AN OUTLINE OF
APPROVED CURRENT RESEARCH PROJECTS
1978

INTERNATIONAL CROPS RESEARCH INSTITUTE FOR THE SEMI-ARID TROPICS
HYDERABAD : INDIA

C O N T E N T S

Abbreviations Used

S	=	Sorghum	B&N	=	Biochemistry & Nutrition
M	=	Millet	Micr	=	Microbiology
PP	=	Pigeonpea	Cer	=	Cereals
CP	=	Chickpea	Agron	=	Agronomy
G	=	Groundnut	Prod	=	Production
EC	=	Economics	Mark	=	Marketing
FS	=	Farming Systems	Cl	=	Climatology
brd	=	Breeding	LW	=	Land & Water Management
Path	=	Pathology	SFC	=	Soil Fertility & Chemistry
Ent	=	Entomology	Crop.Sys.	=	Cropping Systems
Phy	=	Physiology	SP	=	Soil Physics
Q&N	=	Quality & Nutrition	FPE	=	Farm Power & Equipment
gp	=	Germplasm			

DEFINITIONS

1. The figure in brackets at the end of each project, eg. S-brd-1(74) indicates Year of Start of Revision of the project.

2. The figure in brackets at the end of each Title eg. International Testing of Breeding Material(79) indicates Year of Revision or Completion of the project.

3. Sub-program Leader: The senior Principal Scientist who guides, supervises and coordinates the entire work of the sub-program. He takes the responsibility for ensuring that all the projects in the sub-program are properly planned, coordinated and executed for achieving the main objectives of ICRISAT. He will be responsible for providing necessary support to the project.

4. Project Scientists: The project scientists will contribute to the planning and execution of the project and take responsibility for its proper execution, collection of the appropriate data and summarizing and reporting results. They will be spending a significant amount of their time in day to day work on the project.

5. Cooperating Scientists: The cooperating scientists are other scientists who maintain interest in the objectives of the project and are prepared to work as members of the team for achieving these objectives. They will spend time in planning of the project, counselling and collecting data to fulfill the objectives of the project.

1. Project No: S-brd-1(74)

Title: International testing of breeding material (79)

Project Scientist: Dr. L.R. House

Cooperators: Drs. D.S.Murthy, Bhola Nath, K.V.Ramaiah, B.L.Agrawal and International Scientist for International testing.

Objectives:

1. To evaluate breeding material at all stages of development over a wide range of appropriate environments.
2. To publish the gathered data to guide breeders at ICRISAT and other coop. scientists in SAT in selection of breeding material.
3. To exchange advanced breeding material between ICRISAT and its coop. centers and national programs for further utilisation.
4. To help in developing a network of coop.scientists in tackling common breeding objectives.

Methodology:

Selected international nurseries will be sent to cooperators in different countries.

2. Project No: S-brd-3(74)

Title: Improvement of Sorghum: Advanced populations, Back-up and Source populations (79)

Project Scientist: Dr. Bhola Nath

Cooperators: Drs. L.R.House, K.V.Seshu Reddy, K.N. Rao.

Objectives:

Advanced populations:

1. To develop and improve advanced populations for different ecological regions.
2. To extract elite lines from populations.

Source and Back-up populations:

1. To develop random-mating source populations from accessions derived from the germplasm collection, or from progeny derived from the introgression crosses.
2. To maintain and slowly improve these populations by simple recurrent selection procedures so that this wide genetic variation is in a useful form for breeders in the national programs, or for the advanced and back-up populations.
3. To maintain populations similar to the advanced populations, but only improve them slowly so as not to lose any useful genetic variability.

Methodology:

Advanced populations:

1. S_2/S_1 recurrent selection through multilocational tests.
2. Advancing lines from populations through pedigree selection.

Source and Back-up populations:

1. Half-sib testing with low selection pressure at few locations.
2. Incorporating useful variability such as resistance to pests, diseases and striga by bulk crossing.

3. Project No: S-brd-4(77)

Title: Sorghum Improvement: Pedigree breeding and hybrids (82)

Project Scientist: Dr. L.R. House

Cooperators. Drs. D.S. Murthy, K.V. Ramaiah

Objectives:

Pedigree Program:

1. To carry into advanced generations with selection entries from introgression program and composites; and from crosses between parents with unique traits.

Hybrid Program:

1. To develop hybrids and evaluate their performance against best varieties.
2. To make and evaluate male sterile seed parents using entries from other breeding program, B-line composites, backcrossing and pedigree breeding.
3. To develop good parents with useful traits incorporated as per the varietal program.

Methodology:

1. Standard pedigree breeding procedures (2) Backcrossing (3) Test crossing for good B-line reaction, (4) Incorporating developments from all aspects of the sorghum program.

4. Project No: S-brd-5(74)

Title: Grain-grass Sorghums (79)

Project Scientist: Dr. K.V. Ramaiah

Objectives:

1. To develop short, early grain grass sorghums with a plant resembling wheat or eleusine millet with ratoonability characteristics.
2. To test promising selections in dry areas of SAT alongwith early grain sorghums.

Methodology:

1. Several crosses have been made between grain-grass parents and adapted high yielding good grain parents, shoot-fly, stem borer, midge, mould and striga resistant lines. A modified diallel selective mating system of Jensen has been followed in generating segregating material. A grain-grass population has been developed.
2. Best segregants have been screened for shoot-fly, mould and striga by respective cooperating scientists.
3. A population density trial has been conducted in collaboration with physiologists to determine the optimum population density for yield testing grain-grass lines.
4. Grain-grass parents have been screened for drought by physiologists.

5. Project No: S-brd-9(75)

Title: Striga resistance breeding (80)

Project Scientist: Dr. K.V. Ramaiah

Cooperators: Drs. L. R. House, R.K. Maiti, S.V.R. Shetty.

Objectives:

1. To develop striga resistant cultivars with good yield and quality.
2. To build up strong multilocation testing across SAT to cover all species of striga and physiological strains.
3. To study genetics of inheritance of striga resistance.
4. To help regional and national programs in training their staff and exchange of material.
5. To identify beneficial crop mixtures for supressing striga incidence.

Methodology:

1. Striga laboratory for identifying low stimulant producing sorghums has been established and is screening 25 lines every day.
2. The technique for identifying mechanical type of resistance is being standardized in collaboration with physiolgoists.
3. A natural striga sick-plot has been identified in Akola (PKV) for field testing.
4. Several crosses have been made (i) between striga resistant lines and adapted high yielding good grain lines (ii) between lines posessing different types of resistances, and (iii) between striga resistant lines and a genetic male-sterility source.
5. Necessary crosses have been made to study the genetics of inheritance of striga resistance.

6. Project No: S-brd-Path-1 (74)

Title: Development of Sorghums with quality grains resistant to grain mould & protected from it (79)

Project Scientist: Dr. D.S. Murthy

Cooperators: Drs. K.N. Rao, L.R. House, R.J. Williams.

Objectives:

To develop short term sorghums with good quality and resistant to grain moulds, coloured spotting and physiological breakdown.

Methodology:

1. Generating a wide range of elite material segregating for grain mould resistance, grain quality and high yield through a systematic conventional crossing program.
2. Screening the early generation material in natural and artificial mould favouring environments/in cooperation with pathologists.
3. Identifying genotypes combining grain mould resistance, grain quality and high yield.
4. Testing the elite F_4 and F_5 derived lines in the SAT for grain mould resistance and adaptation.
5. Developing a mould resistance composite and improving mould resistance levels through recurrent selection.
6. Transferring the large free threshing and colourless glumes of photo-sensitive lines to photoinsensitive and early background by conventional crossing methods and test the derivatives for mould damange.

7. Project No: S-brd-Ent-1(74)

Title: Breeding for pest resistance (79)

Project Scientist: Dr. B.L. Agrawal

Cooperators: Drs. K.V.Seshu Reddy, J.C. Davies, L.R. House.

Objectives:

To select and develop resistance to shootfly, stem borer, midge and storage pests.

Methodology:

1. Pedigree breeding using single crosses, backcrosses to the adapted parents, and double crosses are being used to incorporate resistance into adapted varieties.
2. Population breeding using recurrent selection as the long term approach for combining pest resistance with yield and grain quality.

8. Project No: S-brd-Phy-1(77)

Title: Development of Sorghums with drought resistance (82)

Project Scientists: Drs. F.R. Bidinger, L.R. House

Cooperators: Dr. N. Seetharama

Objectives:

1. To develop varieties and hybrids with drought resistance.
2. To identify and use various mechanisms of drought resistance.

Methodology:

(i) Bring together varieties known to be native to dry areas (ii) Evaluate this collection regionally in dry areas. At headquarters undertake more detailed physiological studies of response to stress (iii) After identification, utilize good sources for improving drought resistance of sorghum being developed for the low and medium rainfall regions (iv) Develop drought screening techniques.

9. Project No: S-brd-Q&N-1(74)

Title: Breeding and evaluation of high quality, nutritious sorghum grain types. Food technological aspects (79).

Project Scientist: Dr. D.S. Murthy

Cooperators. Drs. Umaid Singh, L.R.House, K. David Nicodemus, R. Jambunathan, Ken Riley.

Objectives & Methodology:

1. To evolve cultivars with a stable high lysine content in a range of protein backgrounds.
2. Evident quality to evolve cultivars with good seed in a traditional sense; bold, vitreous, lustrous, and usually white with no subcoat.
3. Food technology: (i) To attempt to define and measure appropriate traits for grain quality in cooperation with existing food laboratories, (ii) Run a simple routine laboratory to screen for chapattis and possibly other food preparations. Designed to help eleminate obviously poor material from the crop improvement programs.

SORGHUM GERMPLASM — Sub-program Leader: Dr. L.J.G. van der Maesen

10. Project No: S-gp-1(74)

Title: Maintenance and evaluation of Sorghum germplasm. (80)

Project Scientist: Mr. K.E. Prasada Rao

Cooperators: Drs. LJG van der Maesen, L.R.House, J.C.Davies, R.J. Williams, F.R.Pidinger, R. Jambunathan.

Objectives:

To maintain, evaluate, document and distribute germplasm.

Methodology:

(i) Growing accessions as and when needed for renewal (ii) Application of selfing technique for maintaining the purity (iii) Recording observations as appropriate (iv) Proper storage to keep the seed viable for sufficiently long periods, maintenance of records (v) Acquisition of material to fill gaps in the collections and organising the collection in indigenous and experimental accessions.

