ON-FARM RESEARCH
FARMING SYSTEMS RESEARCH PROGRAM
FIVE-YEAR REPORT 1978-83

ICRISAT
International Crops Research Institute for the Semi-Arid Tropics
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NOTE TO THE READER

This is an informal report of work for 1978-83. This report is designed to stimulate thinking and comments from professional colleagues and is not to be considered as a formal publication bearing the endorsement of the Institute.

This is one of seven subprogram reports from the Farming Systems Research Program. The seven subprogram reports include the following:

Agroclimatology
Soil Physics and Conservation
Soil Fertility & Chemistry
Farm Power & Equipment
Land & Water Management
Cropping Systems
On-Farm Research

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CONTENTS

I. SUMMARY

On-farm research is the vital link between the experiment station and the farmer and is an important step in the process of developing improved relevant farm practices. On-farm research is a multidisciplinary process, directed at problem-solving field experimentation. Though each farm situation is unique in itself, similar factors, farms and regions can be grouped into operational areas and practices can be tested for dissemination to analogous systems and situations.

ON-FARM WATERSHED DEVELOPMENT:

In 1978 a cooperative on-farm research project was initiated with AICRPDA (All India Coordinated Research Project on Dryland Agriculture) three state agricultural universities and ICRISAT. Small watersheds in three villages were selected and land development was completed before the rainy season. The first 2-year experience showed that: (i) the crop yield levels varied widely across farmers fields within the watershed, and (ii) on deep vertisols, emphasis on replacing the kharif fallow by rainy-season cropping must be concentrated in the high rainfall regions (750 mm and above).

DEEP AND MEDIUM-DEEP VERTISOL WATERSHED DEVELOPMENT AT ICRISAT CENTER:

Research results of watershed based management of deep and medium deep Vertisols at ICRISAT since 1973 indicated that deep Vertisol technology developed at ICRISAT can increase profits by about 600% compared with a traditional system based on rainy-season fallow followed by postrainy season sorghum and chickpea.

Our experience has been that by cultivating the land immediately after the harvest of the preceding crop, by improving drainage, by dry seeding of crops ahead of the onset of the rainy season, and by using improved seeds and fertilizer, two crops can be grown on Vertisols where one is grown at present. By combining these aspects a maize/pigeonpea intercrop has given an average of over 3.8 t/ha of foodgrain production per year without the use of irrigation for over five consequetive years. Therefore, we decided that emphasis will be placed on testing and refining the deep Vertisol technology in dependable rainfall areas.

ON-FARM VERIFICATION OF VERTISOL TECHNOLOGY:

In 1981 a joint project was initiated at Tadanpally, Medak District, A.P., to test the technology options under field

conditions. Yields of rainy season sorghum as an intercrop in this watershed were about 2000 kg/ha; those of intercrop maize 1600 kg/ha. Sole crop maize yielded 2300 kg/ha. The traditional postrainy-season sorghum yielded only 700 kg/ha after fallow. In addition 600-1000 kg/ha of pigeonpea was harvested. In general production and profits were markedly higher under the improved system, with a 244% return on added expenditure of Rs.586/ha.

In 1982-83 the verification experiments were laid out at 6 locations in the states of Andhra Pradesh, Maharashtra, Karnataka and Madhya Pradesh. During 1983-84, the verification of deep Vertisol technology was expanded to 28 locations in about 2000 hectares involving 1406 farmers in the four states.

