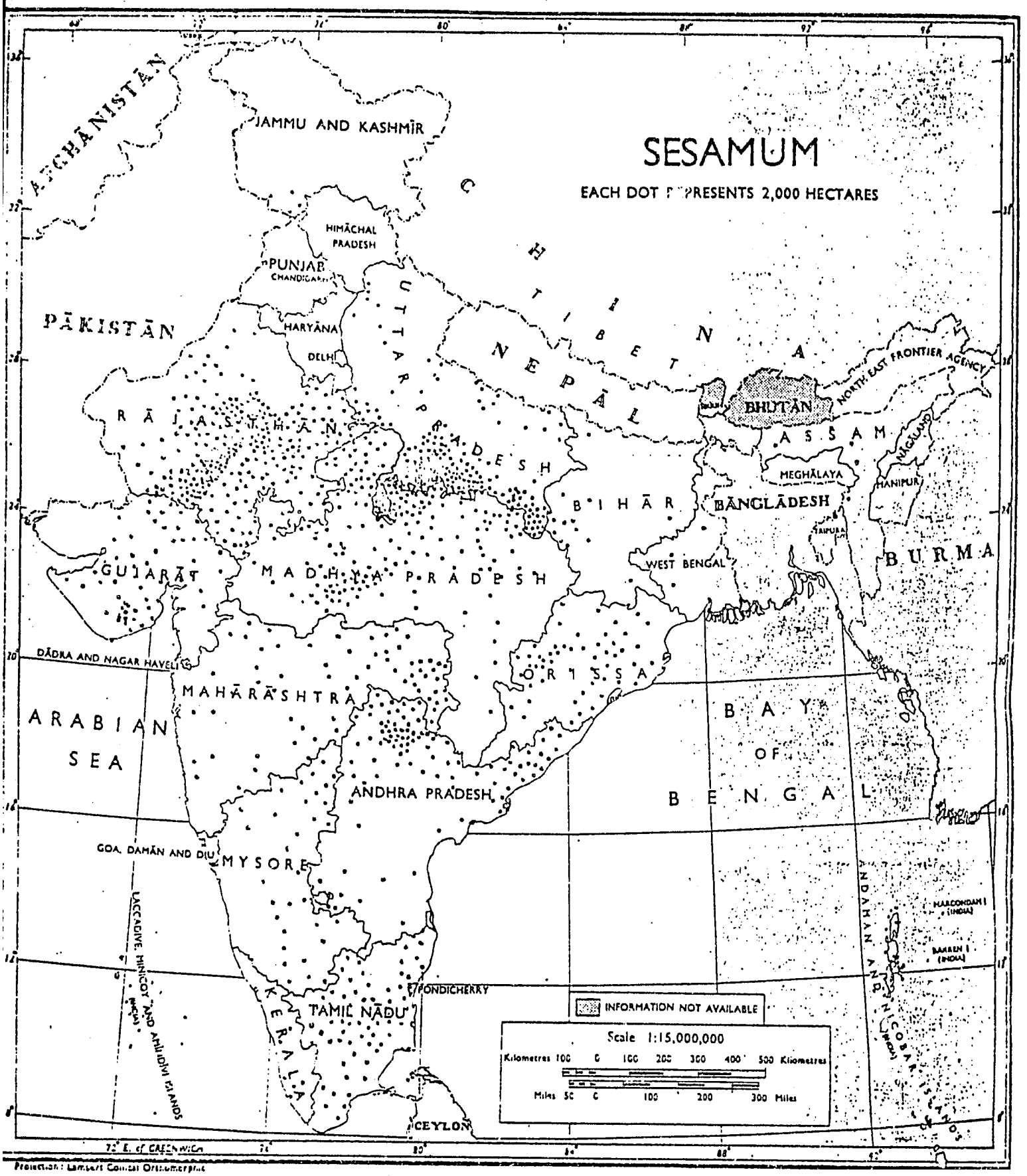


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Chart 2.5

RAPE & MUSTARD

EACH DOT REPRESENTS 1,000 HECTARES

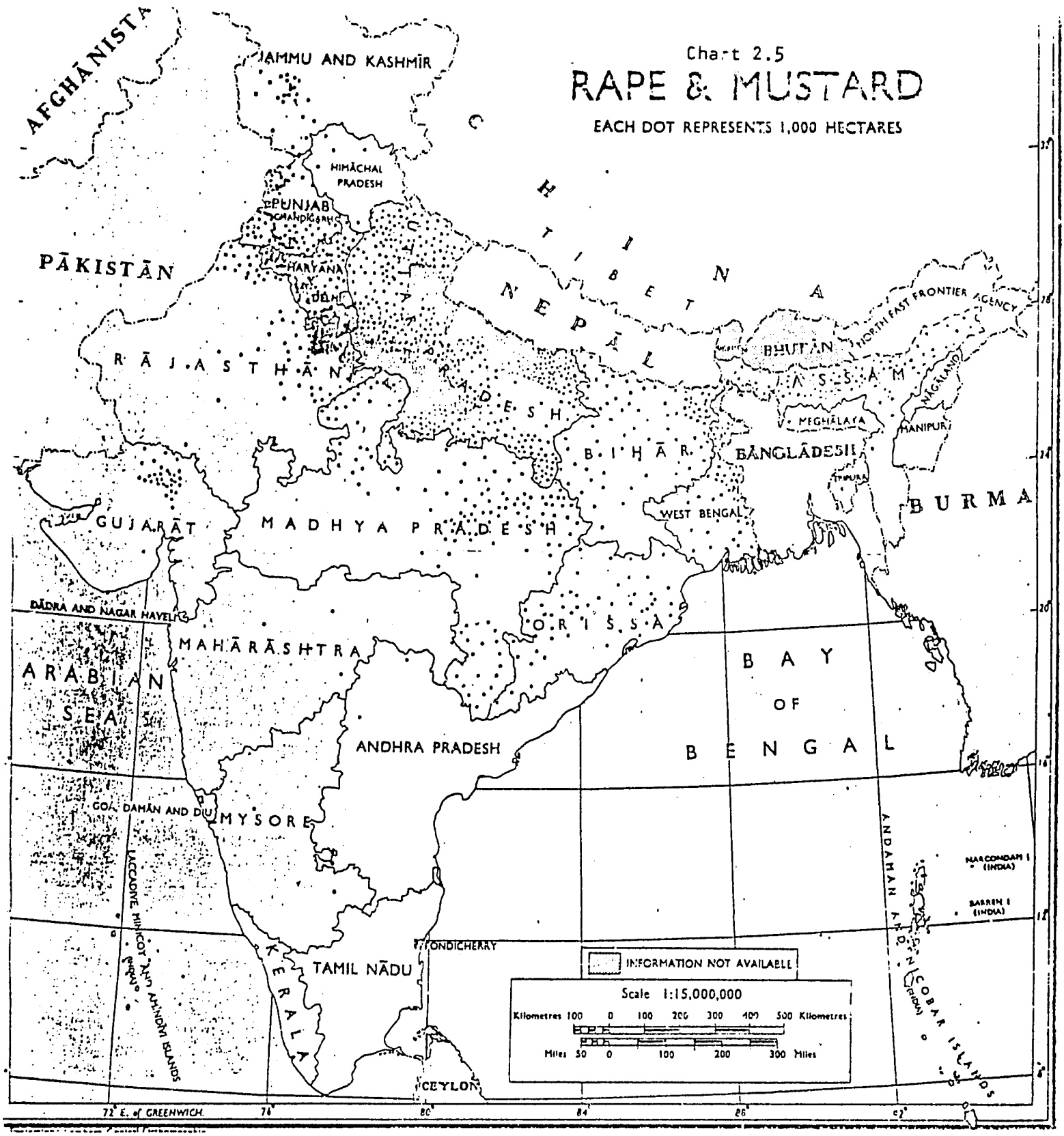


Chart 2.5

RAPE & MUSTARD

EACH DOT REPRESENTS 1,000 HECTARES

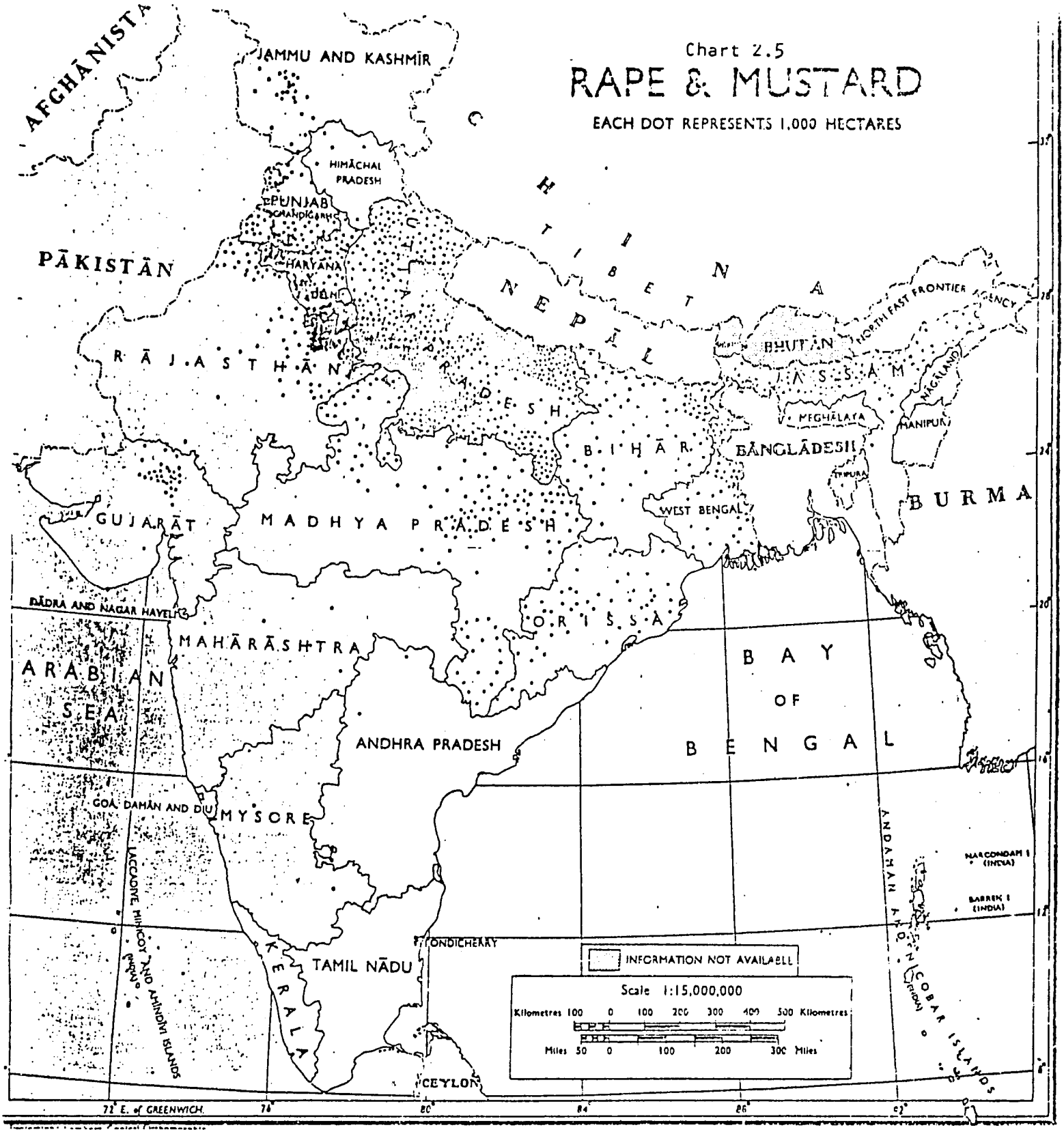


Chart 2.5

RAPE & MUSTARD

EACH DOT REPRESENTS 1,000 HECTARES

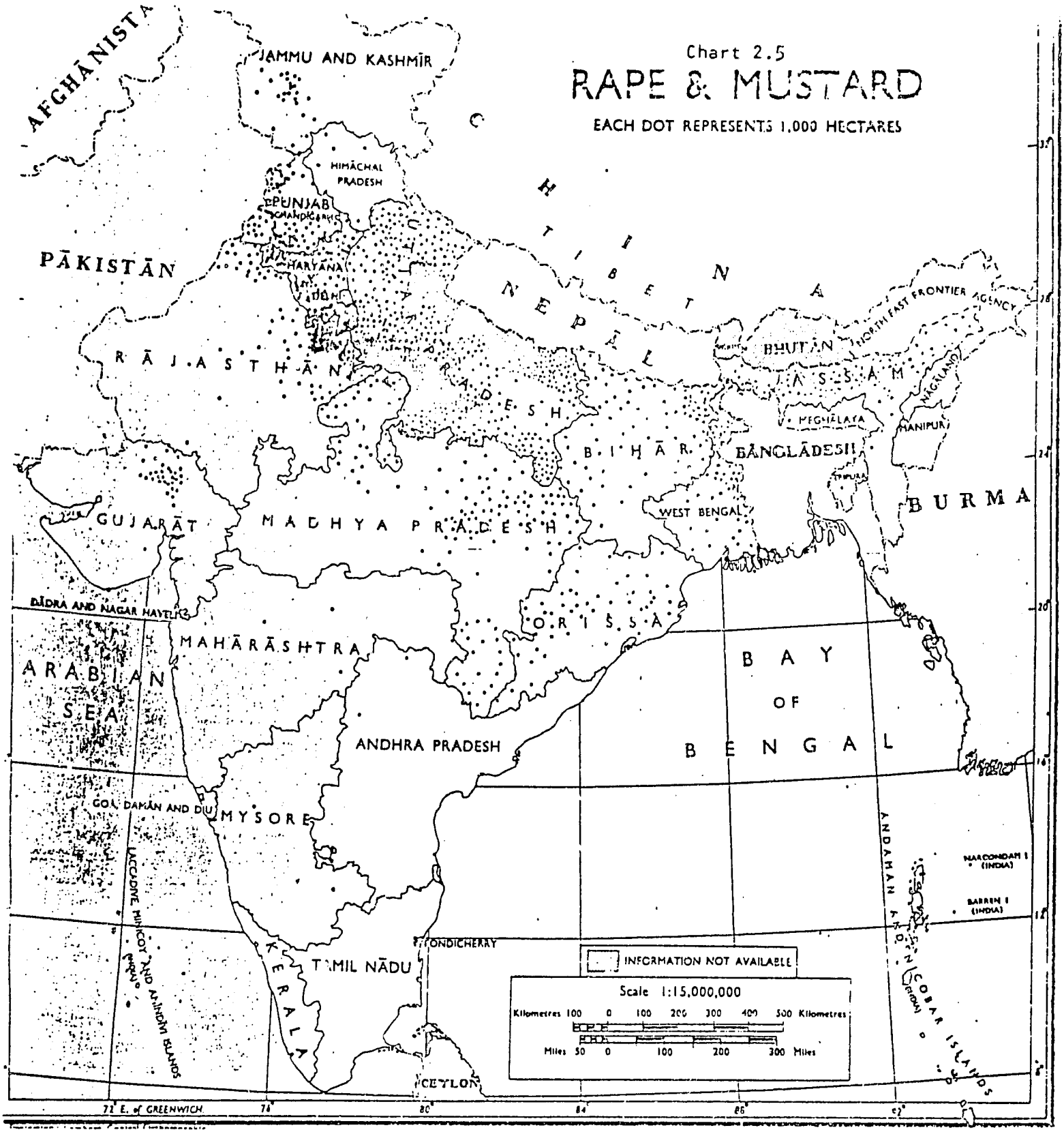
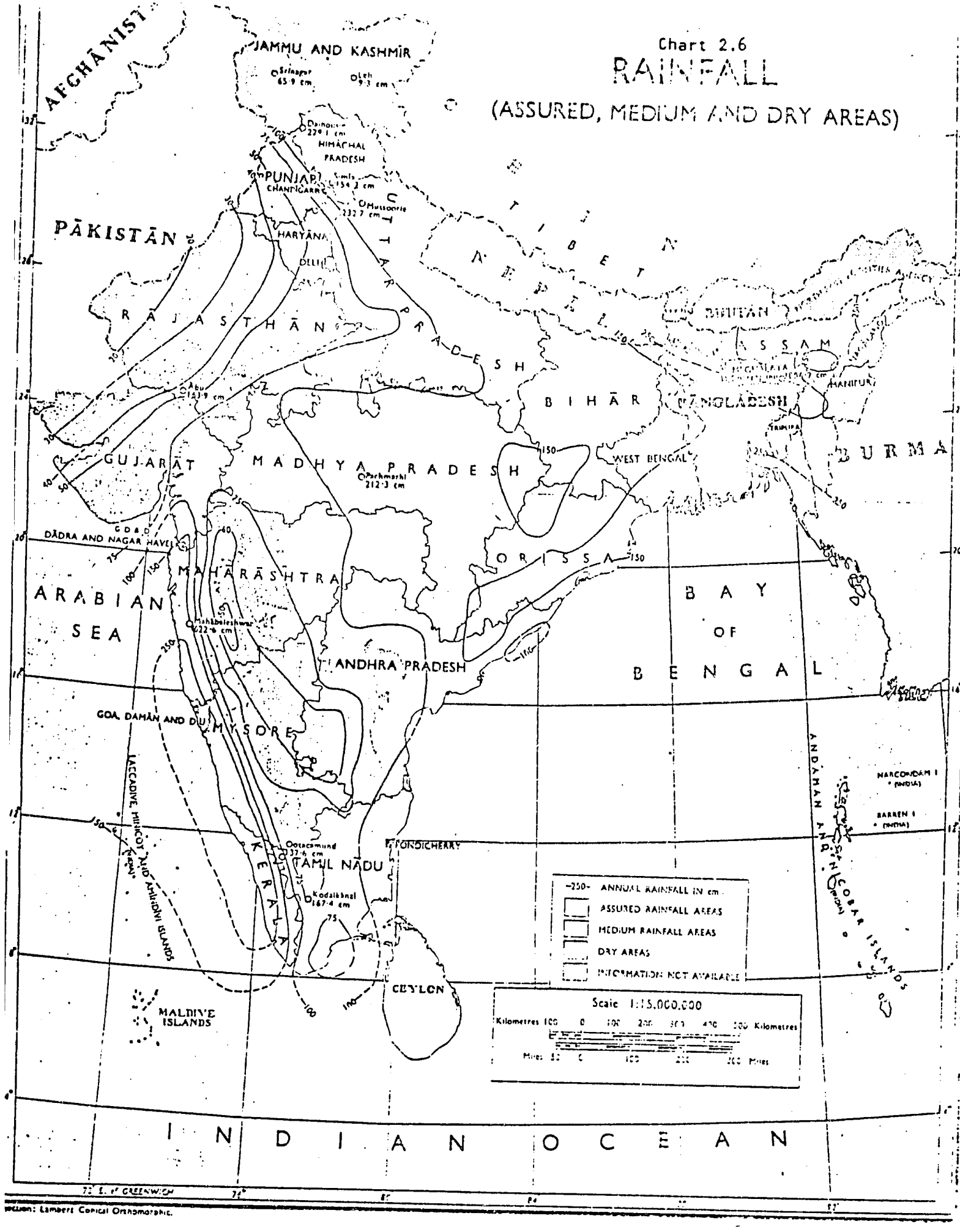