11. Project No: S-gp-2(75)

Title: Collection of Sorghum germplasm and taxonomical classification (80)

Project Scientist: Mr. K.E. Prasada Rao

Cooperators: Drs. LJG van der Maesen, L.R.House, D.L.Oswalt, D.J.Andrews J.C.Davies, S. Appa Rao.

Objectives:

1. To fill the gaps in the collection. (2) To obtain new genetic resources in Sorghum spp. (3) To classify world collection and new accessions (Harlan & de Wet).

Methodology.

(i) Collection of sorghum in India, S.E.Asia where gaps exist. Acquisition of all possible information to reach this goal. (ii) Collection of wild species [illegible] of Sorghum in Africa through cooperation (iv) Field study of material under evaluation for classification

12. Project No: S-gp-3(74)

Title: Introgression (79)

Project Scientist: Mr. K.E. Prasada Rao

Cooperators: Drs. LJG van der Maesen, L.R. House.

Objectives:

To utilise genetic resources of Sorghum spp. by introgressing new germplasm from the collection into adapted breeding material.

Methodology:

1. Introgressing a stratified sample from each taxonomic and geographical groups into adapted cultivars.
2. To use tetraploids and polyhaploids to introgress germplasm from S. almum and C. halepense into the cultivated races.

13. Project No.: S-gp-4(76)

Title: Assembling and maintenance of minor millet collections. (81)

Project Scientist: Mr. K.E. Prasad Rao

Cooperators: Drs LJG van der Maesen, S.M. Rao, D.J. Andrews.

Objectives:

Collection and maintenance of Eleusine coracana, Setaria italica, Panicum miliaceum, Panicum miliare, Paspalum scrobiculatum and Echinochloa crus-galli and publication of relevant information.

Methodology:

IBPGR Advisory Committee on Sorghum and Millets, requested the ICRISAT to accept the responsibility for maintenance of germplasm collections on hand and improve them by obtaining additional materials. 400 gr. sample of each accession will be maintained at ICRISAT and relevant information published. Seeds will be stored in cold room.

SORGHUM PHYSIOLOGY

Sub-program Leader: - Dr.F.R. Bidinger.

14. Project No: S-Phy-1(74)

Title: Growth and Yield Physiology (79)

Project Scientist: Dr. N. Seetharama

Cooperators: Drs. G.Alagarswamy, F.R.Bidinger, R.K.Maiti, L.R.House

Objectives & Methodology:

Area-1: To understand relationship between various aspects of crop growth and resulting crop yield and to formulate and test hypotheses concerning more efficient, adapted and productive plant types.

Area-2: To evaluate the effectiveness of breeding for superior yield by recombining physiological characteristics; and to evaluate the efficiency of breeding [illegible] geographic location and season using physiological parameters.

Area-3: To assess the plasticity of selected genotypes under varying levels of specific management factors, particularly those which are likely to be yield limiting [illegible] farmers conditions; and to compare the results of performance [illegible] high and low input management conditions.

Area-4: To determine the optimum management practices for testing experimental materials

15. Project No: S-Phy-2(75)

Title: Efficiency of uptake and utilisation of nutrients (80)

Project Scientist: Dr. N. Seetharama

Cooperators: Drs. G.Alagarswamy, R.K.Maiti, F.R.Bidinger, D.L.Oswalt.

Objectives & Methodology:

Area-1: To determine if there is useful variability in sorghum for nitrogen and phosphorus uptake and translocation; To establish methods of selecting for improved nitrogen and phosphorus efficiency if this is proven desirable.

Area-2: To determine if there is useful variability in sorghum for phosphorus uptake under low soil phosphorus levels. To determine if differential seedling phosphorus efficiency is related to crop growth and yield.

16. Project No: S-Phy-3(75)

Title: Drought Resistance (80)

Project Scientist: Dr. F.R. Bidinger

Cooperators: Drs. N. Seetharama, R.K. Maiti, G.Alagarswamy, L.R.House.

Objectives & Methodology:

Area-1: To develop a methodology for screening breeding and source materials for their ability to produce a satisfactory yield under drought stress.

Area-2: To screen various materials to identify sources of resistance to drought stress for wider testing and for incorporation into breeding program.

Area-3: To develop detailed information of the effects of stress on aspects of crop growth metabolism, water relations, etc., to understand what governs genotype resistance or susceptibility to drought stress.

Area-4: To determine possible improvement of stress resistance of populations by selection under stress conditions, and to determine and select for specific stress response in segregating materials grown under stress.

17. Project No: S-Phy-4(75)

Title: Plant Anatomy, Morphology and Development (80)

Project Scientist: Dr. R.K. Maiti

Cooperators: Drs. N. Seetharama, F.R.Bidinger, S.S. Bisen, G.Alagarswamy K.V. Seshu Reddy, K.V. Ramaiah.

Objectives & Methodology:

Area-1: To study relationship between seed characters and seedling development in a range of genotypes; and to develop techniques for evaluating genotypes for seedling vigour.

Area-2: To develop basic information on the growth and development of the sorghum panicle and realtionship between developmental processes and panicle productivity; and to investigate the role of panicle growth and development in crop yield - supporting studies for other physiology projects.

Area-3: To develop methods for studying root growth in the field and in controlled conditions and to collect basic information on root development and growth in sorghum.

Area-4: To assess mechanical resistance to haustorial penetration as a mechanism of striga resistance; and to assess the role of leaf morphological factors in shootfly resistance.

SORGHUM PATHOLOGY — Sub-program Leader: Dr. R.J. Williams

18. Project No.: S-Path-1(74)

Title: Identification and utilisation of sorghum grain mould resistance (79)

Project Scientist: Dr. K.N. Rao

Cooperators: Dr. R.J. Williams

Objectives:

1. To determine the etiology of sorghum grain moulds and their effect on grain quality and quantity.
2. To identify sources of stable resistance and to cooperate with the breeding group in utilization of the resistance.
3. To evaluate the effects of diverse head and grain types on the susceptibility to grain moulds in sorghum.

Methodology:

1. Isolation of fungi from moulded heads and testing their pathogenicity.
2. Measure viability of moulded and non-moulded seeds.
3. Cooperate with economists and biochemists on economic and toxin aspects respectively.
4. Inoculation of germplasm and other materials at ICRISAT with mould fungi, and assessment of mould development both on inoculated and naturally moulded panicles.
5. Evaluation of the grain mould resistant source at several locations in India and Africa to determine the spectrum and stability of the resistance.

19. Project No: S-Path-2(74)

Title: Identification of sources of stable resistance to sorghum downy mildew (79)

Project Scientist: Dr. R.J. Williams

Cooperators: Dr. K.N. Rao

Objectives:

1. To identify and maintain sources of stable resistance to sorghum downy mildew.
2. To evaluate ICRISAT sorghum breeding material for susceptibility to SDM.
3. To assist breeders in utilization of resistance.

Methodology:

1. Identification of a screening technique to use at ICRISAT.
2. Screening material at ICRISAT center.
3. Multilocational testing at 'hotspot' locations in India and parts of Africa, to evaluate the stability of resistance.

20. Project No: S-Path-3(75)

Title: Identification of sources of stable resistance to sorghum leaf diseases. (80)

Project Scientist: Dr. R.J. Williams

Cooperators: Dr. K.N. Rao

Objectives:

1. To identify sources of resistance to leaf diseases.
2. To assess the stability of resistance through multilocational tests.
3. To study [illegible] reasons for susceptibility to leaf pathogens and breed for improved resistance levels.

Methodology:

1. Development of screening techniques for use at ICRISAT center.
2. Assembly of lines found resistant in other programs.
3. Evaluation of lines at ICRISAT center.
4. Evaluation of the stability and spectrum of resistance through cooperative multilocational ISLDN program.
5. Evaluation of ICRISAT breeding materials at key 'hot spots'.

21. Project No: S-Path-4(76)

Title: Investigations on sorghum stalk rots (81)

Project Scientist: Dr. K.N. Rao

Cooperators: Dr. R.J. Williams

Objectives:

1. To determine the importance of sorghum stalk rots in SAT.
2. To develop suitable efficient screening techniques to identify resistance.
3. To utilize stalk rot 'hot spots' to evaluate the stability and spectrum of stalk rot resistance.

Methodology:

1. Literature review and discussions with SAT sorghum workers.
2. Develop inoculation techniques for use at ICRISAT center.
3. Assemble and screen supposed sources of resistance.
4. Initiate and coordinate a multilocational testing program for evaluation of resistance stability.

22. Project No: S-Path-5(77)

Title: Identification of sources of resistance to sorghum ergot (82

Project Scientist: Dr. K.N. Rao

Cooperators. Dr. R.J. Williams

Objectives:

1. To identify sources of resistance to ergot and to test the stability of the resistance in a multilocational testing program.
2. To maintain resistant lines and where necessary assist breeders in utilization of identified resistance.

Methodology:

1. Inoculating the materials at ICRISAT center.
2 Multilocational testing under severe epiphytotic conditions in India and East Africa.

SORGHUM ENTOMOLOGY — Sub-program Leader: Dr.J.C. Davies

23. Project No: S-Ent-1(74)

Title: Pest incidence on hybrid and local cultivars of sorghum (79)

Project Scientist: Dr. K.V. Seshu Reddy

Cooperators: Dr. J.C. Davies

Objectives:

1. To determine the range of pests found on sorghum, their parasites and obtain valid identifications of the species involved.
2. To obtain information on their relative importance and accumulated information on the seasonal abundance, behaviour patterns and plant preferences of the various pests.
3. To compare the species of pests and parasites present with those of other areas in SAT.
4. To characterise the damage caused.

Methodology:

1. Three standard cultivars CSH-1, Swarna and local sorghum (Pachajonna) were sown and detailed pest counts carried throughout the cropping seas
2. Unknown species of pests and predators were sent to the British Museum for identification.

24. Project No: S-Ent-2(74)

Title: Pest Carryover Studies. (79)

Project Scientist: Dr. K.V. Seshu Reddy

Cooperators: Dr. J.C. Davies

Objectives:

1. To obtain basic information on the sources of carryover of shootfly and midge.
2. To improve our knowledge of the Chilo carryover population known to exist in sorghum stubble and stalks.
3. To determine the levels of parasitism in carryover populations.