IMPORTANT OBSERVATIONS

a. Analysis of the limited observations from the watersheds indicated that improved technology resulted in increased production and income. However, a wide range of marginal rate of return indicated the need for closer monitoring of the different factors of the technology and optimising the input factors.

b. The availability of bullocks for small farmers varies much from year to year than it does for large farmers. In most cases, small farmers have less sturdy bullocks. Particular attention will have to be paid to making draft power available to small farmers in the potential regions.

c. Labour in the high potential regions for the deep Vertisol technology may not qualify for Food for Work or Rural Development Programs. Difficulties have been faced in recruiting casual labor for constructing community drains. This suggests a need for flexible wage scales if the work is to be completed in time.

d. One of the key elements in the improved technology options is increased use of fertilizers on unirrigated crops. To tap this potential for increasing fertilizer consumption will require investments in improving the fertilizer distribution network. Increase in the number of sale points will be required.

e. Credit volume in the dryland areas needs to be expanded. In addition to the short-term credit, medium term credit would be required to purchase wheeled tool carriers and long term credit for land development. An annual loan system should be instituted for dryland areas embracing rainy and postrainy season crops as one loan instead of two. The two disbursements of cash credit could be made

without requirement of repayment of the rainy season portion prior to disbursement of the loan portion meant for the postrainy season.

f. The most important determinants of profitability in the improved cereal/pigeonpea intercrop in Andhra Pradesh is effective Heliothis pod borer control. Poor control of Heliothis pod borer reduced yields by 700 to 800 kg/ha, which is equivalent to a loss in profits of about Rs.2500/ha ($ 250) at 1983-84 prices.

ICRISAT ROLE VIS-A-VIS NATIONAL RESEARCH AND EXTENSION PROGRAMS

Since, in the past SAT areas of the world have been neglected, research information is highly inadequate to solve the complex crop production problems emanating from highly diverse agroclimatic and socio-economic environments. On-farm research is a relatively new concept and therefore in its initial stages, international centres such as ICRISAT and national institutions can compliment each other and provide the necessary research back-up.

Some of the components which need attention in future are (o) contribution of broad bed and furrow management in increasing productivity and returns in the short run; (o) efficiency and utility of wheel tool carrier and other implements; (o) methods of Heliothis control; (o) sequential double cropping; (o) dry seeding; (o) cropping systems in relation to rotational needs and much needed flexibility in crop sequence choices.

TRAINING/WORKSHOPS

Adoption and realization of the benefits of a new crop production technology depends on its effective communication to policy decision makers, input suppliers (manufacturers, bankers, etc.) extension workers and farmers. Training of different groups requires different approaches. Two seminars for Policy makers have been organised in one of which, participation of senior executives from financial (credit) institutions was a salient feature. These proceedings are available.

In addition, workshops/training were conducted for middle level state officials of Departments of Agriculture, who spent 190 days during 1981, 623 days in 1982 and 546 days in 1983 in training and visit programs at ICRISAT. Attempts are being made to develop training programs for specific groups.

1981: Improving the management of India's deep black soils.

1982: Second policy makers' seminar to review the program of improved Vertisols management in relation to assured rainfall regions of India.

1983: Watershed based dryland farming in black and red soils of peninsular India.

FUTURE PLANS AND APPROACH

Considerable increase in productivity and rate of return substantiates the viability of the deep Vertisols technology on the rainy-season fallows beyond doubt. There is a great scope for refining and adjusting the different components of the technology and developing relevant problem solving options. Therefore, in future our major emphasis will be on multidisciplinary on-farm research emanating from the present experiences of technology verification.

II. CONCEPTUAL FRAMEWORK

On-farm research (OFR) at ICRISAT is holistic search for technological solutions to production problems by physical, biological, socio-economic and institutional constraints. A close working relationship between the researchers and farmers remains the essential ingredient in effective OFR that allows farmers agroclimatic and socio-economic environments to influence the process of development of improved crop production technology.

Farming Systems Research at ICRISAT is conducting adaptive and verification phase of its work in collaboration with the national institutions on carefully selected benchmark farm situations, in order to describe and diagnose problems that the farmers face, evaluate technology options, and monitor the adoption and performance of technologies. OFR has demonstration value in the transfer of technology, but extension is not the responsibility of ICRISAT. The OFR is conducted by the FSRP scientists in close collaboration with the Economics Program of the Institute.