Chart 2.6

RAINFALL

(ASSURED, MEDIUM AND DRY AREAS)



RESEARCH INFRASTRUCTURE

3.1 Introduction

Systematic multi-locational and multidisciplinary research on oilseeds did not begin in India till the late sixties. However, a good deal of work on the collection of cultivars and the selection of varieties suitable for cultivation under specific local conditions was done before 1947 both at the Pusa (Bihar) stacion of the Indian Council of Agricultural Research (ICAR) and the research stations of government departments of agriculture in a few important provinces such as Bombay and Madras. These stations worked in isolation and independently of one another. Various ad hoc research schemes in state departments of agriculture, central institutions and basic universities were sponsored after 1947 by the Indian Central Oilseeds Committee (ICOC) with funds generated by the agricultural produce cess earmarked for oilseed research. ICOC was abolished in 1966 and replaced by the Oilseeds Development Council under the administrative control of the Department of Agriculture of the Union Ministry of Agriculture. With the reorganization of agricultural research in 1967, the responsibility of oilseed research was taken over by the ICAR. (80)

The All India Coordinated Research Project on Oilseeds (AICORPO) with 32 research centers scattered over the important oilseed growing regions, and covering three edible and two nonedible oilseed crops - groundnut, sesame, rape and mustard, castor and linseed - was set up in 1967, marking the beginning of multi-locational, multidisciplinary coordinated research on oilseeds. It was elevated to the status of a project directorate in 1976. The directorate undertakes some research on important aspects in addition to fulfilling such national service roles as maintaining and supplying germ plasm, organizing off-season nurseries to promote and accelerate research interests, monitoring and forecasting pests and diseases, issuing early warnings on pest and disease outbreaks and generally performing as a lead center in relation to its subject matters. Research work at various centers is coordinated by the Project Coordinators.

3.2 Institutional Structure of Research

AICORPO today includes three more edible oilseed crops - safflower, niger and sunflower - taking the total number of edible crops for coordinated research to six. There are 62 research centers and three off-season nurseries - two in Himachal Pradesh and one in Tamil Nadu. Nineteen of the 62 research centers work on groundnut, seven on rape and mustard, eight on sesame, five each on safflower and niger, six on sunflower, four each on castor and linseed, while four centers work on physiology, microbiology and other aspects of oilseeds. There are eight units each led by a project coordinator, one for each oilseed crop, and one coordinator for niger and sesame projects. For research on soybean, a separate All India Coordinated Project was set up in 1967. It has 19 research centers with its coordinating unit in Pantnagar and functions outside the Project Directorate of Oilseeds Research.

A National Groundnut Research Center was set up in Junagadh, Gujarat, in 1979 to carry on basic and fundamental aspects of groundnut research with a view to breaking the yield barrier in groundnut. It has independent status but it too participates in the tests of the coordinated network.

The coordinated research centers are located at either ICAR Institutes or agricultural universities under a Memorandum of Understanding between ICAR and the concerned university. ICAR provides 75 % of the cost of the center while the university bears the remainder and also provides necessary facilities such as adequate farm land with irrigation and drainage facilities, laboratory facilities and equipment, seed stocks and foundation seeds, microbial culture, etc. Each center is headed by a senior scientist under administrative control of the head of the university department and assisted by a scientific staff of two to six depending upon whether the center is a main center or a subcenter. Although the coordinated center is under the direct control of the institute/university, it is responsible for implementing the technical program assigned to it strictly according to the recommendations of the annual workshop. Conceptually, neither the scientist, nor the host institution has

the power to modify the technical or the experimental program of the center but in practice some deviations occasionally occur. Although each center is responsible for one crop, it participates in the multi-locational testing of other crops as well.

The project coordinator heads the "coordinating unit" of the project and is supported, generally, by a research assistant and several administrative assistants. He is under the administrative control of the institute director or the vice-chancellor of the agricultural university, but under the technical control of the Deputy Director General (Oilseeds) of ICAR. The primary function of the project coordinator is to monitor and to coordinate the research work at different centers involved in the coordinated project and provide leadership to the entire program. The annual workshop is a very important part of the whole system. It is a forum where the year's work is reviewed, technical programs for the following year are formulated, specific tasks are assigned to different centers and recommendations regarding varietal releases are made. (41)

3.3 Research Focus

After a variety has been developed at a center, it is entered into the AICORPO system for multi-locational and multidisciplinary trials - the initial evaluation trial (IET), the coordinated varietal trial (CVT) and the national elite trial (NET) to test its performance. It is also tested for its agronomic characteristics, e.g., fertilizer response, and for pathological entomological and other characteristics. The focus of research in the AICORPO network on groundnut and rapeseed/mustard may be summarized as follows:

Groundnut:

A. Breeding and Genetics

1. Germplasm evaluation;

2. Breeding for breaking present yield barrier and for special characteristics - earliness, high yield, high shelling percentage, high oil content, high quality oil and meal, suitability to different cropping systems;

3. Mutation breeding - irradiation with gamma rays and chemical mutagens;

4. Hybridization;

5. Varietal trials.

B. Agronomy

1. Date of sowing-cum-variety-cum-spacing trials;

2. Fertilizer response;

3. Average plant population for bunch and spreading varieties;

4. Effect of gypsum;

5. Effect of Rhizobium culture;

6. Effect of different micro-nutrients;

7. Weed control;

8. Intercropping of groundnut with other crops.

C. Physiology

1. Research to increase module number and to increase number of pods;

2. Screening of varieties for drought tolerance;

3. Studies on dormancy reduction and induction.

D. Entomology

Research for control of aphids, leaf minors, thrips, red hairy caterpillars and white grub.

E. Pathology

Research on seed treatment, chemicals and its dosage; on control of leaf spots, rusts, seed rot, root rot and stem rot, and bad necrosis virus.

Rape and Mustard:

A. Breeding and genetics

1. To breed high yielding, disease and pest resistant, drought resistant varieties;

2. To breed varieties with better seed quality, oil and meal;

3. To screen germplasm for tolerance to salinity, frost and freezing temperature;

4. To screen germplasm for better plant types to suit intercropping;

5. To develop short duration varieties with high yield and high oil content.

B. Agronomy

1. To develop agronomic practices for different agro-climatic zones;

2. To determine fertilizer response;

3. To determine the effects of sowing time, seed rate, row spacing, etc., on yields.

C. Entomology/Pathology

To investigate insect and disease problems and their control.

3.4 Adaptive Trials

When a variety's performance has been satisfactory in all trials, it is ready for the next stage of evaluation. The AICORPO system provides for pre-release adaptive trials of newly developed seed varieties with recommended packages of inputs (minikits) on farmers' fields to be conducted by the extension divisions of the state departments of agriculture. It also provides for discussions and evaluation of the results of these adaptive trials at the annual workshops, before varietal releases can be recommended. However, this critical stage of evaluation seems to have run into difficulties. The trials allotted to the states are often not conducted or, if conducted, are too few to be statistically meaningful. Often the results are not relayed back to the respective project coordinators for evaluation.[21/]

21/ See various annual reports and reports on the proceedings of annual workshops.

The AICORPO system's response to this problem has been to get some seeds distributed to willing farmers through agricultural universities, ICAR Institutes and reputed organizations outside the AICORPO network such as the National Dairy Development Board (NDDB) and the Vanaspati Manufacturers' Association (VMA). While some information on yield performance of the varieties does flow back to the scientists through these channels, these trials are not a satisfactory substitute for a well laid out study under actual farm conditions. At most, current practices can generate limited data, limited by inadequate geographical coverage and by the small number of farms covered. Field testing of technology through field demonstrations is not wholly satisfactory either because of the limited number of demonstrations held and of the limited area under demonstrations. Field demonstrations of groundnut technology, for example, were held only four times from kharif 1980 to 1983 on half acre plots. The total number of demonstrations were only 50, 74, 73, and 19 during 1980, 1981, 1982 and 1983 respectively.[22/] Considering the vast area under oilseeds spread over so many states covering diverse agro-climatic conditions, the number of field demonstrations is totally inadequate. Adaptive trials and field testing of research results therefore seem to be the weak links in the research system.

3.5 Research Outside AICORPO System

Oilseed research outside the AICORPO system is limited to a few centers - the International Crop Research Institute for the Semi-Arid Tropics (ICRISAT), the All India Coordinated Research Project in Dryland Agriculture (AICORPDA) and VMA's Oilseeds Research and Development Institute (VORDI). Oilseed research began in ICRISAT only about a decade ago and is limited to the development of groundnut crop varieties suitable for the post-rainy (rabi/summer) season. It has developed a large germplasm collection and a few varieties that are now in various stages of evaluation in the AICORPO system.

22/ AICORPO Kharif Annual Report on Groundnut for various years.

The relationship between ICRISAT and AICORPO is reciprocal. Just as the varieties developed at ICRISAT enter the AICORPO network for multi-locational testing at various coordinated centers, so are the varieties developed within AICORPO tested at the ICRISAT center. ICRISAT scientists participate in the evaluation of technology at annual AICORPO workshops, as do AICORPO scientists at the international workshops organized by ICRISAT. AICORP-DA, set up in 1970, is concerned with selecting the most efficient crops and varieties suited to dryland regions and developing suitable systems of intercropping and alternative cropping patterns. Only a small part of its activities is focussed on oilseed. It has 23 centers and covers the disciplines of agronomy, soil science, plant science and agricultural engineering, however, it does not engage in the development of new varieties. Organizations like VORDI, NDDB enter into the AICORPO system as additional agencies for multi-locational testing of varieties developed in the AICORPO system and for trying out some pre-release varieties on farmers' fields in their areas of operation. VORDI has also tested out at the farm level some agro-chemicals and growth regulators manufactured by private sector manufacturers. (78)

ANNEX

DEVELOPING A NEW GROUNDNUT VARIETY: THE STORY OF KADIRI 3

One compact plant of bunch habit and early maturity was spotted from a culture called "Robout 33", grown for the first time in 1969 at Regional Oilseeds Research Station, Kadiri, Andhra Pradesh. Next, the produce of this single plant was isolated and multiplied. The stabilized material was then tested for yield potential over several years. Finally, it was released in Andhra Pradesh in 1978 under the name of "Kadiri 3".

The variety entered into the AICORPO System under its culture name of "Robout 33-1" in 1976 for exhaustive tests at different locations to determine its suitability to other agro-climatic zones. The Coordinated Varietal Trials (CVT) were conducted in kharif 1976 and 1977, the National Elite Trials (NET) from 1978 to 1981. In all, 21 centers were involved at some time or another in 11 groundnut producing states in these six years of trials with Robout 33-1. Some centers were allotted the trials late, some dropped out and there were crop failures in a few others.

In kharif 1976 CVT, 12 centers were involved, although data are available for 11. In terms of yield, Robout 33-1 stood first at five centers, and second at three centers. The yield averaged over 11 centers was 1253 kg/ha. (See Table) In next kharif's CVT, nine centers were involved. The variety ranked first at four centers in terms of yield which averaged 1297 kg/ha.

Twelve centers were involved in NET 1978 and the variety ranked first at six - average yield was 1433 kg/ha. During 1979 NET, the variety ranked first in four centers. In trials the following two years the variety ranked first at one center.

The variety was recommended in 1982 for testing in adaptive trials in farmers' fields all over the country by the Annual Kharif Oilseeds Workshop.

It was additionally tested for suitability in rabi/summer season over a period of three years. Based on the pooled results, it was recommended for adaptive trials in 1983.

Kadiri 3 now awaits clearance from the Central Varietal Release Committee. However, certified seed of this variety will be available to farmers only after a few years.*

*Based on (61) and AICORPO reports for relevant years.

TABLE: YIELD PERFORMANCE OF ROBOUT 33-1 AT CVT 1976 AND NET 1978

CENTER	YIELD (KG/HA)	
	CVT 1976	NET 1978
ICRISAT	1711 (1)	497
Karimnagar	1049 (2)	1376 (1)
Junagadh	1817 (1)	1848
Dharwar	1656	1410
Raichur	572	1993 (1)
Khargone	1308 (1)	1963 (1)
Akola	1215	323 (2)
Jalgaon	754 (1)	660
Chiplima	1667 (1)	1161 (1)
Pollachi	1468 (2)	
Jindivanam	569 (2)	986 (1)
Rajendranagar		1151 (1)
Aliyarnagar	717	
Hissar		3776 (2)*
Mean	1253.27	1392.5
EV	35%	65%

NOTES: Figures in parenthesis denote rank.
*Fully irrigated

SOURCE: AICORPO reports.

4. AVAILABLE TECHNOLOGY

4.1 Recommended Package of Practices

A recommended package of practices which defines a crop's production technology, consists of three broad components: an improved variety of seeds, a number of agronomic practices that must be adopted, and the inputs that are required to be applied in order to realize the yield potential of the seed variety included in the package. The most important component of a crop package, seed, varies somewhat from one state or agro-climatic zone to the other, but there is a greater degree of commonality and uniformity in recommended agronomic practices. Included inputs are, similarly, common across zones or states or vary only marginally. For example, the technologies for kharif groundnut in Gujarat and for soybeans for all zones have been summarized and presented in tabular form in Annexes A and B.