Methodology:

Sorghum stalks of CSH-1, Swarna and 'local' sorghum from kharif crop 1975 and 1976 were 'stooked' in the traditional way after harvest. Monthly sampling of 200 stalks from each cultivar was carried and is being carried out. Trapping of shoot-fly was carried out daily as a range of sites at Patancheru using fish meal traps. Grass hosts of shoot-fly and suspected hosts were collected and shoot-flies emerging identified.

25. Project No: S-Ent-3(74)

Title: Screening of sorghum varieties for pest resistance (79)

Project Scientist: Dr. K.V. Seshu Reddy

Cooperators: Dr. J.C. Davies

Objectives:

1. To develop suitable methods of ensuring a high and reasonably uniform pest incidence for screening sorghum from the germplasm breeding material and cultivars developed by the breeders for pest resistance, particularly, for shoot-fly, stem borer and midge.
2. To keep the breeders informed of the pest susceptibility tolerance of lines under test or likely to be used as parental sotck.
3. Initially most of the work is concerned with identifying resistance in the existing cultivars.

Methodology:

1. Shoot-fly: Interlard/fish meal technique is found to be good in getting maximum shoot-fly attack. Material which appeared promising in interlard screening trials for 3 or more seasons, was given a test under grid system of interlard in order to give maximum challenge. Data was obtained on egg laying by shoot-fly and dead hearts caused.
2. Stem borer: (i) A suitable artificial diet was developed for rearing the stem borer on a mass scale for screening work. The egg masses produced by the reared moths are placed at the 'black head stage' in the leaf whorls of sorghum plant at 4-6 weeks old. (ii) A method of field screening involving sowing of material under test within fields previously cropped with sorghum in the rabi season where stubbles were allowed to stand.
3. Midge: Preliminary screening tests were carried out in collaboration with the Maharashtra Department of Agriculture in areas where midge is endemic.

26. Project No: S-Ent-4(75)

Title: Testing of granular insecticides for stem borer control (80)

Project Scientist: Dr. K.V. Seshu Reddy

Cooperators: Dr. J.C. Davies

Objectives:

1. To develop the best possible regimes for protection of breeder's material.
2. To identify a suitable and, if possible, cheaper substitute for endrin, which will shortly cease to be produced in India.
3. It is possible that findings may be useful at the improved farmer level for use with high yielding varieties and hybrids and also seed production plots.

Methodology:

1. A block of CSH-1 with four replications was sown in December 1976.
2. Three different granular insecticides are being compared in a randomized block design with and without seed treatment.

27. Project No: S-Ent-5(77)

Title: Stem borer Chilo partellus Zell. Pheromone evaluation(79)

Project Scientist: Dr. K.V. Seshu Reddy

Cooperators: Dr. .C. Davies. Dr. B. Nesbitt & Mr. P. Beevor of Tropical Products Institute, London.

Objectives:

Evaluation of synthetic Chilo partellus, pheromone developed at the Tropical Products Institute, London.

Methodology:

Baiting square pan traps with synthetic pheromone - Daily counts.

SORGHUM BIOCHEMISTRY & NUTRITION Sub-program Leader: Dr. R. Jambunathan

28. Project No: S-B&N-1(74)

Title: Improvement of protein quality of sorghum (79)

Project Scientist: Dr. V. Subramanian

Cooperators: Drs. R. Jambunathan, L.R.House, Ken Riley

Objectives:

To select lines with low prolamine, high lysine sorghum having optimum protein percentage and high yield potential.

Methodology:

1. Protein content in sorghum samples will be estimated by the Technicon auto analyser method. (2) Lysine (basic amino acids) will be estimated by the dye binding capacity (DBC) method at constant protein or at constant weight of the sample. (3) Lysine values will be determined by the amino acid analyser and the correlation btween DBC and lysine values will be tested. (4) A reference table relating the DBC value and lysine concentration will be prepared. (5) Breeders samples will be screened using the rapid procedures and lysine values will be estimated using the reference table. (6) This information will be supplied to the breeders to enable them to make further selection of samples with higher yield potential.

29. Project No: S-B&N-2(76)

Title: To study the factors affecting the nutritional quality of sorghum incl ling cooking quality (81)

Project Scientist: Dr. V. Subramanian

Cooperators: Drs R. Jambunathan, L.R.House, N.Seetharama, K.E. Prasada Rao, D.S. Murthy.

Objectives:

(1) To obtain the protein fractions of sorghum samples obtained at different stages of maturity (2) Determine the variation in starch content of some selected sorghum samples (3) Study the digestibility of sorghum samples using in vitro methods (4) To identify the factors that affect the cooking quality of sorghum.

Methodology:

(1) Samples of maturing sorghum grains at different intervals after pollination will be analysed for the protein and amino acid distribution patterns. (2) Standard methods for the determination of starch in sorghum will be used. (3) Various combinations of enzymes will be used to study the dry matter disappearence and it will be correlated with biological value (4) Preliminary information will be obtained on various traditional methods of food preparation using sorghum to identify the factors that govern the cooking quality of sorghum.

SORGHUM MICROBIOLOGY Sub-program - Dr. P.J.Dart Leader:

30. Project No: Micr -Cer-1(76)

Title: Nitrogen Fixation associated with sorghum (81)

Project Scientist: Dr. R.V. Subba Rao

Cooperators: Dr. P.J. Dart

Objectives:

(1) To evaluate sorghum bicolor lines and hybrids, S. almum, S.virgatum, S.verticilliflorum, S.arundinaceum, S. halepense, and grain-grass sorghum for potential to stimulate nitrogen fixing bacteria.(2) Select and cross promising material to see if this nitrogenease activity can be enhanced (3) To determine the amounts of nitrogen fixed and transferred to the sorghum plants and the agronomic factors affecting this.

Methodology:

(1) Develop a reliable assay technique for measuring nitrogen fixation by sorghum and related species, based on the acetylene reduction assay for nitrogenase activity (2) Evaluate breeders material, locally adapted varieties improved varieties and hybrids grown in the field for nitrogenase activity using the acetylene reduction assay (3) Determine the heritability of this root associated nitrogen fixation as a guide for deciding which breeding procedures to follow (4) Follow the soil - plant N balance to determine the relative contribution from the different sources of Nitrogen for sorghum plants. Use 15_N enriched nitrate and nitrogen gas to measure the movement of nitrogen (5) Determine the effect of soil temperature, moisture and nutrient status on the level of this root associated nitrogen fixation.

PEARL MILLET BREEDING — Sub-program Leader: - Mr.D.J. Andrews

31. Project No. M-brd-1(73)

Title: Advanced Composites I - Intrapopulation Improvement (80)

Project Scientist: Dr. S.C. Gupta

Cooperators: Mr. D.J. Andrews, Dr. K.N. Rai

Objectives:

To breed widely adapted high yielding populations of several maturities with good seed quality.

Methodology:

Recurrent selection with multilocational progeny testing is used to improve 13 composite populations for yield, adaptation, agronomic desirability and disease resistance. Full-Sibs, S_1, S_2 or inbred tester progenies are tested at 3-5 locations with an additional replication in the Disease Nursery.

32. Project No: M-brd-2(74)

Title: Advanced Composites II - Interpopulation Improvement (80)

Project Scientist: Dr. K.N. Rai

Cooperators: Dr. S.C. Gupta, Mr. D.J. Andrews

Objectives:

To breed widely adapted populations of several maturities with good seed quality which, between pairs of populations, produce good variety or single cross hybrids.

Methodology:

Reciprocal recurrent selection with multilocations progeny testing is/will be used to improve 4 pairs of composites for yield, adaptation, agronomic desirability, disease resistance and combining ability. Reciprocal Full-Sibs, or Reciprocal Test Crosses are tested at several locations and in the Disease Nursery.

33. Project No: M-brd-3(73)

Title: Source Material (80)

Project Scientist: Dr. K. Anand Kumar

Cooperators: Mr. D.J. Andrews, Dr. R.J. Williams

Objectives:

(1) To form composites where sources with valuable characteristics may not be in generally adapted backgrounds (2) To maintain composites, usually of exotic origin which may require mild selection and time for recombination.

Methodology:

(1) A 340 entry Working Collection of diverse germplasm was established in 1974 by reviewing the existing germplasm and breeding material available at that time. This has been catalogued for useful characteristics. (2) 8 Populations, mostly from West Africa, have been investigated through progeny evaluation. This has been used both to improve the populations as such, and to allow utilization of individual progeny. (3) A source nursery has been started, mostly to preserve the unique early maturing D_2 breeding lines obtained from Dr. Majmudar's Jamnagar breeding program.

34. Project No: M-brd-4(73)

Title: Variety crosses and synthetics (80)

Project Scientist: Dr. B.W. Hare

Cooperators: Mr. D.J.Andrews, Dr. B.S. Talukdar; Millet Pathology scientists; ICRISAT Cooperative Scientists.

Objectives:

(1) To create vaiability by crossing specific parents, and to select progeny under several environments (2) To identify suitable parents for creating synthetic populations (3) To provide cooperators with segregating material.

Methodology:

Parents selected for crossing on a number of criteria including origin, head, grain and plant characteristics, agronomic performance and disease resstance. F_2 populations are grown at Hissar where evaluation of height and maturity and downy mildew and smut resistances is possible. From the best single plant selections (grown in the offseason) the best F_3 progenies are selected for entry into an F_4 uniform progeny nursery (UPM). In 1977, both an F_3 and an F_4 uniform progeny nursery were multilocationally tested. The best F_3 and F_4 progenies are reselected and tested in replicated trials. These are then utilised in the ways listed in the objectives.

35. Project No: M-brd-5(73)

Title: Hybrids (80)

Project Scientist: Dr. B.W. Hare

Cooperators: Mr. D.J.Andrews, Drs B.S. Talukdar, K. Anand Kumar, S.C. Gupta, K.N. Rai, Millet Pathology scientists; ICRISAT Coop. scientists.

Objectives: To breed high yielding stable hybrids, which may be single cross, variety top cross or variety cross hybrids.

Methodology:

Inbred on partially inbred progenies from other projects - Variety Crosses, Source Material and Population Improvement - are test crossed on A lines to evaluate them as potential hybrid parents. Apparent sterility maintainers are backcrossed to A lines to produce new seed parents. Restorers are reselected and retested. Hybrids are yield tested in two stages, initially at a few locations in India and a disease nursery in Africa and the best at more locations including African locations. Hybrid parents are being specifically bred by intercrossing and selecting from crosses involving existing R and B lines. New R and B lines are also being developed in the interpopulation improvement project.