Objectives of OFR:

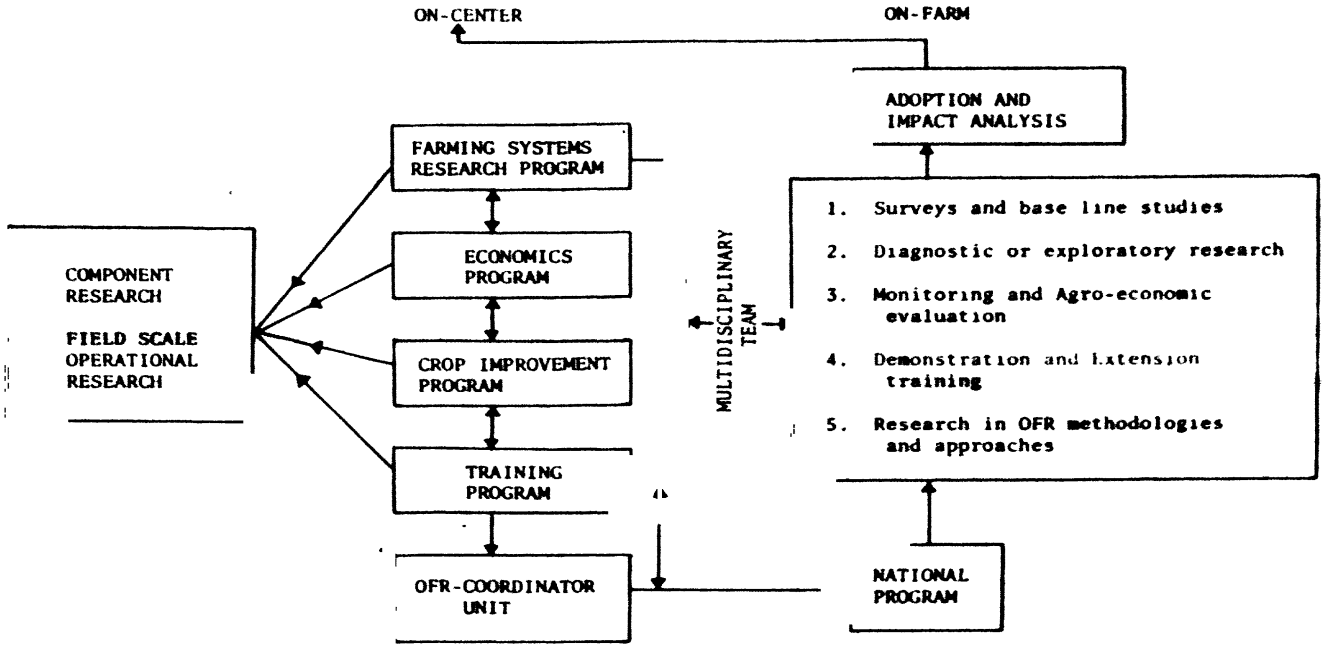
1. To study the existing systems in an effort to identify farmers' constraints to production, and indicate potential research areas.

2. To test, screen and evaluate technology options--components and/or systems under real world situations.

3. To monitor the adoption and assess the impact of technologies.

4. To develop and test OFR methodologies and approaches, and participate in training programs with OFR field activities.

5. To provide a channel for technology transfer in cooperation with national programs.



RELATIONSHIP OF ON-FARM AND ON-CENTRE RESEARCH

III. FIVE YEAR REPORT

ICRISAT's farming systems research aims at developing improved production practices that will optimise the use of agroclimatic, biological and socio-economic factors, to increase and stabilize crop productivity.

Since small SAT farmers with their variable resource base react differently and are unable to provide experiment station conditions, it is essential that new technological options are adjusted to meet specific local needs. On-farm research is the vital link between the experiment station and the farmers and is an important step in the process of developing improved relevant farm practices. Though each farm situation is unique in itself, but for similar factors, farms and areas can be grouped into operational areas and practices can be disseminated to analogous systems and situations. Since, farming systems are complex and problems related to agro-ecological, biotic and socio-economic factors are multidimensional in nature, on-farm research is a multidisciplinary process, directed at problem-solving field experimentation.