4.2 Groundnut (Kharif)

New varieties released since the setting up of AICORPO in 1967 total about 38, of which 19 are Spanish or Virginian bunch type, eight Virginia runner type and the rest semi-spreading type. Bunch varieties are relatively short duration varieties, maturing in three to four months. These are suitable to irrigated areas but can be adopted in areas with low rainfall as well. Characteristically, bunch varieties produce nondormant seeds. This quality frequently leads to considerable yield loss because of sprouting in the field or on the threshing floor should there be a wet spell at harvest time. Runner or spreading varieties take from four to five months to mature. Their seeds, unlike those of bunch variety, are of high dormancy, requiring about two to two and a half months for maximum germination.

Groundnut varieties currently recommended for farmer use in kharif season, together with their characteristic features, are listed in Table 4.1. These varieties provide a base of yield potential varying from an average of 1250 kg/ha to about an average of 2800 kg/ha, the higher average yields generally representing the potential of irrigated crops.[23/]

Most of the practices that have the greatest impact on yield relate to the seeds - seed selection, seed treatment, seed rate, spacing, and sowing time. Bold and well-filled pods alone are recommended for sowing. Since the viability of stored kernels deteriorates and seeds are attacked in storage by pests, shelling should be done just before sowing by using hand or power-operated decorticators. Seeds should be treated with either Thiram or Bavistin to control pathogens causing seed and seedling diseases. Seed rate varies according to variety type (bunch or runner) and spacing. At the commonly recommended spacing for bunch variety of 30 x 10 cm. The required seed rate is 100 to 110 kg/ha, which gives a plant population of 0.33 million/ha, considered to be optimum. Generally recommended spacing for semi-spreading and spreading (runner) varieties is 30 x 15 cm. The seed rate at this spacing is 95 to 100 kg/ha to give a plant population of 0.22 million/ha, considered to be optimum. Early sowing ensures better yield. The advancement of sowing by two weeks before the normal onset of monsoon with the help of one presowing irrigation is highly recommended. (62) AICORPO results indicate yield gains of 19 to 46 % in the case of premonsoon sowing. (64) Manual weeding or application of weedicides is recommended to keep the crop weed-free for 45 days after sowing.

23/ The term "yield potential" refers to the yield obtained at research stations in varietal trials.

Besides farmyard manure at the rate of 10 tons/ha, some fertilizer application is recommended. Although groundnut fixes atmospheric nitrogen with the help of Rhizobium,[24/] it takes about 25 to 30 days for the Rhizobium nodules to form. Hence, application of 10 kg N/ha as a starter dose is recommended. A top dressing of another 10 kg of N/ha may be applied after a month depending upon the state of root nodules. In case the soil is deficient in phosphorous and potash, 16 to 40 kgs of P and up to 50 kgs of K may be used per hectare. About 500 kg/ha of powdered gypsum is recommended for application to the plant base when the crop is in peak flowering stage. One or two irrigations during dry spells at the stages of peak flowering, peg formation and pod development are extremely important to realize potential yield.[25/] Moisture stress at these periods of plant growth can reduce yields by 33 to 63 %. Since the released varieties are not pest and disease resistant, a variety of insecticides and chemicals are specified in the package for farmer use. (25) (33)

4.3 Groundnut (Rabi)

Technology for rabi/summer groundnut is yet to take concrete shape. Research on rabi/summer groundnut began in ICRISAT first and was not taken up in AICORPO till 1980/81. AICORPO results suggest that

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24/ In areas where groundnut is a new introduction, rhizobial culture is recommended for application in the first year. (62) (63)

25/ This has been variously called "protective irrigation," "supplementary irrigation" and "life-saving irrigation."

varieties bred for kharif are not entirely suitable for rabi/summer cultivation. Several varieties are at final trial stage - Robout 33-1 (Kadiri 3), J-1, ICRISAT's ICGS-11, RSHV-1, and CO-1. Meanwhile, the recommended package includes some varieties released 46 years ago, such as TMV2, AK-12-24, and some released more recently, such as TMV7 (1967), J-11 (1964), Spanish improved (1965), Kadiri 3 (1978), and TMV12. (33) (2)

Soil and atmospheric temperature determine the sowing time for rabi/summer groundnut. Minimum soil temperature must be above 18°C. Plant growth is adversely affected in atmospheric temperature of less than 13°C. About 20 to 30 kg of N in two equal doses, one at sowing and the other at peak flowering, should be applied. Agronomic practices are the same as for kharif groundnut. However, 10 to 11 irrigations evenly distributed over the growth phase are needed for yield maximization.[26/]

4.4 Rapeseed and Mustard

Grown under a wide range of agro-climatic conditions, the rape and mustard group of oilseeds includes five types of crops - Indian mustard, toria, brown sarson, yellow sarson and taramira. Varieties recommended for commercial use in different states are listed in Table 4.2. Toria is the only short duration crop in the group, maturing between 70 and 100 days while others are all long duration crops. Taramira, a hardy crop that can be grown on very poor soils and in low rainfall areas, takes about 150 days to mature. Indian mustard and the brown and yellow sarson take between four and five and a half months. Potential yields of recommended varieties vary a great deal from type to type. It is eight to 15 Q/ha for toria, five to six Q/ha for taramira, 10 to 20 Q/ha for mustard and from 10 to 15 Q/ha for the two types of sarsons. Taramira is a totally rainfed crop, while the other types can be grown both under rainfed and irrigated conditions. (24)

26/ AICORPO results indicate that yields start declining after 11 irrigations. (64)

Sowing time for these crops is during September to November. Optimum sowing time varies from state to state depending upon the temperature which must not exceed 30°C.

Early sowing is highly recommended in order to minimize pests and disease incidence. Delayed sowing reduces yields drastically. Seed rate varies from three to five kgs. Seed treatment with Carbondazin or Brassicol or Captan or Agrosan or Dithane is recommended for protection against root-rot and sclerotinia diseases. Under dryland conditions seeds should be sown in furrows with a ridger-seeder to establish a good crop stand and for better moisture conservation. Seed should be sown four to five cm deep while fertilizer should be drilled at seven to 10 cm depth so that seed does not come in contact with the fertilizer. For better germination and early seedling vigor, seeds should be presoaked in water. Crops should be thinned 15 to 20 days after sowing to maintain plant-to-plant distance of 10 to 15 cm. Thinning should be followed by weeding. (7)

Two irrigations, one at flowering and a second at the fruiting stage, are recommended as protective measures. Of all the types, mustard is most responsive to nitrogen; Sixty kg/ha of N is recommended for irrigated and 40 kg/ha of N for rainfed mustard. The recommended nitrogen dose for toria is 40 kg/ha. Dosages of other nutrients depend upon soil conditions. Half the nitrogen, and other nutrients if needed, should be drilled in before sowing, and the balance should be applied at the time of first irrigation in the form of foliar spray. Since no varieties are resistant to pests and diseases, timely plant protection measures must be undertaken. (24)

4.5 Soybean

Early varieties of soybean - Bragg, Clark 63, Lee, Davis and Hardee - were highly susceptible to yellow mosaic virus in the northern Indian plains, especially in the Tarai region of Uttar Pradesh, with heavy yield losses. Three varieties - Alankar, released in 1977, and PK-262 and PK-327, released

in 1982 - are tolerant to this virus. (58) About 19 other varieties have been released so far with maturity periods varying from 105 to 130 days and potential yields of 15 to 35 q/ha. (13)

Soybean sowing time is between early June and mid-July. In the southern zone a rabi crop can be raised by sowing between early October and November. Recommended spacing between rows is 45 to 60 cm and five cm between seeds. For an optimum plant population of 0.4 to 0.6 million per hectare, the recommended seed rate is 75 kg/ha. Seeds should be treated with Thiram and in case of drought, two irrigations - one during flowering and the other during pod filling stage - are recommended. With Rhizobium inoculated seeds, 20 kg/ha of nitrogen application is recommended; use of other nutrients is dependent upon soil conditions. Plant protection measures have been standardized - two to three sprays of thiodan and metasystox may be applied according to disease or pest infestation.

4.6 Sunflower

Sunflower varieties generally mature in 100 to 110 days. Two varieties, Morden and BSH-1 are short-duration varieties and have wide adaptability. Morden, a dwarf variety, matures in about 80 days, while BSH-1, a hybrid, matures in about 95 days. The latter is suited to assured rainfall zones and irrigated tracts and is resistant to rust. Yields of Morden in rainfed and irrigated cultivation are about 600-800 kg/ha and 1500-1700 kg/ha respectively; BSH-1 yields about 1000-1500 kg/ha. Both were released in 1980. (25)

Since it is a cross-pollinated crop, sunflower cultivation requires renovated seed for high yield. Seed rate is only 10 kg/ha. Seeds need to be soaked for 12 hours in water and dried in the shade for quick germination. These should be pre-treated with Thiram or Brassicol. Early sowing is recommended.

Delayed sowing may reduce yields up to 50 % of potential because of reduction in vegetative and reproductive phases and increase in incidence of disease. Sowing should be so adjusted to the local rainfall pattern that flowering and pollination do not coincide with rainy days. Fields should be kept free of weeds for at least 45 days by hoeing and hand weeding, or by using weedicides. Critical stages of growth when irrigation is needed are germination, floral primordia initiation, capitulum initiation, flowering and seed development. For light soils nine to 10, and for heavy soils five to six irrigations are required to realize potential yield. About six to eight tons/ha of farmyard manure and 30 to 40 kg of N/ha are recommended. Unfavorable weather and low bee activity during flowering affect pollination and seed-setting adversely therefore hand pollination on alternate days in the morning hours is recommended. (25)

The technology for other oilseeds - safflower, niger and sesame - has more or less the same pattern: a number of agronomic practices related to seed care, use of a small amount of nitrogenous fertilizer, protective irrigation and the use of plant protection measures. Safflower varieties released for commercial purposes take 160 to 170 days to mature while niger takes about 95 to 110 days. Several sesame varieties are of shorter duration needing 70 to 100 days to mature. The level of potential yields is small and variable. Thus, under good management, potential sesame yields are 400 to 850 kg/ha while those of niger vary between 450 and 500 kg/ha. The average potential yield of safflower ranges between 600 and 1400 kg/ha.

ANNEX A

PRODUCTION TECHNOLOGY OF KHARIF GROUNDNUT FOR GUJARAT

Recommended Agricultural	Gujarat
Varieties	Gaug 10, Gaug 1, JL 24
Seed Selection	Select bold and well-filled pods and shell them using hand or power-operated decorticator just before sowing.
Seed Treatment	Treat with Thiram @ 3g/kg seed or Bavistin @ 2g/kg seed.
Seed Rate & Spacing	45 x 10 cm for bunch varieties and 60 x 10 cm for spreading varieties. 100-110 kg/ha approximately.
Sowing Time	15 June to 1 July early sowing in the first week of June recommended with one pre-sowing irrigation.
Manures/Fertilizers	10 tons/of compost N:12.5 P:25 K:0.
Gypsum Application	500 kg/ha on soil close to base of plant at flowering stage.
Micronutrients	Zinc Sulphate @ 25 kg/ha if zinc deficiency exists.
Weed Control	Manual weeding or chemicals 2-3 times.
Irrigation	At peak flowering, peg formation and pod development.
Pest Control	Spray monocrotophos 0.05% or dimethoate 0.05% for aphids, jassids, thrips and white flies.
Control of Diseases	Spray Bavistin 0.05% plus Dithane M-45 0.2% to control rust and leaf spot.

ANNEX B

PRODUCTION TECHNOLOGY OF SOYBEAN

ITEM	NORTHERN HILL ZONE	NORTHERN PLAIN ZONE	CENTRAL ZONE	SOUTHERN ZONE
Varieties	Bragg, Lee, Shilajeet, PB-1	Bragg, Ankur, Shilajeet, PK-327, PK-262	Bragg, Ankur, JS-2, Gaurav Durga	Davis, KHSY-2, Hardee, CO-1, Improved Pelican
Planting Time	Beginning June to middle July	Last week of June to middle July	Middle of June to middle July	Middle June to middle July (kharif); Oct.-Nov. (rabi)
Spacing	Row to row 45 cm, seed to seed 5 cm.	45 - 60 x 5 cm	30 - 45 x 5 cm	
Depth of Seedling	3 - 5 cm	3 - 5 cm	3 - 5 cm	3 - 5 cm
Fertilizer	20:40:40 NPK+ Bacterial Culture	20:40:40 NPK	20:40:40 NPK+ Bacterial Culture	20:40:40 NPK+ Bacterial Culture
Seed Rate (kg/ha)	75	75	75	75

Seed Treatment: Thiram 3gm/kg seed

Irrigation: During flowering and pod filling stage, if drought.

Plant Protection: 2 - 3 sprays of 0.1% Thiodan + 0.1% Metasytox if needed.

Harvesting: When leaves dry and fall, approx. 14% moisture.

Seed Drying & Storage: 12% moisture, to be stored in moisture proof bags.

Weedicide: Basalin 2 litre/800 litre water/ha presowing incorporation in soil.

TABLE 4.1. IMPROVED VARIETIES OF GROUNDNUT RELEASED IN DIFFERENT STATES

VARIETY	HABIT GROUP	YEAR OF RELEASE	CENTER WHERE DEVELOPED	AREA FOR WHICH RELEASED	AVERAGE YIELD (kg/ha)
ZONE I (NORTHERN ZONE)					
Bihar					
'BG-1'	SS	1979	Kanke	Bihar	2000
'BG-2'	SS	1979	Kanke	Bihar	2200
Haryana					
'MH-1'	B	1975	Hisar	Haryana	2000
'MH-2'	B	1978	Hisar	Haryana	3000
Punjab					
'M-145'	S	1968	Ludhiana	Punjab	2200
'M-13'	S	1972	Ludhiana	Entire country	2750
'M-37'	S	1980	Ludhiana	Punjab	1350
'M-197'	SS	1982	Ludhiana Punjab	Loamy soils of	1800
Uttar Pradesh					
'Chandra'	S	1977	Mainpuri	Uttar Pradesh	2500
'Chitra'	SS	1984	Mainpuri	Uttar Pradesh	2000
ZONE II (WESTERN ZONE)					
Gujarat					
'GAUG-1'	B	1973	Junagadh	Gujarat	1500
'GAUG-10'	S	1973	Junagadh	Gujarat	1800
'GG-2'	B	1983	Junagadh region of Gujarat for summer season	Saurashtra	
'GG-11'	S	1984	Junagadh	Entire Gujarat	
ZONE III (CENTRAL ZONE)					
Madhya Pradesh					
'Jyoti'	B	1971	Khargone	Madhya Pradesh	1600
Maharashtra					
'TG-1' ('Vikram')	SS	1973	BARC, Trombay	Entire country	2695
'JL-24' ('Phule Pragati')	B	1978	Jalgaon	Maharashtra and Gujarat but adapted to entire country	1800

Table 4.1 (contd.)

	'TG-17'	B	1982 Trombay	BARC, for summer season	Maharashtra	2000
	'UF.70-103'	SS	1984	Akola nut area in western Maharashtra and Vidharbha regions	Summer ground-	
			ZONE IV (SOUTH - EASTERN)			
Orissa						
	'Kisan'	B	1980	Chiplima	Orissa	1600
	'Jawan'	B	1983	Chiplima	Orissa	
			ZONE V (PENINSULAR ZONE)			
Andhra Pradesh						
	'Kadiri-71-1'	S	1971	Kadiri region of Andhra Pradesh	Rayalseema	1390
	'Kadiri-2'	SS	1978	Kadiri Visakhapatnam and Chittoor districts of Andhra Pradesh	Srikakulam,	1800
	'Kadiri-3' ('Rabut33-1')	SS	1978	Kadiri entire country.	Andhra Pradesh; but adapted to	2100
Karnataka						
	'S.206'	B	1969	Raichur Karnataka	Northern	1900
	'S.230'	S	1969	Raichur Karnataka	Northern	1280
	'Dh.3-30'	B	1975	Dharwar of northern Karnataka	Bunch tract	2800

Table 4.1 (contd.)