36. Project No: M-brd-7(74)

Title: Yield tests (80)

Project Scientist: Dr. K. Anand Kumar

Cooperators: Mr. D.J. Andrews

Objectives:

To conduct trials on materials emerging from the breeding program both at Hyderabad and cooperating centres to determine performance and stability and adaptability.

Methodology:

Replicated trials are conducted under this project that are not a direct part of the yield testing of other projects (Composite products, Hybrids and Synthetics).

37. Project No: M-brd-8(74)

Title: International Cooperation (80)

Project Scientist: Dr. K. Anand Kumar

Cooperators: Mr. D.J.Andrews, Dr. B.W. Hare; Millet Pathologyscientists Outreach Scientists.

Objectives:
(1) To channel seed and information in both directions between ICRISAT and breeders in the SAT (2) To conduct coordinated trials in SAT countries.

Methodology:
(1) The International Pearl Millet Adaptation Trial (IPMAT) of about 20 entries is sent, by request, to cooperators in SAT countries. REsults are processed at ICRISAT and a detailed report published on performance and adaptation. Seed of many entries is available for retesting. (2) Seed of upto 50 outstanding segregating progeny per year are multiplied for distribution to interested breeders (3) Seed ob est hybrid pollen parents is increased for distribution (4) Specific seed requests are filled where possible.

38. Project No: M-brd-9(76)

Title: Comparison of population breeding methods (80)

Project Scientist: Dr. S.C. Gupta

Cooperators: Mr. D.J. Andrews

Objectives:

To compare the efficiency of different methods (Gridded Mass Selection, Recurrent Restricted Parental Selection, Full Sib Selection and S_2 Progeny Selection) of population improvemet in pearl millet.

Methodology:

The World Composite has been used as the base population on which the four methods have been started. The final comparison will be made after 6 years which will allow 6 cycles of selection of RRPS, GMS and FS evaluation (each kharif season) and 3 cycles of S_2 evaluation (every other kharif season). Interim comparisons will be made after 2 and 4 years.

39. Project No: M-brd-Agron-1(75)

Title: Agronomy (80)

Project Scientist: Mr. D.J. Andrews

Cooperators: Drs. R.W. Willey, B.A. Krantz

Objectives:

To determine the range and optimum cultivation requirements and intercropping characteristics for new genotypes.

Methodology:

(1) Contrasting genotypes (morphologically and maturity) were supplied for intercropping aptitude studies (2) Successful genotypes selected in sole crop breeding program tests will be screened for intercropping suitability. (3) Successful genotypes from breeding program are supplied to FS Agronomy for general cultivation and evaluation.

40. Project No: S-brd-Path-1(74)

Title: Breeding for disease resistance (80)

Project Scientists: Drs. S.C.Gupta, K.Anand Kumar; B.S.Talukdar, K.N. Rai.

Cooperators: Drs. R.J.Williams, S.D.Singh, R.P.Thakur, D.J.Andrews.

Objectives:

The identification and incorporation of resistance to Downy Milew, Ergot and Grain smut is fundamental to all parts of the breeding program.

Methodology:

(1) Breeding material (nurseries and traisl) are screened in the field in India, Africa and the DM. Disease nursery with pathologists doing the disease scoring where possible and creating the infection pressure in the disease nursery (2) Breeding and germplasm material are supplied to Pathologists for resistance assessment (3) Sources of resistance for Downy Mildew, Smut and Rust are corssed to population and elite inbred material.

41. Project No: M-brd-Phy-1(75)

Title: Physiology (80)

Project Scientists: Drs. B.W. Hare, B.S. Talukdar, K. Anand Kumar.

Cooperators: Dr. F R. Bidinger

Objectives:

(1) To screen breeding material for drought resistance (2) To select and characterise entries for the Breeders/Physiology Nursery (3) To conduct certain agronomy tests for information on effective populations and plot sizes for use in evaluation and selection of breeding material.

Methodology:

Drought; Material is screened at two levels in consecutive years in the field using the high stress summer season. The first level is a simple stress applied at flower initiation by withholding irrigation without replication. Recovery resistance is identified by response to a late irrigation. Those lines selected are tested a year later in a replicated test with several stress treatments.

B/P Nursery: Lines are accumulated from breeding nurseries and germplasm which show morphological traits probably connected with yielding ability. Lines are evaluated in several seasons for consistency of character expression.

Agronomy tests: Trials have been conducted to determine what plot size and plant population (various spacings) is optimum for genotype evaluation, and whether an interaction exists between population density and genotype.

42. Project No: M-brd-Q&N-1(74)

Title: Grain Quality (79)

Project Scientist: Dr. K. Anand Kumar

Cooperators: Mr. D.J. Andrews, Dr. R. Jambunathan.

Objectives:

(1) To select grain with good visual appearance (2) To select for nutritional quality (3) Preparation, cooking and taste.

Methodology:

Genotypes from selected yield tests and certain breeding material content. A proportion of these are analysed for UIR value (2) Protein and lysine were analysed from a 52 entry inbred trial grown in 5 different environments, and from IPMAT-2 for protein in 4 environments. (3) Five principal genotypes grown in 4 environments have been analysed for protein, protein fractions and amino acid content.

PEARL MILLET GERMPLASM

Sub-program Leader: - Dr. L.J.G. van der Maesen

43. Project No: M-gp-1(73)

Title: Germplasm evaluation and maintenance (80)

Project Scientist: Dr. S. Appa Rao

Cooperators: Mr.D.J.Andrews, Drs. K.Anand Kumar, R.Jambunathan, Umaid Singh, LJG van der Maesen.

Objectives:

(1) To maintain genetic resources of pearl millet (2) To evaluate existing accessions (3) To document and publish evaluations (4) To distribute germplasm material (5) To restore identity to the lines in hand.

Methodology:

(1) To grow out accessions when needed for renewal of stock (2) Maintenance of germplasm by sibbing method (3) Recordig appropriate observations (4) Storage of seeds in proper containers in cold storage (5) Checking of classifications, establishing workable ones.

44. Project No: M-gp-2(78)

Title: Collection of pearl millet germplasm (83)

Project Scientist: Dr. S. Appa Rao

Cooperators: Mr. D.J.Andrews, Drs. J.C.Davies, LJG van der Maesen Mr. K.E. Prasada Rao.

Objectives:

(1) To obtain new genetic resources of pearl millet (2) To fill the gaps in the collection

Methodology:

(1) Collection of pearl millet in Inida, SE Asia where gaps exist. Acquisition of all possible information to reach this goal (2) Collection of wild species (3) Collection of millet in Africa through cooperation (4) Field study of material under evaluation for classification.

PEARL MILLET PHYSIOLOGY — Sub-program Leader: Dr. F.R. Bidinger

45. Project No: M-Phy-1(78)

Title: Crop growth and yield under optimum management conditions(81)

Project Scientist: Dr. G. Alagarswamy

Cooperators: Drs. F.R.Bidinger, R.K.Maiti, N. Seetharama; Millet Breeding staff; Soil Physics & Agroclimatology programs.

Objectives:

(1) To better understand the growth and development of millet in response to the physical environment of the crop. (2) To develop and test hypotheses on the determinants of grain yield in different millet genotypes and on ways in which yield potential in the crop might be improved.

Methodology:

(1) Quantification of crop growth and yield by a variety of methods ranging from intensive crop sampling to simple yield component analysis at harvest. (2) Joint experiments wit the soil physics and agroclimatology programs for studies involving detailed measurement of the physical environment (3) Collaboration with external research organisations for specialised studies and/or assistance in data analysis and modeling.

46. Project No: M-Phy-2(78)

Title: Crop growth and yield under low intensity management conditions (81)

Project Scientist: Dr. G. Alagarswamy

Cooperators: Dr. F.R.Bidinger; Millet Breeding Staff, Cereal Microbiology, Biochemistry and Soil Chemistry Programs.

Objectives:

(1) To investigate the determinants of growth and yield under low intensity management/low fertility, and to determine the implications of these for selection strategy (2) To investigate whether or not currently used breeding methods (particularly selection under high intensity management) are identifying the genotypes with the best available performance under low fertility and low intensity management.

Methodology:

(1) Analysis of genotype growth, yield structure, and nutrient uptake and distribution in high versus low fertility (2) Testing of the effects of direct selection in low intensity management/low fertility conditions in comparison to selection under high intensity management/high fertility conditions.

47. Project No: M-Phy-3(75)

Title: Improvement in drought resistance (80)

Project Scientist: Dr. F.R. Bidinger

Cooperators: Drs. R.K.Maiti, C. Alagarswamy; Millet Breeding Staff.

Objectives:

(1) To realistically assess the possibility for direct, field screening for drought resistance during the summer season at ICRISAT, and to define the limitations and the applicability of the results of this screening. (2) To better understand the physiology of drought response in millet and to look for simpler methods of identifying desirable genotypes.

Methodology:

(1) Evaluation of the effects of various types of stress treatments for consistency of results and ability to distinguish among genotypes. (2) Initiation (in 1979) of a small drought resistance screening nursery to compare the results of summer season screening at ICRISAT to the effects of naturally occurring stress in a variety of locations (3) Detailed measurement on the development, growth, water relations, etc., of a set of genotypes with contrasting response. Some of these studies will be done in the field here and some by cooperating external organisations.

48. Project No: M-Phy-4(78)

Title: Improvement in crop establishment (80)

Project Scientist: Dr. R.K. Maiti

Cooperators: Millet Breeding Staff

Objectives:

(1) To develop and test methodologies for screening for seedling emergence and growth under conditions of crusted soils, seedling drought, and low soil nutrient status. (2) To identify and/or develop materials with improved stand establishment ability and early vigour for incorproation into the breeding program.

Methodology:

(1) Field screening (summer season) for emergence from crusted soils and seedling drought resistance (2) Glasshouse screening using soil flats or boxes for seedling drought resistance and for growth in P deficient soils.

PEARL MILLET PATHOLOGY — Sub-program Leader: Dr. R.J. Williams

49. Project No. M-Path-N1.1(78)

Title: Studies on the biology and epidemiology of pearl millet downy mildew (81)

Project Scientist: Dr. S.D. Singh

Cooperators: Dr. R.J. Williams

Objectives:

(1) To determine factors affecting oospore viability and longeveity and to develop a reliable technique for in vitro germination of oospores. (2) To determine whether physiologic races occur, and if they do to determine geographical distribution of virulence spectra. (3) To complete the study on possible seed transmission of downy mildew with a determination of factors which make seed carried inoculum non-viable.