Farmers and extension workers interact with the multidisciplinary teams in developing problem-solving innovations based on experiment station basic research.

On-Farm Watershed Development: Stage I

In 1978 a cooperative on-farm research project was initiated with AICRPDA (India's dryland research project), three state agricultural universities and the ICRISAT Programs on Farming Systems and Economics. Small watersheds in three villages were selected and land development was completed before the rainy season.

The objectives of the project were (1) to adapt, test, and measure the performance of prospective land and water management technology on farmers fields; (2) to find ways for farmers to participate in the technology development process; and (3) to examine the need and feasibility of group action for adoption of watershed-based systems of resource development and management.

The watersheds developed were; An 11.7 ha Alfisol watershed at Aurepalle, Andhra Pradesh; 10.8 ha medium Vertisol watershed near Kanzara, and 13.9 ha deep Vertisol watershed near Shirapur in Maharastra state (Fig. 1).

Experience of the first 2-years (1979/80 and 1980/81) showed that: (1) no significant difference in profits was observed (2) improved seed, chemical fertilizer and better soil and crop management in red soils of Aurepalle gave higher yields than the traditional technology, but higher gross returns from the higher yields were evened out by higher cost levels (3) in Shirapur watershed, rainy-season crops failed due to early cessation of rains and traditional postrainy-season sorghum benefited from the application of chemical fertilizers (4) broadbeds and furrows (BBF) in red soils are not advantageous (5) the crop yield levels varied widely across farmers fields within the watershed, and (6) on deep vertisols, emphasis on replacing the kharif fallow by rainy-season cropping must be concentrated in the high rainfall regions (750 mm and above).

Deep and Medium-Deep Vertisol Watershed Development in On-Farm studies: Stage II

Research results of watershed based management of deep and medium deep Vertisols at ICRISAT since 1973 indicated that deep Vertisol technology developed at ICRISAT can increase profits upto 600% compared with a traditional system which was based on one crop a year (rainy-season fallow followed by postrainy season sorghum and chickpea). This technology consists of five steps which need to be practised together for maximum impact. These are:

- shaping the land into graded broadbeds and furrows to faciliate cultivation and surface drainage after the harvest of the preceding;
- preparing seedbeds during the dry season with improved bullock-drawn equipment;
- sowing dry just ahead of the monsoon;
- using moderate amounts of fertilizers and recommended high yielding cultivars;
- cultivating a second crop on the same land after the first crop has been harvested.

Using this technology a maize/pigeonpea intercrop has given an average of over 3.8 tonnes of foodgrain production per year without the use of irrigation for over five consequtive years. Therefore, we decided that emphasis will be placed on testing and refining the deep Vertisol technology in dependable rainfall areas.

Therefore, in 1981 a joint project was initiated with Indian research institutions, the Andhra Pradesh Department of Agriculture, and 14 farmers at Tadanpally, Medak District, A.P., to test the technology options under field conditions. Objectives of the project were to:

1. Verify whether the experience gained at ICRISAT could be replicated in farmers fields;

2. Evaluate the performance of the technology options;

3. Test the ability of delivery systems to support demands of the improved technology options;

4. Study the technical and economic performance of the options in real world conditions;

Yields of rainy season hybrid sorghum as an intercrop in the watershed were about 2000 kg/ha; those of intercrop maize 1600 kg/ha. Sole crop maize yielded 2300 kg/ha. The traditional postrainy-season sorghum yielded only 700 kg/ha after fallow. The detailed economic analyses of the results are presented by the economics program. In general production and profits were markedly higher under the improved system, with a 244% return on added expenditure of Rs.586/ha.