'KRG-1'	B	1981	Raichur	Raichur, Bellary and Gulbarga districts	1200 (RF) 2230 (I)
Tamil Nadu					
'TMV-7'	B	1967	Tindivanam	Tamil Nadu	1400
'TMV-8'	SS	1968	Tindivanam	Southern and Central Tamil Nadu	1700
'POL-1'	B	1968	Pollachi	Pollachi tract of Tamil Nadu	1270
'TMV-9'	SS	1970	Tindivanam	Tamil Nadu, but suited for entire country	1150 (RF) 2000 (I)
'TMV-10'	SS	1970	Tindivanam	Tamil Nadu, but suited for entire country	1700
'POL-2'	B	1973	Pollachi	Coimbatore, Salem, Trichi districts	1500 (RF) 2700 (I)
'TMV-11'	B	1977	Tindivanam	Tamil Nadu	1200
'TMV-12'	B	1978	Tindivanam	Tamil Nadu	1250(RF) 2100(I)
'Co-1'	B	1979	Coimbatore	Tamil Nadu	1300(RF) 2200 (I)
'Co-2'	B	1983	Coimbatore	Tamil Nadu	

B: Bunch: SS: semi-spreading; S: spreading; RF: Rainfed; I: Irrigated.

SOURCE: Technologies for Better Crops: Groundnut: Package of Practices for Increasing Production, Indian Council of Agricultural Research, Krishi Bhavan, New Delhi, 1985.

Table 4.2. Improved Variaties of Rapeseed-Mustard released in different states

Name of the variety	Area of adaptability	Average yield kg/ha	oil %	Maturity in days	Remarks
		Toria			
M 27	Assam & Orrisa	1,200 (R)	44.6	90	-
TS 29	Assam & Orrisa	1,200 (R)	44.0	85	-
Agrani (B 54)	West Bengal & Assam	800-1,000 (R)	45.0	80	Dwarf plant, modertately susceptible to Altrnaria downey mildew and aphids
BR 23	West Bengal & Assam	900-1,200 (R)	43.0	100	-
T 9	Uttar Pradesh, Madhya Pradesh & Rajasthan	1,200-1,500(R+I)	44.3	100	-
T 36	Uttar Pradesh, Madhya Pradesh & Rajasthan	1,200-1,500 (I)	43.0	100	-
Sangam	Haryana	1,500 (I)	44.2	105	Profusely branched, small brown coloured seeds, resistant to phyllody
ITSA	Punjab	800-1,000 (I)	44.0	-	Smooth leaves, yellow petals
TL 15	Punjab	1,000 (I)	44.0	85	Profuse primary & secondary branching, seeds brown
DK 1	Himachal Pradesh	800-1,000 (I)	44.0	75	-
		Mustard			
Seeta (B 85)	West Bengal	1,200-1,400(R+I)	38.0	90	Plants spreading, stem pigmented
BR 40	Bihar	1,200-1,400(R+I)	40.0	115	-
Laha 101	Uttar Pradesh	1,500(I)	41.0	150	-
Varuna	Uttar Pradesh	2,000(R+I)	39.8	130	-

Table 4.2 (contd.)

Shekhar	Uttar Pradesh	1,800(R+I)	40.0	135	-
Kranti(PR 15)	Uttar Pradesh	1,500-1,800(I)	40.0	135	-
Patan-67	Gujarat	1,900 (I)	38.0	119	-
Durgamani	Rajasthan	1,000-1,200(R+I)	39.0	135	Resistant to orobanche
RL-18	Punjab	1,250 (R)	37.5	150	Tall plants, black-brown seeds
Pusa Bold	Delhi	1,800 (I)	40.0	140	-
Prakash	Haryana	1,500-2,000(R+I)	39.0	150	Profuse branching, leaves hairy, escapes frost, moderately resistant to diseases and aphids
RH 30	Haryana	1,600(R+I)	40.0	-	Profuse branching, leaves rough with deep serration, non-shattering and very bold seeds
RLM 198	Punjab	1,700-1,800(I)	38.0	152	Tolerant to aphids, Alternaria blight & cold spell, leaves broad
RLM 514	Punjab	1,500-2,000(R+I)	40.0	152	Seeds dark-black
RLM 619	Punjab	1,500 (I)	43.0	140	Short plants, tolerant to Alternaria blight, white rust & downey mildew
		Brown Sarson			
BS 2	Uttar Pradesh	1,200-1,500(R)	44.5	115	-
BS 70	Uttar Pradesh	1,200-1,500(I)	45.0	130	-
Pusa Kalyani	Uttar Pradesh	1,300-1,500(I)	45.0	135	-
BSH I	Haryana	1,200-1,500(I)	45.0	135	Leave hairy with large obtuse terminal lobe, petals deep-yellow

Table 4.2 (contd.)

KOS I	Kashmir	1,000(R)	44.0	230	- Yellow Sarson
Bency (B 9)	West Bengal	1,200-1,400(R)	46.0	90	Plants tall erect, fruit two chambered moderately susceptible to aphids
66-197-3	Bihar	1,400-1,600(I)	42.0	120	-
T 151	Uttar Pradesh	1,400-1,500(I)	46.0	120	-
K 88	Uttar Pradesh	1,400-1,800(I)	43.0	130	-
Patna Sarson 66	Gujarat	1,200(I)	42.0	110	-
Ys Pb 24	Gujarat	1,000(I)	46.0	145	Plants tall, seeds yellow
		Taramira			
T 27	Haryana	650(R)	36.0	150	Hairy, profuse branching, late in maturity, yellow-green seed colour
ITSA	Punjab	560(R)	35.0	150	Plants hairy, greyish brown seed

TABLE 4.3 IMPROVED VARIETIES OF SESAME RELEASED IN DIFFERENT STATES

Name of the variety	Area of adapt-ability	Year of release	Average yield kg/ha	Oil %	Maturity in days	Remarks
TMV-1	Tamil Nadu	1946	560	50.0	85	Fairly bushy, with moderate branching, red brown to black seed
TMV-2	Tamil Nadu	1947	425	52.0	80	Plants open with moderate branching, dirty white seeds
TMV-3	Tamil Nadu	1948	560	52.0	80	Profuse branching, plants bushy
T-12	Uttar Pradesh	1960	500	53.0	85	4-6 branches, white seed
T-4	Uttar Pradesh	1961	600	52.0	100	Moderate branching, white seed
T-85	Maharashtra	1962	550	50.0	90	Bold white seed
Punjab Til-1	Punjab	1966	500	50.0	80	Bold white seed
Mrug 1	Gujarat	1967	500	53.0	85	More branches, monocapsular, white seed
KRR-1	Tamil Nadu	1967	400	51.7	120	Plants bushy, white seed
Purva-1	Gujarat	1968	400	50.0	120	Multicapsular, reddish seed
T-13	Uttar Pradesh	1968	600	50.0	90	4-5 branches, white seed

Table 4.3 (contd.)

Pratap (C-50)	Rajasthan	1968	500	50.0	100	Unbranched, capsules 6-8, white seed
KRR-2	Tamil Nadu	1970	400	52.0	118	Profuse branching, seeds dull white
N-32	Madhya Pradesh	1970	77-	53.0	95	Single stem, multicapsular, seeds shining white
Vinayak	Orissa	1972	500	-	-	Tolerant to leaf spot
Gauri	Andhra Pradesh	1974	800	37.0	95	Brown seeded
B-67	West Bengal	1974	-	40.0	-	-
T-13	Rajasthan	1975	600	-	-	-
TMV-4	Tamil Nadu	1977	650	52.0	85	Bushy, profuse branching, brown seed
TMV-5	Tamil Nadu	1978	400	54.0	75	Moderate branching, seeds brown plumpy
Phule Til 1	Maharashtra	1978	650	51.0	Til-1	Seeds light brown and bold
TC-25	Rajasthan	1978	500	48.4	80	Branched (4-5), white seeded
Madhavi	Andhra Pradesh	1978	850	44.0	70	Light-brown seeds
Haryana Til-1	Haryana	1979	500	50.0	85	Tall medium branched, seeds bold white, field

Table 4.3 (contd.)

JT-7	Madhya Pradesh	1980	800	37.0	85	Branched, white bold seeds
Kalika	Orissa	1979	600	48.7	82	-
Gujarat Til-1	Gujarat	1979	630	49.2	85	Light-brown seed
TMV-6	Tamil Nadu	1979	700	54.0	85	Tall growing, moderate branching, seeds brown
Kanak	Orissa	1979	600	47.10	78	-
Kayamkulam-1	Kerala	1980	500	-	95	Branching type
Thilehama (Kayamam-kulam-2)	Kerala	1982	600	-	-	-
Co-1	Tamil Nadu	1983	730	50.1	90	Branched, seeds white
Patan-64	Gujarat	-	746	52.5	-	Seeds white
N 128	Maharashtra	-	450	49.0	120	Monocapsular habit, brown seeds
N-8	Maharashtra	-	375	51.0	125	Monocapsular habit, brown seeds with whitish tinge

TABLE 4.4 IMPROVED VARIETIES OF NIGER RELEASED IN DIFFERENT STATES

NAME OF THE VARIETY	AREA OF ADAPTA-BILITY	YEAR OF RELEASE	AVERAGE YIELD kg/ha	OIL %	DAYS TO MATURITY	REMARKS
Ootacamund	M.P., Orissa Maharashtra and Karnataka	Before 1955	500	42	110	Sensitive to thermo- and photo-periods
N-5	Bihar	Before 1955	450	40	105	Photo- and thermo-sensitive seeds, small and black
IGP-76 (Sahyadri)	Maharashtra Orissa	-	475	40	105	Photo- and thermo-sensitive small seeded
N 12-3	Maharashtra	1970	450	40	110	-
N 71	Karnataka	-	475	42	95	Seeds are bold and black
Gaudaguda local	Andhra Pradesh	-	570	39	95	-
Phulbani local	Orissa	-	400	40	100	Suitable for crop rotation with ragi or cowpea or French bean

TABLE 4.5 IMPROVED VARIETIES OF SAFFLOWER RELEASED IN DIFFERENT STATES

NAME OF THE VARIETY	AREA OF ADAPTABILITY	YEAR OF RELEASE	AVERAGE YIELD kg/ha	OIL%
A-300	Karnataka (drought prone area)	-	800-1,000(R)	-
N 62-8	Ahmednagar, Pune, Sholapur, and Nasik district	1959	900-1,000(R)	30.3
Manjira	Andhra Pradesh (assured Krishna area)	1976	800-1,000(R)	32.5
S-144	Karnataka (assured moisture area)	1976	900-1,000(R)	32.0
A-1	Entire country	1976	800-900 (R)	31.0
Tara	Entire Maharashtra	1976	1,000-1,200(R)	32.2
K-1	Tamil Nadu	1976	600-800 (R)	-
CO-1	Tamil Nadu	1979	700-800 (R)	-
Bhima (S-4)	Maharashtra (both in moisture and drought-prone areas)	1982	1,200-1,400(R)	32.5
JSF-1	Madhya Pradesh and Rajasthan	1982	1,000-1,500(R)	30.0
T 65	Uttar Pradesh	-	1,200 (R)	-

TABLE 4.6 IMPROVED VARIETIES OF SUNFLOWER RELEASED IN DIFFERENT STATES

NAME OF THE VARIETY	AREA OF ADAPTABILITY	YEAR OF RELEASE	AVERAGE YIELD (kg/ha)	OIL%	DAYS TO MATURITY	REMARKS
EC-68414	Tamil Nadu, Maharashtra, W.Bengal, A.P., U.P.	1972	800-1,000	42-46	110	Drought tolerant suited late planting susceptible to rust and Alternaria.
EC-68415 (Armavi-riski)	Karnataka, Tamil Nadu	1972	800-1,000	42-45	110	Drought tolerant, suited for marginal and sub-marginal lands, susceptible to rust and Alternaria.
Romson Record	Punjab		700	41.2	108	Dark seeded, broad leaves
BSH-1 (cms 34X RHA, 274)	Karnataka	1978	1,000-1,500	42-45	95	Hybrid, uniform maturity, suited for assured rainfall and irrigated tracts, resistant to rust and fairly tolerant to Alternaria leaf spots.
Morden (Cernianka-66)	Whole of India	1980	600-800(R)	42-46	80	Very early maturing, dwarf 1,500-1,700(I) More self-fertile

Surya (PKV-SUF)	Maharashtra	1982	1,000-1,200	-	95	Better seed filling, increased seed weight and increased oil yield/ha over EC-68414, seeds black with white stripes, recommended for Vidharbha region. It has wide adaptability.

5. ASSESSMENT OF AVAILABLE TECHNOLOGY

5.1 Summing Up the Attributes

The recommended packages of practices for different oilseed crops, summarized in the previous section, have certain common attributes. To begin with, they all require irrigation. Thus, the package for kharif groundnut includes at least two "protective" irrigations during dry spells at the stages of flowering, peg formation and pod development while that for rabi/summer groundnut includes 10 to 11 irrigations[27/] spread out evenly over the period of plant growth. Similarly the package of practices for crops in the rapeseed and mustard group, with the exception of Taramira, calls for at least two irrigations. Two irrigations at the time of flowering and pod filling are desirable for soybean. Nine to 10 irrigations are considered necessary for sunflower in light soils and five to six in heavy soils. At least one life-saving irrigation is mentioned for safflower. In most cases, early or pre-monsoon sowing with the help of one pre-sowing irrigation is recommended. None of the varieties included in the packages are drought resistant, although one or two varieties are described as drought tolerant.

Second, most of the recommended varieties have medium to long duration. Only one variety of groundnut, JL-24, may be said to have short duration with its mean maturity period of 90 days. Sunflower has a couple of short duration varieties - Morden, a dwarf variety which needs about 80 days to mature and BSH-1, a hybrid variety which matures in 95 days. Sesame has a few short

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[27/] Irrigation experiments conducted by AICORPO indicate that more than 11 irrigations result in yield reduction. See (64).

duration varieties that mature in 75 to 90 days. In the rapeseed and mustard group of oilseeds, toria alone has short duration varieties of 75 to 100 days. All other oilseeds in this group have varieties with maturity ranging from four to five months.[28/]

The third important characteristic of the available oilseed varieties, is their vulnerability to pests and diseases. Oilseed crops are commonly regarded as high risk crops, not because of the volatility of product prices, nor because of high input costs, but because of the high risk of crop failure due to inadequate rains and high incidence of pests and diseases. Only some pests and diseases are controllable with chemicals. Effective control measures are not yet available for most of them. Plant protection chemicals are, in any event, costly and, given the often poor and indifferent yields obtained by farmers, the use of chemicals often looks like throwing good money after bad.

Sesame is a case in point. Even with modern inputs the average yield at the farm level is no more than 200 to 250 kg/ha. From the farmers' point of view it does not seem to be worthwhile to spend on chemicals for such small yields. (38)

These shared attributes indicate that the recommended packages of practices for seven different oilseed crops in effect represent a single technology, the relevant domain of which is the small proportion of oilseed land that is irrigated. In Section 2 the required attributes of a technology appropriate to the major proportion of the oilseed land were summarized as (a) short duration and (b) drought resistant. It is obvious that such a technology has not yet been developed. Over most of the dryland farmers have

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28/ One mustard and one yellow sarson variety for West Bengal/Arunachal Pradesh is of 90-95 days duration. (24)

been using a few components of the available technology - recommended seed variety and some fertilizer. But water, the crucial element that can make the technology effective, is not available in this physical milieu. As a result yields are indifferent in most years. They are relatively good only in a few years of adequate rainfall but disastrously poor in years of insufficient monsoon.

5.2 Contrasts with HYV Cereal Technology

Certain features of the available oilseed technology contrast sharply with those of the new (HYV) technology for cereals. The three most important features of the HYV cereals technology may be summarized as follows: (a) agronomic practices that have the greatest impact on yield relate to nitrogen - the rates, methods of application, forms, times of application, relation to water management, etc.; (b) they have varietal plasticity, that is, have the ability to perform well at different levels of management which are generally encountered under farm conditions; and (c) it is not what they require but what they can utilize that makes the new varieties outstandingly different and superior to the local varieties.[29/] The available oilseed technology has totally different attributes. First, the agronomic practices that have the greatest impact on yield relate not to nitrogen, but to the seeds - presowing treatment, seed rate, sowing depth, sowing time, etc. They tend to give the impression that the varieties are frail and "require" a lot of special care. The HYV cereal varieties give a 40 to 50 % increase of yield over traditional varieties at zero level of fertilizer application. The new oilseed varieties used alone give no more than 10 to 20 % increase of yield despite all the special care. Second, the oilseed varieties seem to perform well only at the best level of management, and not at those levels which generally prevail on

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29/ See (26).

farms - they do not possess plasticity. Third, unlike HYV cereals, the oilseed varieties do not utilize increasing amounts of nitrogen, they do not respond to fertilizer in terms of more seeds.[30/] In fact, their fertilizer requirement is very small.