Methodology:

(1) Oospore viability, longevity and germination: Until a reliable technique is obtained to germinate oospores studies on viability and longeveity will depend on bioassay through exposure of susceptible millet to the oospores. The possibilities of using triphenyl tetrazolium chloride for indicating viability will be further explored and the possibility of the necessity a host supplied factor for stimulating oospore germination will be examined.

(2) Physiologic races: Cooperative project with Commonwealth Mycological Institute in which we will expose apparent differentials to inoculum of various origins under a standardised environment.

(3) Seed transmission: The factors most likely to be causing the non-viability of seed carried inoculum are seed drying and ageing. The effects of various degrees of drying of partial green ear seed will be investigated along with the effects of heat and fungicide treatment, and length of storage.

50. Project No: M-Path-N1.2(78)

Title: Identification and utilisation of stable resistance to pearl millet downy mildew. (80)

Project Scientist: Dr. S.D. Singh

Cooperators: ICRISAT Millet breeding staff & Coop.Program staff; Scientists in national and University programs.

Objectives:

(1) To identify durable host plant resistance to downy mildew and ensure its incorporation into the products of the ICRISAT Pearl Millet Improvement Program.

Methodology:

Continue the present large scale ICRISAT Center screening and the IPMDMN and PRE-IPMDMN programs. Develop a more integrated program with ICRISAT cooperative program staff to increase screening at Kano, Nigeria and Kamboinse Upper Volta.

51. Project No: M-Path-N1.3(78)

Title: Evaluation of alternative control measures for pearl millet downy mildew (80)

Project Scientist: Dr. D. Singh

Cooperators: ICRISAT Cooperative Program Pathologists; Pathologists in national and University Programs.

Objectives:

To evaluate the potential for effective viable control of downy mildew by methods other than the use of resistance.

Methodology:

Initially this project will deal with the evaluation of the new systemic fungicide Ridomil for downy mildew control when used as a seed dressing. Application methods will be tested and the fungicide will be evaluated at various locations in India and West Africa.

52. Project No: M-Path-N2.1(78)

Title: Studies on the biology and epidemiology of ergot (81)

Project Scientist: Dr. R.P. Thakur

Cooperators: Dr. R.J. Williams

Objectives:

To determine the importance of several potential sources of primary inoculum.

Methodology:

The importance of sclerotia will be evaluated in isolation plots seeded with various levels and sources of sclerotia. Ergot sclerotia collected from weed grasses will be used in cross inoculation studies with millet.

53. Project No: M-Path-N2.2 (78)

Title: Identification and utilisation of stable resistance to ergot(80)

Project Scientist: Dr. R.P. Thakur

Cooperators: ICRISAT Millet breeding staff; ICRISAT Cooperative Program Pathologists; Pathologists in several national and University Programs.

Objectives.

To identify and/or develop sources of stable resistance to ergot and to incorporate the resistance into the ICRISAT millet breeding materials so that the products of the program will have built-in resistance.

Methodology:

(1) Large scale screening of source material will be done at ICRISAT center. Potentially useful lines will be tested in the IPMEN program at several locations in Africa and Asia. (2) Utilisation of resistance sources will need a great deal of input from and activity by the millet breeding staff. This will of necessity be a joint breeding-pathology activity.

54. Project No: M-Path-N2.3(78)

Title: Evaluation of alternative ergot control measures (80)

Project Scientist: Dr. R. P. Thakur

Cooperators: Millet breeding scientists

Objectives:

To evaluate the possibility of effective viable control by methods other than the use of host plant resistance. Initially we will follow up on the observations that rapid pollination greatly reduces ergot infection and as we get more information on the role of sclerotia and alternative hosts in the epidemiology of this disease there may be other possible control measures to test.

Methodology:

Various ways of providing more pollen early in flowering need to be devised and tested. Mixing a small quanity of seed of an earlier flowering cultivar has been suggested, but this might act as an early inoculum source too. Evaluation of cultivar differences in length of protogyny, quantity of pollen produced etc., need investigation. Ideas are solicited from colleagues.

55. Project No: M-Path-N3.2(78)

Title: Identification and utilisation of stable smut resistance(80)

Project Scientist: Dr. R.P. Thakur

Cooperators: ICRISAT Millet breeding staff; ICRISAT Coop.Program Pathologists; Pathologists in national and University Programs.

Objectives:

To identify stable sources of smut resistance and to utilise them in the ICRISAT millet breeding program so that the products of this program will be smut resistant.

Methodology:

(1) Continue initial screening at Hissar and test the products of this program in West Africa (Bambey, Kamboinse, Kano) in the IPMSN program. (2) Work with breeders in utilisation of the identified resistance screening progeny at Hissar.

56. Project No: M-Path-N4.1(78)

Title: Studies on the biology and epidemiology of rust(80)

Project Scientist: Dr. S.D. Singh

Cooperators: Scientists in national and University programs; ICRISAT Coop. program Pathologists.

Objectives:
(1) To determine the relative importance of different Puccinia spp. on millet in the SAT (2) To examine methods of rust promotion for use in a screening program.

Methodology:

(1) The project will undoubtedly involve collection of rusted millet leaves from various locations, and will probably seek the collaboration of CMI personnel in identifying the pathogens (2) An infector row system will be attempted for screening.

58. Project No: M-Path-N.4.2(78)

Title: Identification and utilisation of stable rust resistance(80)

Project Scientist. Dr. S.D. Singh

Cooperators ICRISAT Millet Breeding staff; Pathologists at several Indian locations.

Objectives

To identify stable sources of rust resistance and to utilise them in the breeding program.

Methodology:

(1) Screening source material at Bhavanisagar and Hyderabad and testing the products of this screen in the IPMRN program at other rust 'hot-spots'. (2) Working with the breeding staff in screening breeding progeny.

59. Project No: M-Path-N5.1(79)

Title: Study of the biology epidemiology of blast (80)

Project Scientist; To be recruited

Objectives:

To learn enough about the biology and epidemiology of blast to develop meaningful effective screening techniques.

Methodology:

Not yet thought through sufficiently but will include determination of inoculum sources, factors which promote etc.

59. Project No: M-Path-N5.2(80)

Title: Evaluation of millet hybrids and cultivars for resistance to blast.

Note: This project will likely begin in Kharif 1980.

PEARL MILLET ENTOMOLOGY Sub-program Leader: - Dr. J.C.Davies

60. Project No M-Ent-1(74)

Title: Pest incidence on pearl millet (79)

Project Scientist: Dr. K.V. Seshu Reddy

Cooperators: Dr. J.C. Davies

Objectives:

(1) To determine the range of pests attacking pearl millt (2) To obtain valid identifications of the species involved (3) To characterise the damage caused and to obtain an idea of their relative importance and fix thresholds at which pest control is necessary (4) To compare the species present with those of other areas in SAT (5) To accumulate information on the seasonal abundance behaviour patterns and plant preferences of the various pests.

Methodology:

The standard vultivars HB3and ICH105 were sown during K 76 and K 77 respectively and detailed pest counts carried out throughout the season.

PEARL MILLET BIOCHEMISTRY & NUTRITION — Sub-program Leader: Dr. R. Jambunathan

61. Project No: M-B&N-1(74)

Title: Improvement of nutritional quality of pearl millet (80)

Project Scientist: Dr. V. Subramanian

Cooperators: Drs. R. Jambunathan, K.Anand Kumar, G. Alagarswamy and Mr. D.J. Andrews.

Objectives:

(1) To select millet cultivars having higher lysine concentration and optimum yield potential (2) To study the protein fractions and amino acid composition of mature and immature millet grains (3) To obtain the proximate analyses including the starch content in some selected millet cultivars (4) To determine the digestibility of millet using In-vitro techniques.

Methodology.

(1) Protein content in millet samples will be estimated by the Technicon auto analyser method (2) Lysine (basic amino acids) will be estimated by the dye binding capacity (DBC) method at constant protein or at constant weight of the sample (3) Lysine values will be determined by the amino acid analyser and the correlation between DBC and lysine values will be tested (4) A reference table relating the DBC value and lysine concentration will be prepared (5) Breeders samples will be screened using the rapid procedures and lysine values will be estimated using the reference table (6) This information will be supplied to the breeders to enable them to make further selection of samples with higher yield potential (7) Amino acid composition will be obtained on protein fractions extracted from mature and immature millet grains and their possible relationship with nutritional quality will be studied (8) Proximate analysis including starch estimation will be carried out on selected samples (9) Digestibility studies will be carried out using standard techniques.

62. Project No: M-B&N-2(78)

Title: Physico-chemical properties and cooking characteristics of Pearl Millet (81)

Project Scientist: Dr. V. Subramanian

Cooperators: Drs. R.Jambunathan, M. von Oppen & Mr. D.J. Andrews

Objectives:

(1) To determine the composition of carbohydrates in millet grains
(2) To study the physico-chemical qualities of millet flours and its relationship to cooking characteristics.

Methodology:

(1) Qualitative and quantitative determination of various carbohydrates will be done.

(2) Starch quality of millet will be assessed for both physical and chemical properties and its relationship to cooking characteristics (Chapathi, cooking, etc.) will be studied.

PEARL MILLET MICROBIOLOGY Sub-program Leader: -Dr.P.J.Dart

63. Project No: Micr -Cer-2(76)

Title: Nitrogen fixation associated with Millets (81)

Project Scientist: Dr. R.V. Subba Rao

Cooperators: Drs. P.J.Dart, G.Alagarswamy, F.R.Bidinger, S. Appa Rao and Mr. D.J. Andrews

Objectives:

(1) To evaluate millet varieties for potential to stimulate nitrogen fixation in the field. (2) Select and cross promising material to see if this nitrogenase activity can be enhanced and incorporated into material having other desirable characteristics. (3) Determine the amounts of nitrogen fixed and transferred to the millet plant and the effect of the environment on this (4) Identify the organisms involved and assess the potential for plant inoculation.