The Indian Ministry of Agriculture, the Indian Council of Agricultural Research, and ICRISAT organised the first policy makers seminar on the Management of Deep black soils and as a follow-up action the departments of Agriculture in Andhra Pradesh, Karnataka, Maharashtra and Madhya Pradesh started verification trials in an area of 120 ha with 59 farmers in 1982-83 season.

The verification of ICRISAT's deep Vertisol technology was expanded to 28 locations in about 2000 hectares involving 1406 farmers in the four states during 1983-84.

Important observations

1. Analysis of the limited observations from the watersheds of Tadanpally and Sultanpur in Andhra Pradesh, Farhatabad in Karnataka and Begumganj in Madhya Pradesh, indicated that improved technology resulted in increased production and income. However, a wide range of 26 to 2187% marginal rate of return indicated the need for closer monitoring of the different factors of the technology and optimising the input factors.

2. Tadanpally and Sultanpur tests showed that the most important determinants of profitability in the improved cereal/pigeonpea inter-crop in Andhra Pradesh is effective control of Heliothis pod borer. Timely spraying with endosulfan reduced losses from Heliothis as yields ranged from 1150 to 1250 kgs across the three types of sprayers. The results showed that poor control of Heliothis pod borer reduced yields by 700 to 800 kgs/ha, which is equivalent to a loss in profits of about Rs.2500/ha at 1983-84 prices. Farmers relying on existing support services sprayed several times to control a heavy Heliothis infestation. On an average, they harvested about 450 kg/ha of pigeonpea grain.

3. In the first year of watershed testing in Tadanpally and Sultanpur, farmers planted 65% of the watershed to systems that featured a rainy season cereal usually sorghum, that was either inter-cropped or sequentially sole-cropped with a pulse in the postrainy season. In the second and third year, farmers reverted to their more traditional practice of planting rabi sorghum and sowed a non-cereal based cropping system, usually a kharif fallow chillies sequence.

4. In Begumganj there was more plot to plot variability in profits in the watershed than in neighbouring farmers' fields. Although the improved technology options were on an average more profitable, they were also more variable. Also soybean/pigeonpea inter-crop appeared to be more profitable and is likely to become increasingly popular. There is a need for more adaptive cropping systems research in Madhya Pradesh.

Future plans and approach

Substantial increase in productivity and rate of return underscored the viability of the deep Vertisols technology on the rainy-season fallows beyond doubt. Therefore, as a first step attempts were made to pass-off the technology through analogous transfer and extension to the probable potential areas through the extension agency of the department of Agriculture. This approach had the elements of specification bias in technology prescription and inspite of encouraging results it has been experienced that there is a great scope for refining and adjusting the different components of the technology and develop relevant problem solving options. Therefore, in future our major emphasis will be on multidisciplinary on-farm research emanating from the present experiences of technology verification.

ICRISAT role vis-a-vis national research institutes and extension programs

CGIAR Technical Advisory Committee of CGIAR laid emphasis on

national systems for on-farm and farming systems research since they are directly linked with the transfer and extension of new technologies, which is a continuing process. The international centres and national institutions for agricultural research and extension represent the formal systems of research engaged in developing basic information and techniques necessary to support the on-farm research work. Since, in past the SAT areas of the world have been neglected, research information is highly inadequate to solve the complex crop production problems emanating from highly diverse agroclimatic and socio-economic environments. Relatively on-farm research is a new concept and therefore initially international centres such as ICRISAT and national institutions can compliment each to provide the necessary research back-up.

ICRISAT, in collaboration with the national institutes, is setting up on-farm research projects in different representative areas for which research leads are available. These projects will serve the dual purpose of feed-back to the scientists and necessary demonstration and training to the extension workers and farm leaders.

The limited experience from on-farm verification trials has been extremely useful in establishing priorities for component research. Some of the components which need attention in future are

1. contribution of broad bed and furrow management in increasing productivity and returns in the short run;

2. utility and efficiency of wheel tool carrier and other implements;

3. methods of Heliothis control;

4. sequential double cropping;

5. dry seeding;

6. cropping systems in relation to rotational needs and much needed flexibility in choice of crop sequence.