5.3 Response to Fertilizer

Groundnut fixes its own nitrogen requirement through its root nodules. Since the root nodules take about 25 to 30 days to develop, and since the plant demand for nitrogen is high during the early stages of growth, a starter dose of 10 kg of nitrogen/hectare is necessary. A top dressing of another 10 kg of N/ha thirty days after sowing is recommended depending upon the formation of effective nodules. Soybean, too, makes use of atmospheric nitrogen and the recommendation is for 20 kg/N/ha. Mustard varieties, however, seem to respond reasonably well to nitrogen, up to about 60 kg of N/ha. The overall yield with fertilizer is so small in the case of several oilseed crops that fertilizer application does not seem to be attractive, especially under rainfed conditions. The typical response of some of the oilseed crops to fertilizer in different locations (research centers) is presented in Charts 5.1 to 5.3.

5.4 Yield Potential

About 38 different varieties of groundnut are now available, some of which possess a reasonably high yield potential ranging, on an average,

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30/ For Kanwar's conclusion that fertilizer-responsive genotypes with higher yield potential are not yet available for oilseeds see (40).

between 1500 and 2200 kg/ha.[31/] Recently released mustard varieties have an average yield potential of 1500 to 2000 kg/ha. The yield potential of soybean varieties is in the range of 1500 to 3000 kg/ha. Sunflower varieties are now available with potential yields between 1000 and 1500 kg/ha. Varietal development in other oilseeds has been poor. The yield potential of sesame varieties range from 500 to 850 kg/ha while that of niger varieties is between 400 and 570 kg/ha. Average potential yield of safflower ranges between 600 and 1500 kg/ha. These potential yields should be viewed in their right perspective, that is, their levels in relation to recorded actual yields under irrigated conditions.

Time-series data on irrigated oilseed production are not available. However, rabi groundnut, as an irrigated crop, may have its recorded yields compared with the average yield potential of the newer varieties released for farmer use. Three of the recommended varieties for Gujarat are Gaug 1, Gaug 10, and J-11 with respective potential yields of 1500, 1800 and 1300 kg/ha. The recorded yields of rabi groundnut in Gujarat were 2365 kg/ha in 1977-78, 2100 kg/ha in 1979-80 and 1951 kg/ha in 1982-83.[32/] In no year since 1977-78 has the recorded rabi groundnut yield in Gujarat been lower than the yield potential of the recommended varieties. In fact, they have been distinctly higher. Similarly, three recommended varieties for Maharashtra are AK-12-24, SB-XI and karad 4-11. The current (1985) recommendation is to replace the first two varieties by JL-24. The yield potential of AK-12-24, SB-XI, and karad 4-11 are 1250, 1300, 1000 kg/ha respectively. The average expected yield of JL-24 is 1800 kg/ha. The recorded yield of rabi groundnut in Maharashtra was 2033 kg/ha in 1982-83 and 1753 kg/ha the year before. In all other years

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31/ These "yield potentials" refer to yields that have been obtained at research centers.

32/ See (23).

for which official estimates are available, the recorded yields were higher than all the recommended varieties except JL-24. (23) Similarly, AK-12-24 and Kissan are recommended for Orissa. Kissan's potential yield is 1600 kg/ha. The recorded yield of rabi groundnut in Orissa was more than 2000 kg/ha in 1972-73 and 1973-74, more than 1600 in seven years out of 12 since 1971-72, and slightly short of that level in four years.(23) Examples like this can be multiplied. These data seem to indicate that the yield potential of the new varieties is not always and everywhere distinctly superior to the old.[33/] Results from crop cutting sample surveys for groundnut, summarized in Section 2, also confirm this conclusion.

Time-series data on yields of other irrigated oilseed crops are not available to compare with their yield potential. In an important sense, however, such comparisons could be misleading.[34/] Yields obtained at the research centers should be compared with the yields that the top farmers generally obtain and not with the average state yields. Around the mean state yield is a dispersion of observations and some farmers with a better than average level of management obtain yields higher than the average. It is not enough that the research center yields are superior to the average obtained in the state. These must, necessarily,

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33/ It is interesting to note that an official study suggested that "evolving of high yield varieties as in the case of cereal crops of wheat and paddy is the most urgent need if an early breakthrough in the cultivation of oilseeds crops is to be achieved." (53)

34/ Hopper calls such a comparison a fallacy. See W. David Hopper, (31).

be well above what the best farmers obtain with older varieties.[35/]

Whether a new variety will be attractive to farmers will depend not on its yield at research stations, but on the yield the adopters obtain. If adopter-farmers obtained yields superior to those realized by top farmers, the superiority of the variety would be clearly established and more farmers would be likely to adopt it. If not, few farmers are likely to adopt the variety. The point may be illustrated with the data on groundnut from two areas - Junagadh and Latur.[36/] In Junagadh, the survey included 10 farmers, nine of whom used improved varieties. The median yield of these nine farmers was 500 kg/ha. That is, half the adopters got more than 500 kg/ha, while the other half got less than this yield. The arithmetic average of yields was 494 kg/ha and the coefficient of variation was 44 %. The yield obtained by a farmer growing the local variety of groundnut was 775 kg/ha. In fact, only one of the nine adopters equaled this yield level. In the case of Latur, only two farmers used improved varieties, while 10 used local. The average yield of the two adopter-farmers was 1175 kg/ha, while the mean yield of nonadopters was 1037 kg/ha, with a variation of 26 %. However, nonadopters in the top two deciles got yields far superior to those of the adopters. The top third decile farmer, also, obtained a yield greater than the average adopter yield. This kind of field result is unlikely to impress the average farmer with the superiority of the new varieties, and their yield potential.

35/ Studies of oilseed yields at the farm level are few and none provides a breakdown by levels of management. Thus it is not possible to evaluate the "yield potential" of the technology in a meaningful way.

36/ These data were generated as part of the "Survey of Agronomic Practices in the Areas of Groundnut Cultivation" conducted by the AICORPO. See Annual Report, 1985.

5.5 Yield Instability

It is not enough that a new variety has high yield potential, its yield must be reasonably stable over time and space. The performance of released varieties at various trials shows that their yields have been highly unstable at research centers. Table 5.1 presents yield data for Robout 33-1 and J-11, two groundnut varieties, at research centers participating in the Coordinated Varietal Trial (CVT) in kharif 1978.[37/] The mean of yields of Robout 33-1 from 11 research centers in CVT was 1253.27 kg/ha, and the percentage variation of yields was 35 %. The average yield of the same variety at NET two years later was higher - 1392.5 kg/ha - but the variation of yields also was higher at 65 %. Yield variations of J-11 were not very different. At CVT, its mean yield was 863.37 kg/ha while the variation of yields was 36 %. At NET, its mean yield was 1144 kg/ha but its variation across research centers was 62 %. The interesting point to note is that there is very little yield variability difference between the two varieties, although Robout 33-1 is relatively new and J-11 is old.[38/]

37/ AICORPO Reports, relevant years.

38/ Robout 33-1 was released in Andhra Pradesh as Kadiri 3 in 1978 and is currently in use both in Andhra Pradesh and Gujarat. It is likely to be released to farmers in other states soon by the Central Varietal Release Committee. (See Annex to Section 3 of this review). J-11 was released in Andhra Pradesh and Gujarat in 1968.

The yield performance of selected mustard varieties - KRV Bold, Pusa Bold and Varuna - in rabi season trials in 1980 is shown in Table 5.2. While KRV Bold had better yields than the other two varieties, averaged over six centers (852.7 kg/ha compared to 728 and 653.2 kg/ha of Pusa Bold and Varuna respectively), the variation of its yields across the centers was also higher - 52 %. Yield variations of Pusa Bold and Varuna were as high as 35 % and 43 % respectively. This is one dimension of yield instability - instability over research locations.

Another dimension relates to variations in yields over time at the same location. Varuna (a mustard variety) recommended for use in all states, has the yield potential of 2000 kg/ha but the yield averaged over 5 years of varietal trials at Ranchi, Bihar was only 262 kg/ha, with a range of 167 to 305 kg/ha.[39/] Similarly, BR-23, a toria variety specially recommended for Bihar with average yield potential of 900 to 1000 kg/ha, gave 210 kg/ha averaged over 5 years of varietal trials at the same station. The range of yield was between 78 kg/ha and 404 kg/ha.[40/] The sesame varieties recommended for Rajasthan are C-50, TC-25 and T-13 with yield potential respectively of 500, 500 and 600 kg/ha. At trials at Sumerpur Station, (Table 5.3) the average yields, over a 15 year period were 252.78, 364.26 and 327.70 kg/ha respectively for the three varieties.[41/] In all these trials, the yield potential of C-50 was reached/exceeded only in one year, that of TC-25 in four years, and that of TC-13 in two years. The average yield obtained in

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39/ See (52).

40/ ibid.

41/ See (38).

these trials was between 55 and 73 % of the potential yield. The coefficient of variation which measures the dispersions of actual yields around their means, ranged from 52 to 73 %. In fact, yield instability of these varieties at the research center was almost as great as that of the local variety. (See Table 5.3) The performance of rapeseed-mustard varieties under rainfed conditions at station trials at the Indian Agricultural Research Institute, Delhi over a period of three years is reproduced in Table 5.4. The coefficient of variation ranges from 8 % in the case of Pusa Kranti variety to 23 % in the case of Pusa Bold. Yield instability of two groundnut varieties at station trials in Bihar over five years is shown in Table 5.5. The variation of yield of BG-3 variety was 16 %, while that of AK 12-24 was 37 %. Three years' trials at Birsa station of three soybean varieties (Table 5.6) showed yield variation of 6 % in Punjab-1 variety, to 33 % in the case of Bragg. These data seem to suggest that the productivity of the available genotypes is not very consistent even under controlled conditions at research centers. Genotypes with stable and high yield potential are not yet available for oilseeds.[42/]

5.6 Yield and Income at Farm Level

Data from the evaluation study conducted by the Planning Commission's Programme Evaluation Organization are shown in Tables 5.7 to 5.9 and indicate the range of yields obtained by farmers in selected districts covered by the Oilseeds Development Programme. Rainfed groundnut yields in 13 districts varied from 4.8 quintal/ha to 12.1 q/ha, with an average of 7.8 q/ha. Irrigated groundnut yields in two districts in Tamil Nadu varied from 7.7 q/ha to 13 q/ha. Rainfed mustard yields averaged 5.8 quintals with a range of 2.4 to 12.9 q/ha in eight selected districts, while yields of irrigated mustard averaged

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42/ These results support the point made by J. S. Kanwar. See (40)

8.8 q/ha with a range of 2.7 to 13.3 q/ha. Average yield of sesame varied from 0.6 quintals to 2.6 quintals/ha, while the variation in sunflower yields was between 1.4 and 2.9 q/ha. There was only one district growing soybean in the sample with an average yield on sample farms or 5.9 q/ha. The yield data displayed in these tables are averages of sample farms in selected districts where the degree of adoption of different components of the recommended package of practices was not uniform. These do not, therefore, indicate the impact of the new technology on yields adequately.

With indifferent yields like these, income from oilseed cultivation would be poor. The estimates of costs and returns from groundnut cultivation in Gujarat for three years prepared by the Department of Agricultural Economics, Gujarat Agricultural University, are shown in Table 5.10. It will be observed that returns are poor although 84 % of the farmers in this sample are adopters of the recommended varieties. The estimates of additional costs and additional returns were developed at the Central Research Institute for Dryland Agriculture (Table 5.11) based on four years data from demonstration trials and control farmers' plots of 0.4 ha size. The estimates show that incremental net return from groundnut was negative. The ratio of incremental net return to incremental net cost was greater than unity at one center out of three for safflower. The ratio was less than unity for sesame at both centers, but greater than unity for mustard at both centers. These estimates confirm once again the unremunerative nature of oilseed cultivation under rainfed conditions.

TABLE 5.1. YIELDS OF SELECTED GROUNDNUT VARIETIES AT CVT (1976) NET (1978) AT VARIOUS RESEARCH CENTERS

CENTERS	VARIETIES			
	Robout 33-1 (CVT 1976)	J-11 (CVT 1976)	Robout 33-1 (NET 1978)	J-11 (NET 1978)
	(kg/ha)			
ICRISAT	1711		497	
Rajendranagar		848		1095
Karimnagar	1094	784	1376	908
Junagadh	1817	826	1848	1694
Dharwar	1656	1355	1410	2860
Paichur	572		1993	1600
Khargone	1308	726	1963	1125
Akola	1215	1178	323	307
Jalgaon	754	248	660	
Chiplima	1667	942	1161	671
Pollachi	1468			
Jindivanam	569		986	538
Aliyarnagar			717	642
Hissar (IRR)			3776	
Mean	1253.27	863.37	1392.50	1144.00
Coefficient of Variation	35%	36%	65%	62%

SOURCE: AICORPO Reports, relevant years.

TABLE 5.2 YIELDS OF SELECTED MUSTARD VARIETIES AT RESEARCH CENTERS TRIAL, 1980

CENTERS	VARIETIES		
	KRV Bold	Pusa Bold	Varuna
	(kg/ha)		
Kanpur	1511	1160	933
Meerut	1111	765	481
Bereilly	1032	929	1084
Hardoi	473	540	442
Etawah	642	555	691
Azamgarh	271	419	288
Mean	852.67	728.00	653.17
Coefficient of Variation (CV)	52%	35%	43%

SOURCE: AICORPO Reports, relevant years.

TABLE 5.3 PERFORMANCE OF IMPROVED SESAME VARIETIES AT SUMERPUR

YEAR	VARIETIES (SEED YIELD kg/ha)			
	TC-25	T-13	C-50	LOCAL
1969	-	600.00	348.12	367.00
1970	19.53	74.52	46.41	28.36
1971	512.30	375.00	247.60	-
1972	454.60	362.60	190.00	166.00
1973	173.50	116.70	113.30	126.70
1974	553.30	275.20	210.00	275.00
1975	288.60	230.20	143.40	155.80
1976	255.90	171.30	159.25	142.70
1977	365.70	316.60	-	213.10
1978	205.00	160.00	142.00	127.00
1979	142.06	206.34	191.67	-
1980	413.69	350.59	317.86	-
1981	680.00	1023.80	654.70	740.10
1982	454.76	-	452.00	407.14
1983	580.65	324.89	324.89	411.79
MEAN	364.26	327.70	252.78	263.39
S. D.	190.22	240.35	158.10	193.49
C. V.	52.22	73.32	62.54	73.43

SOURCE: (39)

TABLE 5.4 PERFORMANCE OF RAPESEED-MUSTARD VARIETIES AT IARI, DELHI

	YIELD (q/ha)				
VARIETIES	1980-81	1981-82	1983-84	MEAN	C.V. (%)
PR-45	21.07	28.97	24.44	24.83	13
Pusa Bold	20.47	24.65	13.82	19.65	23
Pusa Kranti	19.45	21.04	17.60	19.36	8
Varuna	18.18	24.97	14.98	19.38	21
Pusa Kalyani	14.99	12.30	16.37	14.55	12

SOURCE: (27)

TABLE 5.5 EXPERIMENTAL YIELDS IN VARIETAL EVALUATION TRIALS: GROUNDNUT, RANCHI

	YIELD OF VARIETIES (kg/ha)	
YEAR	AK 12-24	BG-3
1979	2,259	2,877
1980	912	1,898
1981	2,014	2,407
1982	1,427	2,361
1983	926	1,875
MEAN	1,507.6	2,283.6
CV%	37%	16%

SOURCE: (74)

TABLE 5.6 PERFORMANCE OF SOYBEAN VARIETIES AT BIRSA, BIHAR

	YIELD (q/ha)				
VARIETIES	1976-77	1977-78	1978-79	MEAN	C.V. (%)
Ankur	1968	2159	2465	2197	9
Punjab I	1961	1999	2239	2066	6
Bragg	1205	2054	2829	2029	33

SOURCE: (55)

TABLE 5.7 GROUNDNUT YIELD OF SAMPLE HOUSEHOLDS IN 13 DISTRICTS, 1976-77

DISTRICT/STATE	RAINFED YIELD (q/ha)	IRRIGATED YIELD (q/ha)
Mehboobnagar (Andhra Pradesh)	4.9	
Anantpur (")	6.9	
Amreli (Gujarat)	7.7	
Junagadh (")	12.1	
Belgaum (Karnataka)	7.4	
Dharwar (")	3.8	
Mandsaur (Madhya Pradesh)	6.4	
Dhar (")	5.2	
Dhulia (Maharashtra)	9.3	
South Arcot (Tamil Nadu)	4.8	7.7
Coimbatore (")	7.8	13.0
Hardoi (Uttar Pradesh)	9.8	
Sitapur (")	9.6	
Average	7.8	9.5

SOURCE: PEO, Planning Commission, GOI, Evaluation Report on Oilseeds Development Programme (1976-80), New Delhi September, 1981.