Methodology:

(1) Develop a suitable assay technique for measuring nitrogen fixation using the acetylene reduction assay. (2) Evaluate a range of species and genotypes for ability to stimulate nitrogen fixation in the field (3) Determine heritability of this activity (4) Determine the contribution of this nitrogen fixation to nitrogen uptake by millet. N_{15} labelled NO_3 and N_2 will be used. (5) Examine the effect of soil temperature, moisture and nutrient status on this nitrogen fixation. (6) Isolate bacteria involved, and examine response of plants to inoculation with these bacteria.

PIGEONPEA BREEDING

Sub-program Leader: - Dr. J.M.Green

64. Project No: PP-brd-1(77)

Title: Development of early duration cultivars and superior breeding lines for grain production (80)

Project Scientist: (To be appointed)

Cooperators: Drs. A.N.Murthi, J.Kannaiyan, M.V.Reddy, Umaid Singh J.V.D.K. Rao.

Objectives:

(1) To develop high yielding early maturing cultivars with acceptable grain quality suited to use in pure stands or with early maturing companion crops (2) To contribute breeding lines and populations to breeders throughout SAT.

Methodology:

(1) Identify parent varieties within the germplasm and released cultivars (2) Develop breeding populations using different crossing patterns and methods of advancing generations (3) Screen parents and selections for disease and insect resistance (4) Test selected lines for yield and quality over a range of environments to identify superior genotypes for use as cultivars.

65. Project No: PP-brd-2(77)

Title: Development of medium duration cultivars and superior breeding lines for grain production (82)

Project Scientist: Drs. K.B. Saxena, L.J. Reddy

Cooperators: Drs. S.S.Lateef, J.Kannaiyan, M.V.Reddy, Umaid Singh, M.R. Rao, I.V. Subba Rao.

Objectives:

(1) To develop high yielding medium maturing cultivar with acceptable grain quality that are adapted to pure and companion cropping with various other crops (2) To contribute breeding lines and populations to breeders throughout the semi-arid tropics.

Methodology:

(1) Select within and among germplasm cultures and cultivars for establishment of parental lines (2) Develop breeding populations using different crossing patterns and methods of advancing generations (3) Screen parents and hybrid generation for disease and insect reaction (4) Screen and select parents and breeding populations for water logging and salt tolerance (5) Test selected lines for yield and quality over a range of environments and in different farming systems to identify superior genotypes for use as cultivars.

66. Project No: PP-brd-3(77)

Title: Development of late maturing cultivars and breeding populations for grain production (80)

Project Scientist:

Cooperators: Drs. S.S.Lateef, J.Kannaiyan, M.V.Reddy, Umaid Singh, J.V.D.K.Rao.

Objectives:

(1) To develop high-yielding late maturing cultivars with acceptable grain quality that are adapted to companion cropping (2) To contribute breeding lines and populations to breeders throughout the SAT.

Methodology:

(1) Identify parent varieties within the germplasm collections and released cultivars with desired characteristics such as large pods and large seed size (2) Develop breeding populations using different crossing patterns and methods of advancing generations (3) Screen parents and selections for disease and insect resistance (4) Incorporate resistance to sterility mosaic, wilt, and phytophthora spp. (5) Test selected lines for yield over a range of environments to identify superior genotypes for use as vegetable types.

67. Project No: PP-brd-4(75)

Title: International Cooperation (79)

Project Scientist: Dr. J.M. Green

Objectives:

(1) To develop working relationships with pigeonpea improvement programs throughout the semi-arid tropics, and to provide materials and assistance to development projects not engaged in breeding (2) To develop international programs that will strengthen pigeonpea improvement proggams in progress.

Methodology:

(1) Make personal visits to pigeonpea research programs in producing areas (2) Attend workshops of legume researchers wherever such appears profitable (3) Coordinate international plantings, including (i) adaptation trial (ii) international nursery (iii) international performance trials.

68. Project No: PP-brd-5(75)

Title: Intergeneric hybridization(80)

Project Scientist: Dr. L.J. Reddy

Cooperators: Drs. LJG van der Maesen, A.N.Murthi, S.S.Lateef, J. J.Kannaiyan, M.V. Reddy.

Objectives:
To increase genetic variability in Cajanus by transferring characters from wild species of Atylosia and to explore the possibilities of finding cyto plasmicgenetic male sterility.

Methodology:
(1) Collect additional species of Atylosia and attempt additional crosses. (2) Introgress different levels of Atylosia germplasm into the standard vultivars by conventional backcrossing (3) Evaluate existing derivaties of Cajanus x Atylosia crosses (4) Isolate, establish and study genetics of various plant types (5) Evaluate derivatives for disease resistance, insect resistance and provide any useful characters to the breeding program.

69. Project No: PP-brd-6(77)

Title: Study of pollination in pigeonpea (80)

Project Scientists: Drs. J.M. Green, W. Reed

Cooperators: Dr. A.N. Murthi

Objectives:

(1) To determine the pollen vectors and study their activity (2) To determine distance necessary for isolation (3) To determine extent of crossing on plants in different arrangements and with different relative frequencies (4) To determine planting arrangement necessary for maximum pollination of steriles by fertiles in rows (5) To determine the effect of insect pollination on pod set.

Methodology:

(1) Consultants will make additional observations in 1977 and train local personnel in insect pollinator observation. Effect of row distance and flower color will be studied (2) Purple stem marker will be purified and increased for use in isolation studies (3) Different planting arrangements and relative frequencies will be compared when purple stem marker is available (1978. (4) Varying row numbers of sterile and fertile will be compared for total pod set on steriles.(5) Sterile and fertile plants will be bagged together to check on crossing by thrips.

70. Project No: PP-brd-7(77)

Title: Development of cultivars and breeding populations for vegetable purposes (81)

Project Scientist: Dr. S.C. Gupta

Cooperators: Drs. S.S.Lateef, J.Kannaiyan, M.V.Reddy, Umaid Singh.

Objectives:

(1) To generate breeding populations and develop from these high yielding pigeonpea cultivars suitable for vegetable purposes. (2) To contribute breeding lines and populations to breeders throughout SAT.

Methodology:

(1) Identify parent varieties within the germplasm collections and released cultivars with desired characteristics such as large pods and large seed size- (2) Develop breeding populations using different crossing patterns and methods of advancing generations (3) Screen parents and selections for disease and insect resistance (4) Incorporate resistance to sterility mosaic, wilt, and Phytopthora spp. (5) Test selected lines for yield over a range of environments to identify superior genotypes for use as vegetable types.

71. Project No: PP-brd-8(77)

Title: Breeding for new plant types (81)

Project Scientist: Dr. K.B. Saxena

Cooperators: Dr. I.V. Subba Rao

Objectives:

(1) Searching for new plant types (2) Development of superior yielding new plant types in different maturity groups and their agronomic evaluation under varying planting systems. (3) Determining inheritance of the new plant types. Identification of new plant types in the germplasm and in segregating populations.

Methodology:

(1) Crossing of selected types with standard cultivars of different maturity groups (2) Isolating desired plant type for segregating generations of straight crosses or back crosses (3) Stabilizing the new type and evaluating it for agronomic traits.

72. Project No: PP-brd-9(77)

Title: Population breeding and bulk hybrid advance (82)

Project Scientist: Dr. S.C. Gupta

Cooperators: Drs. S.S.Lateef, J.Kannaiyan, M.V. Reddy

Objectives:

(1) To generate, advance without selection and maintain breeding populations involving promising parents (2) To utilise various techniques of population improvement (3) To supply the seed of the selected advanced populations to breeders throughout SAT.

Methodology:

(1) Hybrid populations will be planted in off-season (2) Harvesting of individual population bulk will be done without selection by single plant descent method. One pod from each plant within a population will be harvested and bulked. Two bulk hybrid populations will be harvested, one will be kept in cold storage and the other will be planted for further advance (3) Four to five thousand hills will be planted in rectangular block of about 40 x 40 meter for each hybrid population (4) Tests between different generations of the same cross will be carried out in order to see whether we are maintaining the variability or not (5) In F5 or F6 generation the frequency of homozygous individuals within a population will be studied.

73. Project No: PP-brd-10(77)

Title: Development of hybrids and seed production technology (F1)

Project Scientist: Dr. L.J. Reddy

Cooperators: Drs S.S.Lateef, J.Kanaiyan, M.V.Reddy

Objectives:

(1) To develop new male sterile stocks (2) To test ms_1 allele in different cytoplasms (3) To determine the feasibility of developing commerical hybrids by testing different cross combinations (4) To develop a hybrid seed production system with the help of natural pollinators (5) To correct the deficiencies of already available ms_1 stocks.

Methodology:

(1) Using backcross method transfer ms_1 allele to different nuclear and cytoplasmic backgrounds (2) Make hybrids using MS-3A and MS-4A and elite cultures and evaluate the hybrids for their yield in a replicated trial (3) Grow male sterile stocks and the pollinator parent with a distinct marker trait in different proportions in isolation blocks.

74. Project No: PP-brd-11(77)

Title: Development of high protein lines

Project Scientist: Dr. L.J. Reddy

Cooperators: Dr.UMaid Singh

Objectives:

(1) To develop high protein lines (2) To determine protein quality of the high protein lines.

Methodology:

(1) Select high protein lines from intergeneric and intervarietal derivatives (2) Cross the high protein parents and evaluate the F1's for their high protein. Intermate the high protein F1's. Make triple crosses between the high protein F1's and high protein parents.

75. Project No: PP-brd-12(77)

Title: Comparison of breeding methods(79)

Project Scientist: Dr. S.C. Gupta

Cooperators:

Objectives:

To determine the efficiency of the pedigree breeding, mass selection with intermating, and backcross breeding in bringing the favourable alleles of large seed size and earliness together.

Methodology:

(1) One hundred progenies each of Sn F4, $B2^1$ FS $B1^1$ FS and R1F2 of each cross; 135 progenies each of $B2^2$ F2 and $B1^2$ F2 of the cross (T-21 x JA-278) 56 and 123 progenies of $B2^2$ F2 and $B1^1$ F2 respectively of the cross (T-21 x EC-100467) were planted in 77k.

(2) The populations obtained by second cycle of intermating (R2) within each cross were also planted in 77k. (3) Data on days to first flower and seed size (100 seed weight) on individual plants were recorded (4) Selection among and within the progenies for earlyness and seed size will be performed (5) Finally, five progenies selected from each population will be used for comparisons of different breeding methods for efficiency in bringing the favourable alleles of large seed size and earliness together in 79k.