At present there is little information on the parameters which can indicate the confidence limits for the viability of a technology in terms of its adoption. The number of farmers involved in the verification trials is totally arbitrary. Also there is a wide variation in productivity and marginal returns on the plots within a project area. As a research methodology it is essential to determine an optimum number of participating farmers and the

distribution of variation in productivity and returns, which helps in establishing and transferring a particular component or components.

Training

On-farm research or verification is a vital link in the delivery system of new technology. Adoption and realization of the benefits of a new crop production technology depends on its effective communication to policy decision makers, input suppliers (manufacturers, bankers, etc.) extension workers and farmers, who are the ultimate users. Since each of them have different roles to play in the technology delivery system, they need exposure to the new technology appropriate to their respective role. Therefore, training of different groups requires different approaches.

To follow up the first policy makers' seminar of 1981, the second policy makers seminar was conducted at ICRISAT Centre from in 1982, to formulate specific proposals taking into consideration the experiences of on-farm verification trials conducted or underway in the Vertisols of different states. Thirtyeight officers representing the Ministry of Agriculture, Government of India, the States of M.P., A.P., Maharashtra and Karnataka, ICAR, ICRISAT and credit institutions had participated in the seminar which included field visits to the operational experiments on the Vertisol watershed at ICRISAT Centre and to on-farm verification trials at Tadanpally/Sultanpur, A.P. This was followed by the visits of 5 groups of senior officers from the States of M.P., A.P., Maharashtra, Karnataka, Tamilnadu, Gujarat, and Government of India to ICRISAT for 2-5 days, each between 31st August and 4th December, 1981.

Workshops/training were conducted for middle level state officials of Departments of Agriculture, who are responsible for guiding and supervising the adoption of deep Vertisol technology. The officers spent a total of 190 man days during 1981, 623 man days in 1982 and 546 man days in 1983 in training and visiting various programs at ICPISAT.

Attempts are being made to develop training programmes for specific groups and to organise and follow-up the training of skills required for the transfer of technology at the project level in cooperation with the national institutions and training systems.

IV. PUBLICATIONS

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1981. Improving the Management of India's Deep Black Soils. Proceedings of the Seminar on Management of Deep Black Soils for Increased Production of Cereals, Pulses, and Oilseeds, New Delhi, 21 May 1981.

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1982. Second Policymakers' Seminar to Review the Program of the Improved Vertisols Management in Relation to Assured Rainfall Regions of India. 10-11 September 1982. A Summary. ICRISAT, ICRISAT Patancheru P.O. A.P. 502 324, India.

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1984. Proceedings of the NABARD-ICAR-ICRISAT Workshop on Watershed-Based Dryland Farming in Black and Red Soils of Peninsular India, 3-4 October 1983, Patancheru, A.P., India.

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1984. Proceedings of Meeting with Directors of Agriculture, NABARD, and ICRISAT Scientists held on 6 April 1984 at ICRISAT Center, Patancheru, A.P. India. Farming Systems Research Program, ICRISAT, ICRISAT Patancheru P.O., Andhra Pradesh 502 324, India. April 1984.

Ryan, J.G., Virmani, S.M. and Swindale, L.D. 1982. Potential Technologies for Deep Black Soils in Relatively Dependable Rainfall Regions of India. Paper presented at the Seminar on Innovative Technologies for Integrated Rural Development organized by the Indian Bank in New Delhi, 16-17 April 1982. Submitted as C.P. No. 105 by the International Crops Research Institute for the Semi-Arid Tropics.

ON-FARM RESEARCH STAFF
(As of Jan 1984)

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S.V.R. Shetty	Agronomist (Till Feb 1983-part time)
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R.T. Hardiman	International Intern (From Sept 1983)
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