TABLE 5.8 RAPESEED MUSTARD YIELD OF SAMPLE HOUSEHOLDS IN 8 DISTRICTS 1975-76

DISTRICT/STATE	RAINFED YIELD (q/ha)	IRRIGATED YIELD (q/ha)
Nowgong (Assam)	7.9	
Mongher (Bihar)	2.4	2.7
Gurgaon (Haryana)	4.0	7.5
Morena (M. P.)	8.9	11.5
Bhatinda (Punjab)	6.1	7.1
Alwar (Rajasthan)		
a) Central Scheme	4.9	8.0
b) State Scheme	5.7	10.0
Agra (U. P.)	12.9	13.3
Nainital (U. P.)	-	9.9
Average	5.8	8.8

SOURCE: Same as in Table 5.7

TABLE 5.9 YIELDS OF SESAME, SUNFLOWER AND SOYBEAN OBTAINED BY SAMPLE HOUSEHOLDS, 1976-77

DISTRICT/STATE	RAINFED (q/ha)	IRRIGATED (q/ha)
	SESAME	
Chandrapur (Maharashtra)	0.6	
Dhenkanal (Orissa)	2.6	
Pali (Rajasthan)	0.5	
Jhansi (U. P.)	0.7	
Average	0.9	
	SUNFLOWER	
Mehboobnagar (A. P.)	1.4	
Coimbatore (T. N.)	2.9	9.0
Begaum (Karnataka)	2.3	6.3
Average	2.4	8.4
	SOYBEAN	
Dewas (M. P.)	5.9	

SOURCE: Same as in Table 5.7

TABLE 5.10 COST OF GROUNDNUT CULTIVATION IN GUJARAT:
1980-81 to 1982-83

ITEM	YEAR		
	1980-81	1981-82	1982-83
Human labour (a) Family	282	298	305
	(9.99)	(9.11)	(9.16)
(b) Hired	238	294	312
	(8.43)	(8.99)	(9.37)
Bullock labour	418	544	520
	(14.80)	(16.63)	(15.62)
Seeds	493	606	628
	(17.46)	(18.52)	(18.87)
Manures	321	306	361
	(11.37)	(9.35)	(10.85)
Chemical fertilisers	207	246	352
	(7.33)	(7.52)	(10.85)
Insecticides/pesticides	21	27	50
	(0.74)	(0.82)	(1.50)
Irrigation	31	21	79
	(1.10)	(0.64)	(2.37)
Miscellaneous costs	123	143	111
	(4.36)	(4.37)	(3.34)
Depreciation	103	104	102
	(3.65)	(3.18)	(3.06)
Interest on working capital	117	92	100
	(4.14)	(2.81)	(3.00)
Rental value of owned land	408	537	354
	(14.45)	(16.41)	(10/63)

Table 5.10 (contd.)

ITEM	1980-81	1981-82	1982-83
Interest on owned fixed capital	62	54	55
	(2.20)	(1.65)	(1.65)
Cost A	2,072	2,383	2,615
	(73.37)	(72.83)	(78.55)
Cost B	2,542	2,974	3,024
	(90.1)	(90.89)	(90.84)
Cost C	2,824	3,237	3,329
	(100.00)	(100.00)	(100.00)
Production in (q/ha)	6.96	7.27	5.05
Farm harvest price (Rs./q)	332	405.78	416.28
Gross return in Rs. (Main + by)	2,548	3,352	2,326
Return over cost A	476	969	-289
Return over cost B	6	278	-689
Return over cost C	-276	80	-2003
Cost C per quintal	369	396	615
Bulk line cost (Rs./q)	N.A.	606	815
Cost benefit ratio	1:0.90	1:1,02	1:0.70

NOTE: Figures in brackets are percentages to total cost C.

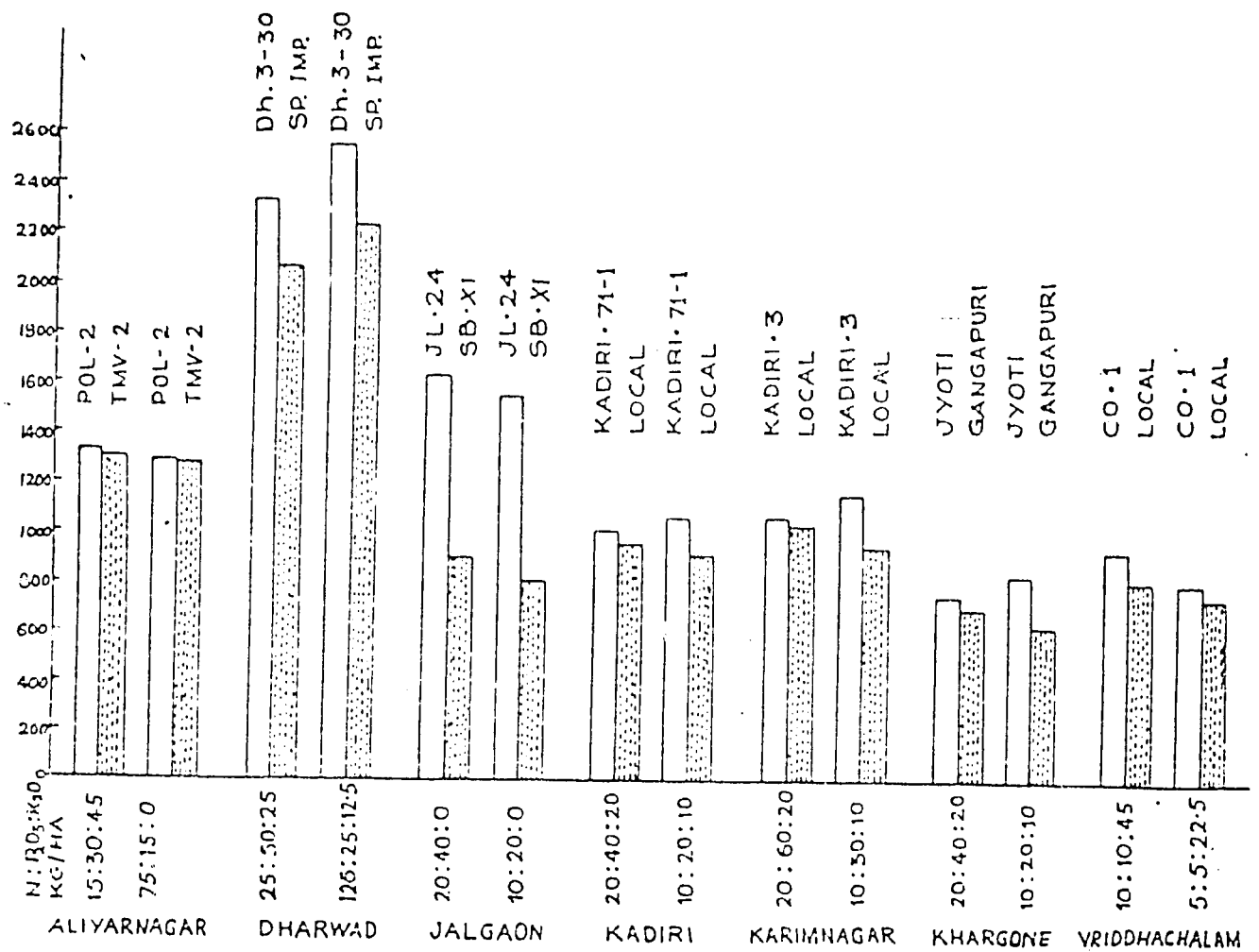
SOURCE: Research Report, Department of Agril. Economics, Gujarat Agricultural University, Junagadh, 1983.

TABLE 5.11 COSTS AND RETURNS FROM OILSEEDS CULTIVATION
(Rs/ha)

CROP	CENTER	COST			NET RETURNS			
		TRADI TIONAL	MOD-ERN	DIFFER-ENCE	TRADI-TIONAL	MOD-ERN	DIFFER-ENCE	RATIO OF BENEFIT TO COST
Groundnut	Rajkot	1592	1517	-75	263	133	-130	0
Safflower	Bellary	323	667	344	60	345	285	0.83
	Bijapur	273	532	259	143	813	670	2.59
	Solapur	521	687	166	133	239	146	0.88
Mustard	Hissar	903	1141	238	1077	2060	983	4.13
	Varanasi	378	889	511	363	1274	911	1.78
Sesame	Nagaur	239	428	189	156	277	121	0.64
	Jodhpur	530	783	253	1311	1491	180	0.71

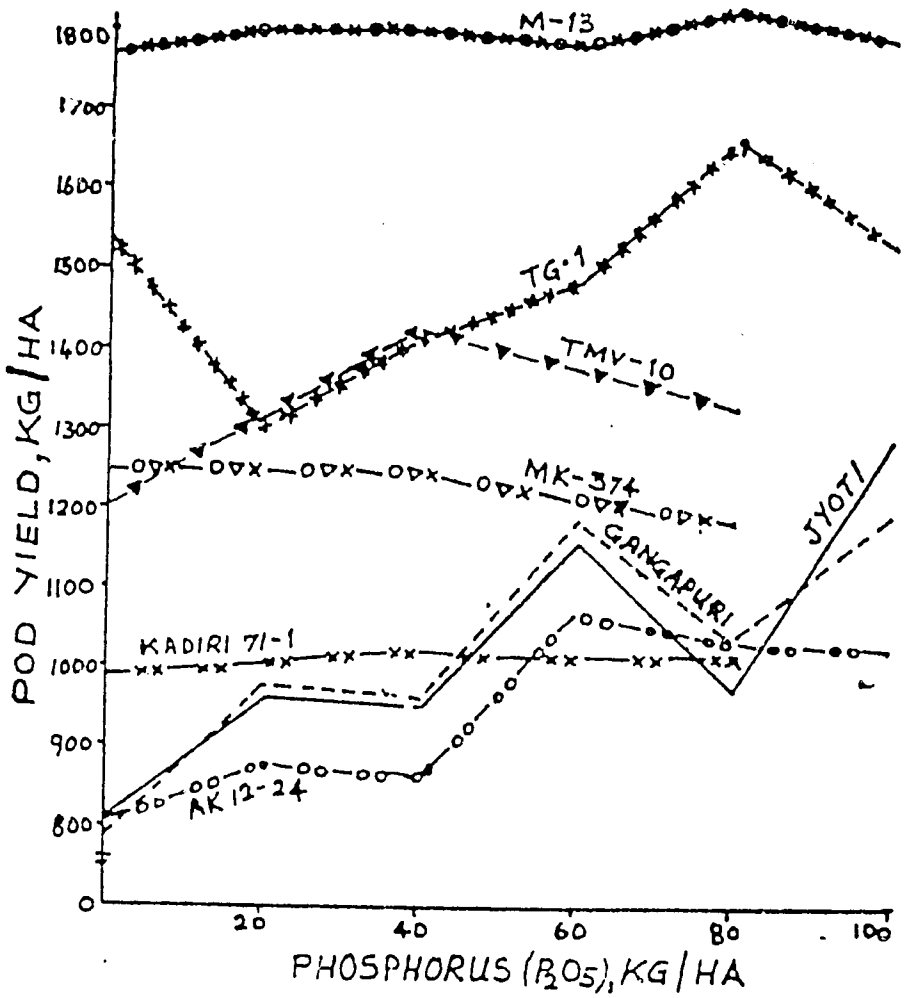
SOURCE: Y.V.R. Reddy and B. K. Rastogi, Economics of Recommended Technology in Dryland Agriculture, Central Research Institute for Dryland Agriculture, 1985.

Chart 5.1



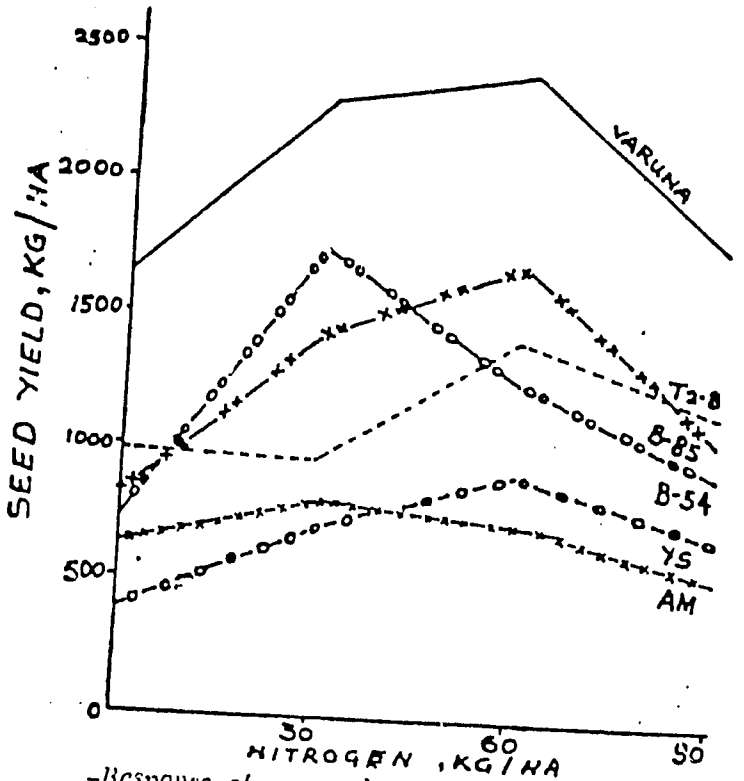
Response of groundnut varieties to fertilizers.

a

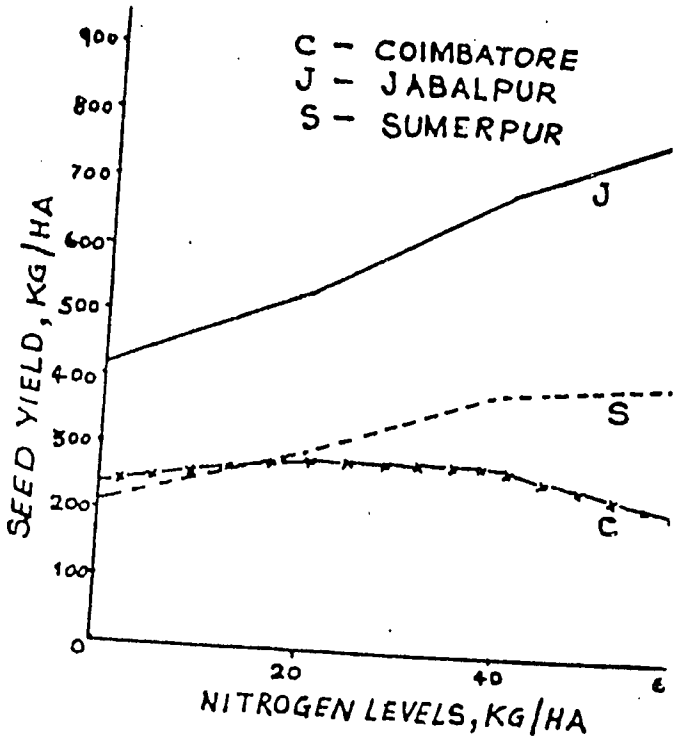


-Response of groundnut varieties to phosphorus.