76. Project No: PP-brd-13(77)

Title: Diallel selective mating scheme evaluation (81)

Project Scientist: Dr. K.B. Saxena

Objectives:

(1) To compare relative efficiency of various breeding procedures in double cross populations (2) To develop high yielding populations or cultivars.

Methodology:

(1) Development of single crosses using selected parents (2) Development of double crosses using outstanding and diverse single crosses (3) Imposing pedigree and mass selection and population advance by single plant descent method on double cross populations (4) Development of selective mating populations by intermating selected double cross F_1 populations (5) Mass selection in selective mating populations (6) Testing of derived composites, and lines and comparison of end products obtained through various methods.

77. Project No: PP-brd-14(77)

Title: Evaluation of triallel for genetic analysis (79)

Project Scientist: Dr. L.J. Reddy

Objectives:

(1) To produce single and three way cross populations for breeding (2) To gain some information on specific components of genetic variance (3) To introduce favourable alles from recently recognised superior germplasm entries into the breeding material.

Methodology:

(1) Diallel crossing of nine elite lines drawn from the germplasm selections and All India Coordinated Program to produce F_1's. (2) Plant F_1's and parents in a 7 x 7 simple lattice. Record observations on yield and yield components Estimate general combining ability of parents (3) Use F_1's of seven parents for making three way crosses excluding backcrosses (4) Test the three way and single crosses in a replicated trial. Carry out analysis of variance of three way hybrids as given by Rawlings and Cockerham (1962)

78. Project No: PP-brd-15(77)

Title: Generation tests (78)

Project Scientist: Dr. K.B. Saxena

Objectives:

To get information on early generation testing. This will help in selecting potential crosses and rejecting poor crosses in early generations.

Methodology:

(1) Conduct replicated tests consisting of parents and generattion bulks (2) Record observations on competitive random plants for yield and its components (3) Determine relationship between generation for various characters (4) Estimate variances for individual plant yield and other characters in parents and generations.

PIGEONPEA GERMPLASM

Sub-program Leader: - Dr. L.J.G. van der Maesen

79. Project No: PP-gp-1(75)

Title: Maintenance and evaluation of pigeonpea germplasm(79)

Project Scientist: Dr. A.N. Murthi

Cooperators: Drs. J.Kanniyan, M.V.Reddy, Umaid Singh, S.S.Lateef, J.V.D.K. Kumar Rao, I.V. Subba Rao.

Objectives:

(1) To maintain genetic resources of Cajanus and Atylosia, and other members of subscribe Cajaninae. (2) To evaluate available accessions (3) To document and publish evaluations in catalogues etc. (4) To distribute germplasm material

Methodology:

(1) Growing the accessions when needed for renewal of stock and observations. (2) Taking of appropriate observations on morphoagronomic triats (3) Storage in proper containers in cold storage rooms (4) Testing of classifications and establishing a workable one (5) Expulsion of duplicates.

80. Project No: PP-cp-2(75)

Title: Collection of Cajanus and Atylosia germplasm and preparation of taxonomical revision (79)

Project Scientist: Dr. LJG van der Maesen

Cooperators: Dr. A.N. Murthi

Objectives:

(1) To obtain new genetic resources in Cajanus cajan and Atylosia spp.
(2) To document and publish collections
(3) To prepare a taxonomical revision of the genus Cajanus and the genus Atylosia for making uptodate facts available, and facilitate further collection.

Methodology:

(1) Collection of Cajanus in India e/., Assam, Madhya Pradesh, Uttar Pradesh, Orissa and in Africa, West Indies, East Asia, or obtaining the material by correspondence (2) Collection of Atylosia species in India, Far East, Africa, North Australia. (3) Visits to Indian herbaria and those abroad where material is deposited, Kew (4) Request on loan the specimen for close examination at Wageningen (5) Herbarium and field study of the acquired material.

PIGEONPEA PHYSIOLOGY

Sub-program Leader: -Dr.A.R.Sheldrake (since left)

81. Project No: PP-Phy-1(75)

Title: Comparison of pigeonpea genotypes (78)

Project Scientist: Dr. I.V. Subba Rao

Cooperators: Drs. K.B.Saxena, S.C.Gupta, A.N.Murthi

Objectives:

Comparison of different genotypes should yield information about desirable and undesirable genetic characteristics which can be effectively utilised in breeding programs.

Methodology:

The comparisons will depend on observations in the field and in pots, on measurements and other simple laboratory techniques.

82. Project No: PP-Phy-2(75)

Title: Response of pigeonpeas t environment and cultural practices (78)

Project Scientist: Dr. I.V. Subba Rao

Cooperators: Drs. K.B. Saxena, A.N. Murthi

Objectives:

(1) To investigate the effect of height of ratooning and stage of ratooning on the performance of pigeonpea (2) To investigate the effect of irrigation in improving the yields of ratoon crop of pigeonpea (3) To investigate the effect of ratooning at preflowering stages for forage and grain yields of medium duration cultivars of pigeonpea at different densities of population (4) Effectof foliar application of growth regulators and nutrients in improving the grain yield (5) Performance of pigeonpea under saline and waterlogging conditions.

Methodology:

The experiments will be conducted in the field and pots and observations will involve weighing and measuring of plants and parts of plants.

83. Project No: PP-Phy-3(75)

Title: Source-sink relationships in pigeonpea (78)

Project Scientist: Dr. I.V. Subba Rao

Objectives:

To study the photosynthetic production of assimilates on the shoot and their translocation, partitioning and utilization in sinks such as apical meristems, roots, storage tissues, root nodules and reproductive structures. These studies should provide a deeper understanding of the effects of genotype and environment on the growth, development and yield of pigeonpeas.

Methodology

(1) Effects on source and their photosynthetic activity (shading, removal of shading). (2) Reduction of leaf area (defoliation) (3) Alteration of sink size by removal of flowers and pods.

PIGEONPEA PATHOLOGY Sub-program Leader: - Dr.Y.L.Nene

84. Project No: PP-Path-1(78)

Title: Studies on pigeonpea wilt (80)

Project Scientist Dr. J. Kannaiyan

Cooperators: Drs. K.B. Saxena, L.J. Reddy

Objectives

(1) Improve the laboratory screening technique further (2) Study epiphytology including survival, mode of infection and spread of wilt organism (3) Detect and characterize physiological races of the wilt fungus, if any. (4) Estimate yield losses (5) Identify acceptable sources of resistance and assist breeders in screening material for resistance.

Methodology:

(1) The laboratory technique would be improved to get a good correlation between field and laboratory tests (2) Standard procedures to study epiphytology will be followed (3) Standard procedures for identifying and characterizing physiological races will be followed.

85. Project No: PP-Path-2(78)

Title: Studies on sterility mosaic of pigeonpea (80)

Project Scientist: Dr. M.V. Reddy

Cooperators: Drs. D.V.R.Reddy, W.Reed, R.Jambunathan, K.B.Saxena, L.J.REddy, S.C. Gupta.

Objectives:

(1) Understand the nature of the casual agent and epidemiology of the disease (2) Investigate the presence of races, if any (3) Estimate losses due to the disease (4) Study the mechanism of resistance (5) Identify acceptable sources of resistance and assist breeders in screening material for resistance.

Methodology:

(1) Standard procedures employed in plant virology like transmission, purification, electron microscopy, serology, host range, etc., will be followed in identifying the casual agent. The host range of the mite, its mode of survival during offseason and spread will be studied to find out how the pathogen perpetuates from year to year (2) A set of differentials including resistant and some susceptible lines will be used to identify the races, if any (3) Losses due to the disease will be estimated by artificially inoculating plants at different ages. (4) Morphological and biochemical differences between resistant and susceptible lines will be studied to get an idea about the possible role of these characters in the mechanism of resistance.

86. Project No: PP-Path-3(78)

Title: Studies on Phytophthora blight of pigeonpea (80)

Project Scientist: Dr J. Kannaiyan

Cooperators: Drs. K.B Saxena, L.J.Reddy, S.C.Gupta

Objectives:

(1) Identify the species of Phytophthora involved in causing blight(s). (2) Identify the physiological races of the fungus, if any. (3) Work out an efficient screening technique (4) Study the epiphytology of the disease (5) Identify acceptable sources of resistance and assist breeders in screening material for resistance.

Methodology:

(1) Experiments necessary to work out a screening technique will be conducted (2) Isolates of Phytophthora sp. from different localities will be collected and compared morphologically as well as pathologically with the isolate available with us (3) Duration of survival and factors (type of soil, collateral hosts, etc.) influencing the survival of the fungus will be studied.

87. Project No: PP-Path-4(78)

Title: International Survey of Pigeonpea Diseases (80)

Project Scientist: Dr. Y.L. Nene

Cooperators: Drs. M.V.Reddy, J.Kannaiyan, J.M.Green, D Sharma.

Objectives:

To have a complete picture of the relative incidence of various diseases in pigeonpea growing areas of the world. This will help us in identifying diseases which are presently serious and also those which have the potential to become serious.

Methodology:

(1) Pigeonpea growing areas of the world would be visited and surveyed for various diseases. Some such areas are Trinidad, Puerto Rico, Costa Rica, Dominican Republic, Panama, Venezuela, Guatemala, Brazil, Colombia, Bermuda, Kenya, Ethiopia, Uganda, Tanzania, Sierra Leone, Sudan, Mauritius, Sri Lanka, Thailand, Indonesia, Philippines, New Guinea, New Caledonia, etc. (2) Surveys in states of India will be continued.

PIGEONPEA ENTOMOLOGY — Sub-program Leader: - Dr. W. Reed

88. Project No: PP-Ent-1(77)

Title: Pest distribution and associated crop losses in pigeonpea (80)

Project Scientist: Dr. S.S.Lateef

Cooperators: Drs. V.S.Bhatnagar, S.Sithanantham

Objectives:

(1) To determine the arthropod pests of pigeonpea, their seasonal and geographical distribution (2) To determine the damage and losses caused by the pests: (i) on and around ICRISAT (ii) throughout India (in association with AICPIP), (iii) throughout the major pigeonpea areas of the world.

Methodology:

(1) By recording the populations of the arthropods on pigeonpea crops throughout each season, on and around ICRISAT, identifying and assessing the damage caused and analysing samples of pods collected from trials. (2) By sample surveys of farmers' fields in the major pigeonpea areas of India. Counts of pests and their damage will be recorded on green crops and samples of pods will be collected from mature crops for analysis at ICRISAT. Wherever possible, this will be in collaboration with AICPIP scientists. (3) By establishing communication with national scientists in the major pigeonpea growing countries and by visits to them.