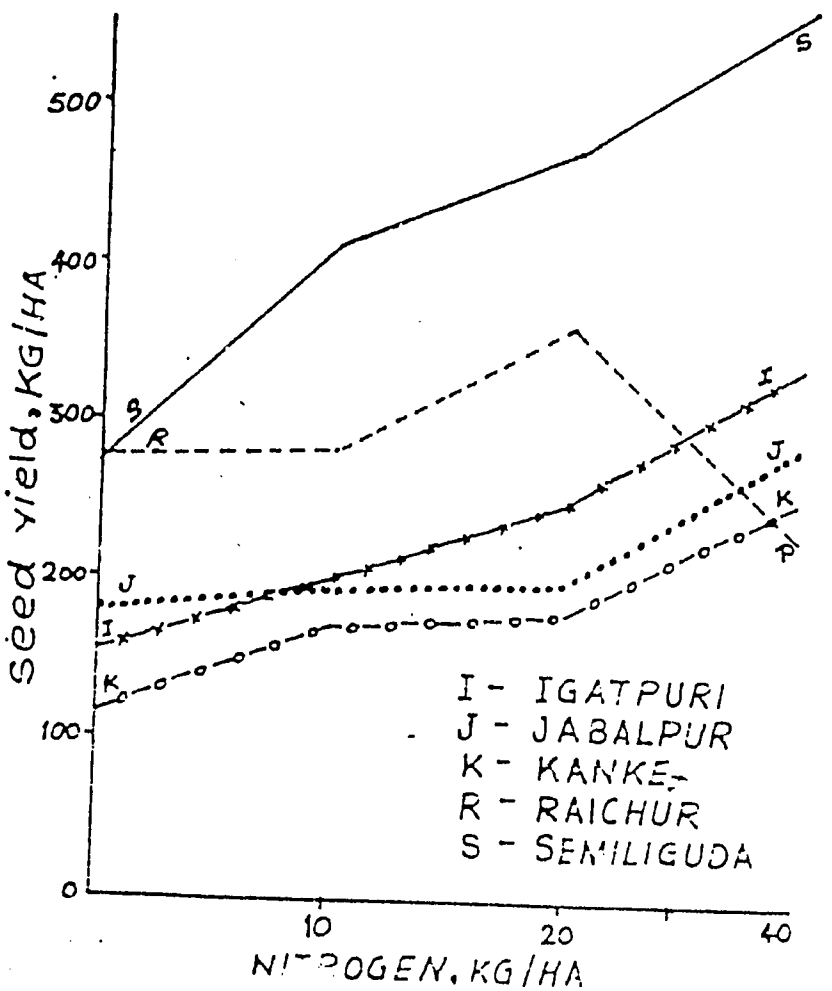
Chart 5.3



–Response of rapeseed-mustard varieties to nitrogen.



–Response of sesame to nitrogen



–Response of niger to nitrogen.

6. TRANSFER OF TECHNOLOGY

6.1 Supply of Seed

Farmers generally tend to use their own seeds set aside from previous harvests rather than purchase seeds from the market. This is particularly true for self-pollinated crops such as groundnut. There may be some justification for the practice quite apart from the obvious one of minimization of cash costs of production. There is no consensus among scientists about the need for periodic replacement of seeds of self-pollinated crops. Some believe there is nothing wrong with farmers using their own seeds in such cases year after year. Additionally, they see no need to replace a variety if it is well-established and performing satisfactorily in an area. Others disagree and believe seeds should be renewed every few years to maintain purity and vigor regardless of self-or-cross pollination characteristics of the crop. Furthermore, they believe that all old varieties should be replaced by newer.

Whatever the theoretical position may be, in practice, the balance of advantage seems to be in favor of seed renovation and varietal replacement. Seed drying and storage under proper conditions is important to maintain seed viability. Seeds need to be stored under low temperature, low humidity conditions and they need to be protected against insects/molds (fungi) in storage. The problems of suboptimum plant stand, poor germination and yield in many cases may be traced to poor storage on farms. Periodic renewal and replacement of seed would seem desirable from this point of view. There is a broader, though related, problem of farmer preference of home-produced seeds over "purchased seeds" of improved varieties. Obviously, if a variety has more desirable features than the one in use, and if it is found to be equally suitable to the agroclimatic conditions, it would be desirable to substitute it for the old. If farmers do not do so it might be because they do not yet know about the improved seeds. They might not have seen the yield potential of the newer variety demonstrated under field conditions. Those who know

about the variety and its performance might still be inhibited by high seed price (Table 6.1) which, in some cases, makes it unattractive to purchase seeds and shift to the new variety. Groundnut is an example. Improved varieties of groundnut are supposed to give about a 15 to 20 % increase in yield over older varieties.[43/] On an average, this means an increase in yield of about 100 to 150 kg/ha and, at current farm harvest prices, an increase in returns of about Rs 400 to Rs 600. But with the cost of 100 kg of seeds per hectare at Rs 800, the farmer, if he is rational, would rather not use it.

An important question is: are new seeds available to farmers? By all accounts there is an overall scarcity of seeds.[44/] In many areas certified seeds are just not available and only "Truthfully Labelled Seeds" (TLS) are being sold instead. So great is the shortage that TLS is reported to be widely used even in minikits.[45/] Most of the 21 approved varieties of soybean released so far have yet to reach the farmers.[46/] The situation is about the same with rapeseed and mustard. The requirement of certified groundnut seed (at 5 % replacement rate) was estimated for Kharif 1984 at 42.3 thousand tons. The production, however, was only 34 thousand tons. Groundnut, and to a certain extent soybean, may have a special problem with seed supply because the seed multiplication rate is low. For some crops there is also a selective shortage of preferred varieties even when overall supply is not critical.

43/ See (33).

44/ Proceedings of various annual workshops.

45/ See (5).

46/ See (14).

Scientists are critical and charge that seed production and marketing agencies habitually stick to the old varieties and are shy about taking up seed production of new varieties. The seed producing agencies claim that they produce according to the indents they receive. If there is no demand for newer varieties they do not produce them.[47/] Since indents are issued by the state departments of agriculture it may mean that they are either not aware of the new varieties or not convinced about their merits. The extension wings of the state departments of agriculture, which are supposed to estimate the demand for seeds before issuing indents, argue that farmers do not ask for the new varieties. Many scientists, however, request this arguement. They believe that farmers have not yet been given a chance to observe and assess the potential of newer varieties because extension support to popularize the newer varieties through demonstrations is lacking.

The fact is that there is no effective seed supply program yet for the newer varieties of oilseeds. The period between a variety's release for commercial cultivation and its actual availability to farmers is often undesirably long. Not infrequently, the period is further lengthened by considerations and conflicts involving the prestige of individuals and organizations. States often tend to popularize and push varieties developed within the state ignoring better varieties developed elsewhere.[48/]

47/ They are sometimes critical of scientists urging replacement of one variety with another without considering availability of the new variety. This, they argue, creates a distortion in the demand and availability situation. See (70).

48/ See A.C.Chhatrapati, "Oilseeds Development: Evaluating the Thrust Mission", The Economic Times, 16 June 1986.

Certain measures proposed in the Seventh Plan might mitigate the seed availability situation if they are fully implemented. These measures include (a) development of at least one seed farm in each development block; (b) allowing farmers to produce most of the required 1.5 million tons of certified seeds, but reserving the production of breeder and foundation seeds exclusively for the National Seeds Corporation, State Farms Corporation and State Seeds Corporations; and (c) setting up an adequate number of seed processing units and construction of sufficient capacity for seed storage.

6.2 Extension

Although an elaborate extension machinery exists at the state level, one of the recurrent complaints of scientists is that the transfer of oilseed production technology from research centers to farmers is poor and unsatisfactory. There is a widespread impression that the priority in extension is given to the cereals while oilseeds are neglected. The small number of demonstrations and farm adaptive and minikit trials seems to support this impression. Some scientists maintain that 80 % of oilseed technology has not yet reached the farmers.[49/] Some believe that there should be a separate extension directorate at the state level exclusively devoted to oilseeds.[50/]

Most states have by now adopted the T and V extension system to guide farmers on crop technology. The standard pattern has one VEW for about 800 farm families with about a hundred contact farmers per VEW. One AEO guides, trains and supervises about eight VEWs. Eight AEOs are in turn supervised by

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[49/] See (60).

[50/] See (64).

a Subdivisional Extension Officer (SDEO) supported by a team of subject matter specialists. One District Extension Officer (DEO) supervises eight SDEOs. The DEOs are usually supervised by a Joint Director of Extension in the State Department of Agriculture. With some minor variations, this is the basic pattern of the extension organization. Under the special programs for oilseed development some special field assistants are occassionally posted in a few districts. Even so, evidence indicates extension efforts are totally lacking in most of the districts covered by the special oilseeds programs. In 10 out of 13 districts, for example, no field demonstrations were organized at all under the groundnut development program.[51/] The situation appears to be the same in districts covered by development programs for other oilseeds. Since this is the case in special program districts, extension efforts would not be better elsewhere.[52/]

ICAR has introduced some innovations to expedite transfer of technology. Under its Operations Research Scheme a whole village is adopted by scientists to test and adopt technology suited to local conditions. A Lab-to-Land program was introduced in 1979 - the Colden Jubilee year of ICAR. In this program scientists adopt selected farm households and help implement individual farm plans with appropriate technology. Additionally, agricultural universities, cooperatives and a few private voluntary organizations help to acquaint farmers with the newer technological developments.

51/ See (53).

52/ Recounting his experience, Chhatrapati writes that many farmers seem to have never met the VEW and many seem to be unaware that the VEW visits the Panchayat office. Frequent transfer of officials at all levels disturbs the continuity of work. "Reliance on such extension agency for transmission of improved crop technology can only bring indifferent results." See, "Oilseeds Development: Evaluating the Thrust Mission", The Economic Times, 16 June 1986.

Most of the criticism of the failure of the mechanism for transfer of technology seems to be based on the belief that a technology exists that can be extended to all farmers. As the evidence produced earlier in this review indicates, this assumption is only partially correct. The available technology is applicable only to a small proportion of oilseed land and to a small proportion of oilseed farmers. Appropriate technology for rainfed oilseed cultivation is yet to be developed. In dryland areas, therefore, extension programs are unlikely to be effective. One can, of course, try toextend the information that some practices or treatments give better yields on research farms than others, but the resulting yield differences are often too small to make an impression on farmers.[53/]

That does not mean, however, that an extension program can achieve nothing at all. If it is able to persuade some farmers now at lower levels of yields to adopt some newer practices, it might be able to assist them in moving up to the next higher yield and income levels. While the resulting gains in aggregate oilseed output may not be substantial, the income gains of such farmers would represent a welcome increase in farmers' welfare.

[53/] Hopper's view is that an effective extension program cannot be built on small differences in averages. He goes on to argue that "the difference between the treated and the untreated plots may be economic, but unless the yield level of the treated plot is substantially superior to what the better farmers are already getting, the treatment won't be an extension success". (31)

TABLE 6.1 PRICES OF CERTIFIED SEEDS

CROPS	SEED PRICES (Rs/Q)
Groundnut	840
Safflower	500
Sunflower	1915 (Hybrid)
	722 (non-hybrid)
Soybean	630
Sesamum	1240
Rape/Mustard	750

SOURCE: Annual Report 1984-85, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India.

7. PRODUCTION PROSPECTS

7.1 Seventh Plan and National Oilseeds Development Project

It takes eight to 10 years to develop a new variety. It takes another three to four years to organize production of breeder seeds, foundation seeds and adequate quantities of certified seeds for farmer use under the best of circumstances. Production in the short-term and the medium-term, say five years, is already determined by the varieties released so far and the effectiveness of the transfer of technology mechanism. The varieties that may be released within the next year or two will have no influence on aggregate production of oilseeds in the immediate future.

The Seventh Plan sets a target of 16.78 million tons of edible oilseed production (Table 7.1) and proposes a two-fold strategy to achieve it: yield improvement and expansion of area under oilseeds.[54/] It allocates Rs 105 million for oilseed research (up from Rs 60 million in the Sixth Plan) and Rs 1700 million for oilseed development programs (up from Rs 925.2 million in the Sixth Plan). This includes the National Oilseeds Development Project (NODP), initiated in 1984-85, supplemented by the National Dairy Development Board's Oilseed Growers Cooperative Project (OGCP) and by state sector projects. The experience of Sixth Plan projects in groundnut development indicated that adoption of a concentrated area-and-crop-specific approach in a mass action program could have a large pay-off by accelerating oilseed production in potential districts. NODP was founded on this idea to cover 210 districts with large oilseed production potential in 17 states.

[54/] The goal is to achieve self-sufficiency in edible oilseeds by 1990. It is interesting to note that the Plan document recognizes that "there are many gaps in the research and development efforts in the areas of technology, credit, inputs and irrigation management" (p.7).

NODP's action plan includes, first, an efficient and speedy transfer of technology through extensive field demonstrations. Second, an increase in oilseed yields through use of quality seeds and other agronomic practices. and third, the expansion of oilseed areas, particularly in sections with high productivity and irrigation, through double cropping, relay cropping, sequence cropping and intercropping, and through replacement of low value crops by oilseeds. The project operational plan includes subsidized distribution of seeds, plant protection chemicals and equipment; free distribution of fertilizer and seed minikits; subsidized distribution of phosphatic fertilizer, gypsum and sprinkler sets in addition to the existing irrigation subsidy for groundnut crop; assistance with production of rhizobium culture and its subsidized distribution; and, input and credit supply and marketing of produce.

NODP will receive research and extension support from the Indian Council for Agricultural Research (ICAR) through a recently commissioned Technology Mission. The Mission has already identified 180 districts, of the original NODP 210 districts, in 17 states for special thrust. It will coordinate the activities of about 18 different departments and agencies involved in different aspects of oilseeds and vegetable oil to provide all necessary inputs, training to farmers, plant protection umbrella and facilitate technology transfer. In addition, it will monitor all aspects of the oilseed spectrum, ranging from seed production to the marketing of vegoil to consumers.

This is not the place to evaluate NODP or to prejudge its course. In its area and crop-specific approach it resembles to some extent the Intensive Agricultural District Program (IADP) of the mid-fifties without the organizational infrastructure. It might be able to expand oilseed production the same way IADP did food grains in selected districts if NODP could build up the necessary infrastructure rapidly. The present assessment of the oilseed production outlook will have to be based on both the possibilities for accelerating yield improvement and for expanding the oilseed area.

7.2 Contributions of Yield and Area to Output Growth

Output targets of edible oilseeds in Table 7.1 imply an overall compound rate of growth of 6.75 % /ann , (col. 4) which is more than double the growth rate of 2.7 % /ann (col. 3) recorded between 1970/73 and 1982/85. Targets for safflower and soybean output seem to be feasible since they are in line with their trend rates of growth. However, the output targets for other oilseed crops appear unrealistic when compared with their trend growth rates. In the case of groundnut and rapeseed/mustard, for example, the target rates of output growth are respectively about 3.5 and 2.5 times the trend rates. Given the relative importance of these two crops in the edible oilseed basket, it is clear that the achievement of the aggregate production target for edible oilseeds would almost entirely depend upon dramatic improvement in yields and area under groundnut and rapeseed/mustard.

It is possible to derive some insights into the production problem from an examination of statewise data on yield and area under groundnut, rapeseed/mustard and soybean. In Tables 7.2 to 7.5, the output growth rates of these three crops between 1970-73 and 1982-85 have been decomposed into their principal components: yield effect, area effect, and interaction effect between yield and area.[55/] The yield effect is defined as the relative contribution of changes in yield to the change in output, and the other two

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55/ See notes to Table 7.2 for methodology, which follows the additive scheme of decomposition developed by B. S. Minhas and A. Vaidyanathan in "Growth of Crop Output in India, 1951-'54 to 1958-'61: An Analysis by Component Elements", Journal of the Indian Society of Agricultural Statistics, Vol. XVII, No. 2, 1965.

effects have similar interpretations. In Tables 7.2 - 7.5, the numbers in the top line against each state represent the proportion of additional output that can be attributed to changes in yields, area and the interaction between the two elements. The numbers in parentheses indicate the respective percentage contributions of each of these components in the output growth rate. Thus, the estimates in the last line of Table 7.2 show that the aggregate kharif groundnut output in the country declined during the period at a rate of -0.5 %. The yield effect, however, was positive, indicating that output would have grown by about 0.2 percentage points because of the positive, though small, contribution of yield change. This small but positive yield effect was swamped by a large negative area effect (-0.73 percentage points). The contribution of the interaction effect was negative but negligible, at only -0.02 percentage points.

Relative contributions of the component elements show a good deal of variation from state to state. Both yield and area effects have been negative producing negative growth rates of output in five states - Karnataka, Madhya Pradesh, Punjab, Tamil Nadu and Uttar Pradesh. Since both area and yield are declining, there is no scope for output growth in these states. Yield effect is positive but area effect negative in Andhra Pradesh, Maharashtra and Rajasthan. In the first state, a large negative area effect has swamped the smaller, positive yield effect to produce a negative output growth rate, whereas in the other two states, negative area effects have been more than neutralized by yield effects to give a positive output growth rate. In Gujarat, the negative yield effect has been more than neutralized by a positive area effect to produce a positive, though very small, output growth rate. The case of Orissa is unambiguous - yield effect is positive and so is area effect.

Table 7.3 on rabi groundnut presents a different picture altogether. For the country as a whole more than 82 % of the additional output is attributable to the increase in area alone and about 9 % to increase in yield. The relative contributions of area and yield changes to the output growth rate of 6.0 % have been respectively 4.9 and 0.57 percentage points. Estimates at the

state level show some interesting contrasts. Both yield and area effects are negative in Tamil Nadu. In contrast, both area and yield effects are positive in Andhra Pradesh, Karnataka and Maharashtra. Output growth rates are high both in Gujarat and Orissa because of the contributions from increased land but the contribution of yield to output growth has been negative in both.

Turning now to rapeseed and mustard, the scenario appears to be encouraging. (Table 7.4) The yield effect is positive for the country and greater than the area effect which is also positive, consequently, changes in both yield and area could result in additional output. At the state level, however, there is some variation. Thus, the yield effect has been small and negligible in Orissa, Assam and Uttar Pradesh. Area under rapeseed/mustard has been declining in Punjab and Uttar Pradesh and in the latter state the negative area effect has been strong enough to bring about a decline in output. Barring these two states there is scope for area expansion in all states to raise output.

Yield effect on soybean output growth rate (Table 7.5) has been negative in both Madhya Pradesh and Uttar Pradesh where the crop is largely confined. This surprising result is somewhat contrary to expectations that with a gradual increase in farmers' experience with the crop and a build-up of inoculum in the soil there would be an increase in yield levels over time. But it is also in line with the perception of some scientists that recently soybean productivity has been on the decline.[56/] However, the effect of declining yield has been swamped by a large area contribution to give an overall positive output growth in both Madhya Pradesh and Uttar Pradesh.

7.3 Outlook for Yield Improvement

The following conclusions regarding yield improvement emerge from this analysis of trends. Insofar as kharif groundnut is concerned, yields have been declining in Gujarat, Karnataka, Madhya Pradesh, Punjab, Tamil Nadu and

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56/ See Project Coordinator's Report, AICORP on Soybean, p. xxiii, 1983-84.

Uttar Pradesh. Increases in yields have been poor in Andhra Pradesh and Orissa. Satisfactory yield improvement has occurred only in Maharashtra and to some extent in Rajasthan. Taking all the states together, there does not seem to be any large scope for kharif groundnut output increase through yield improvement. This conclusion is further reinforced by the analysis of available technology in Section 5. Thus, a suitable technology for raising yields of rainfed kharif groundnut dramatically is not yet available.[57/]

Yield improvement is also unlikely to be a source of growth in rabi groundnut . Improvements in yields have contributed to output increases only in Andhra Pradesh and Karnataka while yields have declined in Gujarat, Orissa and Tamil Nadu. It was also noted in Section 5 that recorded rabi groundnut yields are not very different from their technological potential. Taking both kharif and rabi groundnut together, it seems unlikely that the trend rate of yield growth can be improved significantly in the near future.

[57/] Section 5 referred to the groundnut demonstration trials conducted by AICOPPO between 1980 and 1983. Some authors have taken an optimistic view of these trials and believe that kharif groundnut output can be increased by as much as 2.2 million tons. There are several reasons however why these trials should not be used as a basis for output projections. First, the number of trials in each state was too small to determine the scope for yield increase. In 1983 there was just one demonstration held in each of the states of Andhra Pradesh and Karnataka. Second, yield increases were all highly unstable from one year to the next. For instance in 1981 in Rajasthan yield increase in seven trials was 183.6 %. It slumped to just 16 % the following year. Third, the trials were conducted on half-acre plots. Some scientists are sceptical about the validity of extending results of partial plot trials to entire farmland.

The outlook for yield improvement in rapeseed and mustard is distinctly better. Yield increases have been a major source of output growth in seven out of 11 states. Further improvements seem likely from a couple of recently released varieties which seem to have done well in field trials in several parts of the country.

Soybean yields have been declining and yield improvement is unlikely to be a source of growth in the immediate future.

7.4 Outlook for Area Expansion

Contribution of area to the overall rate of kharif groundnut output has been negative in eight out of 10 states. It has been substantial only in Orissa which seems to be the only state with possibilities for a further increase in kharif groundnut area. Given the declining trend in area in other states, expansion of area in Orissa is unlikely to make any difference to the total area under kharif groundnut which is likely to decline further.

Area expansion is obviously going to be the major source of output growth in rabi groundnut in all the states, except perhaps Tamil Nadu. There is however a limit to the additional area that can be planted to rabi/summer groundnut given crop characteristics and agro-climatic conditions. Some scientists think that for the country as a whole, this limit is about a million hectares, and that this limit would be reached by the turn of the century, perhaps earlier.[58/] A large part of this additional area would come from Gujarat (about 0.4 million hectares)[59/] and Maharashtra (about 0.2 million hectares).[60/]

58/ See (64).

59/ See (64).

60/ See (20).

The area under rapeseed-mustard has recently expanded a good deal in Gujarat where the crop is nontraditional. There is scope for expanding the crop area in most states except, perhaps, in Punjab and Uttar Pradesh where area has declined.

By and large, soybean has remained confined to Madhya Pradesh and Uttar Pradesh, although efforts are on to introduce it elsewhere as an intercrop. It has been estimated that soybean could be grown on about two million hectares in these two states alone. About 65 % of this area potential, most of it in Uttar Pradesh, still remains to be tapped.

Assuming unchanged yield growth rates, additional area planted to edible oilseed crops must be about seven million hectares to reach the output targets of 1989/90. Scientists seem to pin their hopes on popularization of intercropping, relay and sequence cropping, introduction of kharif oilseed crops in irrigation command areas, and on replacement of millets by oilseeds. These measures are best regarded as part of a long term strategy to increase oilseed production. They offer no solution to the oilseed problem in the short run. Any changes in the cropping pattern in favor of oilseeds would necessarily be slow when the resulting economic advantage to farmers is not very clear. Low-yielding millets, for example, are grown on relatively inferior land where it is not clear that oilseeds have a distinct advantage over millets. Again, persuading farmers to grow oilseeds, especially groundnut, in the irrigation command areas in kharif would be a slow process. Farmers are not convinced yet that the returns from irrigated oilseeds would be superior to other competing crops. The area under kharif groundnut seems to invariably decline in the command areas of new irrigation systems. Introduction of intercropping, relay and sequence cropping on a large scale would require time. It seems reasonable to conclude then that the expansion of area under oilseeds through these steps will not be a rapid process.

TABLE 7.1 SEVENTH PLAN TARGETS OF EDIBLE OILSEEDS PRODUCTION

Crops	1984-85 Assumed production level (million tons)	1989-90 Production level (million tons)	1970-73 to 1982-85 trend rates of growth of output (%)	1984-85 to 1989-90 Target of growth of output (%)
	1	2	3	4
Groundnut	7.30	9.37	1.48	5.11
Rapeseed/Mustard	2.60	3.82	3.12	8.03
Sesame	0.60	0.74	1.51	4.28
Safflower	0.50	0.72	10.93	7.71
Niger	0.20	0.25	2.00	4.56
Soybean	0.60	1.28	35.57	16.27
Sunflower	0.30	0.60	3.55	14.98
Total	12.10	16.78	2.70	6.75

SOURCE: Columns 1, 2 and 4 from the Seventh Plan; Col. 3 from Table 2.2, this review.

TABLE 7.2 RELATIVE CONTRIBUTIONS OF YIELD AND AREA TO THE GROWTH OF GROUNDNUT (KHARIF) OUTPUT

PERCENTAGE INCREASE ATTRIBUTED TO:

STATE	YIELD	AREA	INTERACTION	TOTAL	OVERALL RATE OF GROWTH OF OUTPUT
	1	2	3	4	5
Andhra Pradesh	61.66	-159.62	- 2.04	100	-0.2
	(.12)	(-.32)	(-00)		
Gujarat	-101.57	210.95	-9.38	100	0.4
	(-0.41)	(0.84)	(-0.04)		
Karnataka	- 35.99	- 66.47	2.41	100	-0.9
	(-0.32)	(-0.59)	(0.02)		
Madhya Pradesh	- 26.42	- 82.26	8.68	100	-4.1
	(-1.08)	(-3.37)	(0.36)		
Maharashtra	309.27	-132.91	-76.37	100	1.4
	(4.33)	(-1.86)	(-1.06)		
Orissa	6.54	86.28	7.19	100	7.0
	(0.46)	(6.04)	(0.50)		
Punjab	- 23.63	- 91.58	15.21	100	-9.6
	(-2.27)	(-8.79)	(1.46)		
Rajasthan	395.19	-244.28	-50.93	100	0.4
	(1.58)	(-0.98)	(-0.20)		
Tamil Nadu	- 17.75	- 84.44	2.20	100	-1.3
	(-0.23)	(-1.10)	(0.03)		
Uttar Pradesh	- 41.92	- 69.14	11.06	100	-3.9
	(-1.63)	(-2.70)	(0.43)		
All India	49.09	-145.39	- 3.85	100	-0.5
	(0.24)	(-0.73)	(-0.02)		

Table 7.2 contd.

SOURCE: Area and production data are from Area and Production of Principal Crops in India, 1981-84, Directorate of Economics and Statistics, Department of Agriculture & Cooperation, Ministry of Agriculture, Government of India.

NOTES: 1. Output growth rates in column 4 have been worked out for the period from triennium ending 1972-73 to triennium ending 1984-85 for all states and for all India.

2. Methodology: Let A_o, Y_o, and P_o be the area, yield and production respectively in the base year, and A_t, Y_t, and P_t be the corresponding area, yield and production in the year t. Now,

$$P_o \equiv A_o x Y_o \qquad \ldots(1)$$

and $$P_t \equiv A_t x Y_t \qquad \ldots(2)$$

also $$P_t = P_o + \Delta P$$

$$A_t = A_o + \Delta A \quad \text{and}$$

$$Y_t = Y_o + \Delta Y$$

Where Δ denotes change. Therefore,

$$P_o + \Delta P = (A_o + \Delta A)(Y_o + \Delta Y), \text{ or}$$

$$\Delta P = A_o \Delta Y + Y_o \Delta A + \Delta A \Delta Y \qquad \ldots(3)$$

Where the first term on the right hand side of equation (3) is the yield effect, the second term is the area effect and the third term the interaction effect due to changes in the yield and area.

3. A, Y and P, both in base year and terminal year, have been calculated as averages of triennium at both ends of the period.

4. The same methodology has been followed in the development of the next three tables.

5. The numbers in the top line against each state show the proportion of additional output attributable to changes in yield, area and interaction between the two. For example, the first line against Orissa indicate that 6.54 % of additional output during the reference period can be attributed to changes in yield, 86.28 % to changes in area under the crop and 7.18 % to interaction between changes in area and yield. The numbers in parentheses show the respective percentage contributions of each of the components. Thus, in the 7 % growth rate of output in Orissa, area contributed about 6 percentage points, yield 0.46 and interaction about 0.5 percentage points. Similar interpretation applies to the tables that follow.

TABLE 7.3 RELATIVE CONTRIBUTIONS OF YIELD AND AREA TO THE GROWTH OF GROUNDNUT (RABI) OUTPUT

PERCENTAGE INCREASE ATTRIBUTED TO:

STATE	YIELD	AREA	INTERACTION	TOTAL	OVERALL RATE OF GROWTH OF OUTPUT
	1	2	3	4	5
Andhra Pradesh	28.87	66.51	11.62	100	5.3
	(1.44)	(3.33)	(0.58)		
Gujarat	- 6.91	130.54	-23.63	100	11.3
	(-0.78)	(14.75)	(-2.67)		
Karnataka	24.17	59.32	16.51	100	6.6
	(1.59)	(3.91)	(1.09)		
Maharashtra	5.49	81.87	12.64	100	11.8
	(0.65)	(9.66)	(1.49)		
Orissa	- 3.39	123.68	-20.29	100	15.8
	(-0.59)	(19.54)	(-3.21)		
Tamil Nadu	-25.73	-79.58	5.31	100	-2.4
	(-0.62)	(-1.91)	(0.13)		
All India	9.48	82.56	7.96	100	6.0
	(0.57)	(4.95)	(0.48)		

SOURCE: Same as in Table 7.2.

NOTES: 1. Period of output growth for Andhra Pradesh Karnataka, Orissa, Tamil Nadu is from triennium ending 1973-74 to triennium ending 1984-85. For Gujarat it is from 1979-80 to 1984-85. For Maharashtra it is from 1980-81 to 1984-85.

2. For methodology, see notes in Table 7.2.

TABLE 7.4 RELATIVE CONTRIBUTIONS OF YIELD AND AREA TO THE GROWTH OF RAPESEED AND MUSTARD OUTPUT

PERCENTAGE INCREASE ATTRIBUTED TO:

STATE	YIELD	AREA	INTERACTION	TOTAL	OVERALL RATE OF GROWTH OF OUTPUT
Assam	3.21	93.80	2.99	100	5.9
	(0.19)	(5.53)	(0.18)	100	
Bihar	90.09	7.23	2.70	100	2.9
	(2.61)	(0.21)	(0.08)		
Gujarat	14.55	30.51	54.94	100	24.0
	(3.49)	(7.32)	(13.18)		
Haryana	45.32	35.86	18.83	100	6.6
	(2.99)	(2/37)	(1.24)		
Jammu and	30.42	41.21	28.37	100	11.3
Kashmir	(3.44)	(4.66)	(3.21)		
Madhya	53.73	27.81	18.46	100	6.9
Pradesh	(3.71)	(1.92)	(1.27)		
Orissa	0.94	98.22	0.86	100	5.5
	(0.05)	(5.40)	(0.05)		
Punjab	408.45	-203.17	-105.28	100	1.00
	(4.08)	(-2.03)	(-1.05)		
Rajasthan	10.49	72.04	17.47	100	10.5
	(1.10)	(7.56)	(1.83)		
Uttar Pradesh	19.81	-116.30	-3.51	100	-1.3
	(0.26)	(-1.51)	(-0.05)		
West Bengal	29.79	42.01	28.21	100	10.3
	(3.07)	(4.33)	(2.90)		
All India	50.24	38.92	10.85	100	3.7
	(1.86)	(1.44)	0.40)		

Table 7.4 (contd.)

SOURCE: Same as in Table 7.2.

NOTES: 1. Period of output growth for all states except Jammu and Kashmir is from triennium ending 1972-73 to triennium ending 1984-85; for Jammu and Kashmir, it is from 1972-73 to 1983-84.

2. For methodology, see notes in Table 7.2

TABLE 7.5 RELATIVE CONTRIBUTIONS OF YIELD AND AREA TO THE GROWTH OF SOYBEAN OUTPUT

PERCENTAGE INCREASE ATTRIBUTED TO:

STATE	YIELD	AREA	INTERACTION	TOTAL	OVERALL RATE OF GROWTH OF OUTPUT
	1	2	3	4	5
Madhya Pradesh	-0.28	119.08	-18.80	100	40.0
	(-0.11)	(47.63)	(-7.52)		
Uttar Pradesh	-0.73	114.88	-14.15	100	27.0
	(-0.20)	(31.02)	(-3.82)		
All India	-0.36	116.43	-16.07	100	35.0
	(-0.13)	(40.75)	(-5.62)		

SOURCE: Same as in Table 7.2.

NOTES: 1. Period of output growth is from triennium ending 1972-73 to triennium ending 1984-85.

2. For methodology, see notes in Table 7.2.

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