89. Project No: PP-Ent-2(77)

Title: Development of techniques and study of host plant resistance to pests in pigeonpea and its relatives (81)

Project Scientist: Dr. S.S.Lateef

Cooperators: Drs. K.B.Saxena, L.J.Reddy, S.C.Gupta

Objectives:

To identify pigeonpea germplasm (and derivatives of C.cajan x Atylosia spp. hybrids) that:
(a) is resistant to attack from individual major pests (b) is less susceptible to attack from the pest complex (c) is tolerant to pest damage (including the compensatory habit) (d) yields more than the currently utilised cultivars under the farmers' conditions of no, or minimla, insecticide use.

To cooperate with ICRISAT, AICPIP, and other national, pigeonpea breeders by screening their promising material for pest susceptibility and by supplying selected material to them for incorporation in their pgorams, and To refine screening techniques and trial methodology.

(Cont'd...)

Project No: PP-Ent-2(77)
(Cont'd.)

Methodology:

By screening all available germplasm, breeders' (including AICPIP) promising [illegible] and the derivatives of C.Cajan x Atylosia spp. hybrids for pest susceptibility. By selecting within this material and subsequent screening. Most of this work will be done in insecticide free fields under natural pest threats, but we will also investigate the augmentation of [illegible], infector rows, laboratory bred pests and the use of portable net [illegible] attempts to ensure controlled, even pest distribution on all plants and so avoid the confusion caused by preponderance of 'escapes'. Trial designs (R.B.D., Latin squares and lattices) will be evaluated for their efficiency in detecting differences in susceptibility. Antibiosis feeding trials will be conducted in the laboratory and nethouse.

90. Project No: PP-Ent-3(77)

Title: Integrated pest management on pigeonpea (80)

Project Scientist: Dr. S. Sithanantham

Cooperators: Drs. B.A.Krantz, S.K.Pal, J.M.Green

Objectives:

To develop the concept and practice of integrated pest management on pigeonpea. To identify and develop individual components or practices that will reduce pest caused losses on the crop and to eventually combine these into a practical package for use at the farmer level:

Components that will be investigated initially are: (a) insecticide use, including improved application techniques (b) host plant resistance, (c) biological control, (d) cultural practices, including intercropping.

Methodology:

(1) Determining the potential return from insecticide use by comparing sprayed and unsprayed trials and establishing the 'economic injury levels' of the pests. Investigating the effects of 'minimal' insecticide use by applying sprays only at determined critical periods. Testing the new controlled droplet application technique with reduced dosage of non-polluting insecticides. (2) Investigation of the effect of plant spacing upon pest populations and damage caused in insecticide treated and untreated trials. Study of the effect of plant type)spreading, erect, determinate, indeterminate, early and late maturing) on pest populations. (3) By cooperation with the intercropping entomology projects.

91. Project No: CP-PP-Ent-4(77)

Title: Biology and ecology of the pests of pigeonpea and chickpea (81)

Project Scientist: Dr. S. Sithanantham

Cooperators: Drs. V.S.Bhatnagar, S.S.Lateef.

Objectives:

(1) To obtain information on the bionomics of the arthropod pests in the laboratory and the fields. To study the effects of differing climatic elements, various agronomic practices and other factors on the life histories and populations of the pests and their natural enemies. To produce large numbers of insects in the laboratory for use in host plant resistance screening. (2) In particular, the factors involved in the population dynamics of Heliothis armigera and Melanagromyza obtusa (podfly) will receive special attention. (3) To obtain information on the natural enemies (including insect diseases) of the pests, their distribution in insecticide free and treated areas, effect on host populations and the possibilities of augmentation.

Methodology:

(1) Breeding insects in the laboratory incubators and field cages, and recording their bionomics. (2) Recording field populations of the pests on pigeonpea and chickpea grown under various agronomic practices (including inter-crops and relay crops in cooperation with mixed crop entomology project). Studying the behaviour of thepests on the plants and noting, predation. Bringing samples of the pests into the laboratory and recording the fate of these, including the incidence of parasites and diseases.

PIGEONPEA BIOCHEMISTRY AND NUTRITION — Sub-program Leader: - Dr. R. Jambunathan

92. Project No: PP-B&N-1(74)

Title: Screening of germplasm and breeding material for protein content and limiting amino acids (81)

Project Scientist: Dr. Umaid Singh

Cooperators: Drs. L.J.Reddy, K.B.Saxena, A.N.Murthy.

Objectives:

(1) To test some of the standard methods for protein estimation and study the suitability of these methods as a fast screening method for the estimation of protein in pigeonpea (2) To analyse the whole seed and dhal samples for their protein contents and find out the relationship between the two components (3) To study the relationship between total sulphur and sulphur aminoacids and use the information so obtained for the screening of breeding material (4) To test the suitability of rapid methods for the estimation of tryptophan in pigeonpea (5) Obtain the amino acid composition of the available wild species of pigeonpea.

Cont'd...)

Project No: PP-B&N-1(74)
(Cont'd...)

Methodology:

(1) Use three standard methods viz., microKjeldahl, Technicon auto analyser and dye binding capacity method for protein estimation in pigeonpea whole seed and dhal samples. (2) Use microbiological assays for the estimation of sulphur amino acids and estimate total sulphur content by the wet digestion methods and by using Leco sulphur determinator. (3) Use colorimetric procedures of Opienska & Blauth and Spies & Chambers for the estimation of tryptophan.

93. Project No: PP-B&N-2(76)

Title: Study some of the factors affecting the nutritional quality of pigeonpea including cooking quality.(71)

Project Scientist: Dr. Umaid Singh

Cooperators: Drs. J.M. Green, M. von Oppen

Objectives:

(1) To fractionate seed storage proteins of samples collected at different stages of maturation and determine their amino acid compositions. (2) Identify the protein fractions in pigeonpea having better amino acid composition and then use rapid methods to identify pigeonpea cultivars having better protein quality (3) To evaluate the digestibility of proteins and carbohydrates in uncooked and cooked samples. (4) Conduct preliminary studies to evaluate the cooking quality of pigeonpea.

Methodology:

(1) Use various solvent systems for obtaining solubility fractionation of seed storage proteins and obtain their aminoacid compositions. (2) Use acrylamide gel electrophoresis for studying the fractionated proteins. (3) Identify and characterise the protein fractions using fractionation procedure, electrophoretic techniques and amino acid analyser. (4) Use Protein and carbohydrate hydrolysing enzymes for studying the in-vitro digestibility of the pigeonpea samples.

PIGEONPEA MICROBIOLOGY — Sub-program Leader: - Dr.P.J.Dart

94. Project No: PP-Micr-1(76)

Title: Soil Rhizobium population nodulating pigeonpea (80)

Project Scientist: Dr. J.V.D.K. Kumar Rao

Objectives:

(1) To determine the numbers of Rhizobium in soil and the effect of season and environment, previous cropping history and soil type and depth on these numbers (2) To assess the effectiveness of these populations in nodulating and fixing nitrogen with pigeonpea.

Methodology:

(1) Develop a plant infection technique for large scale counting of pigeonpea rhizobia (2) Count rhizobia in selected growing sites throughout the year, to determine the effect of soil physical status, soil depth, soil moisture, temperature, pH and salinity on numbers. (3) Characterise the ability of these populations in fixing nitrogen. (a) using soil core techniques with improved and local cultivars (b) by assessing the effectiveness of populations at different soil dilutions (c) by determining the relative effectiveness of the strains forming the most prominent nodules.

95. Project No: PP-Micr-2(76)

Title: Response of pigeonpea to inoculation with Rhizobium(80)

Project Scientist: Dr. J.V.D.K. Kumar Rao

Cooperators: Drs. N.P. Saxena, I.V. Subba Rao

Objectives:

(1) To select Rhizobium strains that are highly effective in fixing nitrogen, are competitive in nodule formation, and are able to move and persist in soils. (2) Assess the proportion of nodules formed by the inoculum strain in the field and the effect on this of (a) soil type, pH and salinity (b) field cropping history (c) effectiveness of the existing Rhizobium population. (3) Determine the effect of inoculation on N uptake and grain yield (4) Assess the persistence and spread of the inoculum strain in the soil.

Methodology:

(1) Isolate and collect pigeonpea Rhizobium strains and determine their effectiveness in pot trails (2) Examine the highly effective strains for metabolic and serological identification markers. (3) Produce antibiotic and antimetabolite resistant inoculant strains, and fluorescent labelled antisera for these strains. (4) Inoculate field crops with readily identifiable, effective strains and count the numbers of nodules formed by these strains using markers identified in 2 and 3 . (5) Measure N uptake during plant growth and final yield of inoculated and uninoculated plants in the field. (6) Count numbers of nodules formed by the inoculum strains in uninoculated pigeonpea crops in

96. Project No: PP-Micr-3(76)

Title: Nitrogen fixation by pigeonpea (80)

Project Scientist: Dr. J.V.D.K. Kumar Rao

Cooperators: Drs. I.V.Subba Rao, M.R. Rao.

Objectives:

(1) [illegible] the nitrogen fixation by pigeonpea in the field (2) Assess the ability of pigeonpea nodules to provide the plants nitrogen requirements for maximum yields (3) Determine the nutritional and environmental factors limiting nodulation and nitrogen fixattion.

Methodology:

(1) Develop a technique for the acetylene reduction assay of nitrogen fixation. Compare these estimates with those obtained from nitrogen balance estimates derived from Kjeldahl N analyses and from use of $^{15}NO_3$ to label the soil pool of available nitrogen (2) Determine nitrogen uptake and yield of field grown pigeonpea when uninoculated, inoculated, and inoculated but liberally supplied combined nitrogen. (3) Measure nodulation and nitrogen fixation of pigeonpeas grown in soils of different nutreint status (particularly for P, Zn, Mo, B, Fe) and determine the fertiliser levels, and methods of paplication required to ameliorate deficiencies.

97. Project No: PP-Micr-4(76)

Title: Host plant Rhizobium genetic interactions in nodulation of pigeonpea (80)

Project scientist: Dr. J.V.D.K. Kumar Rao

Cooperators: Dr. A.N. Murthy

Objectives:

(1) Characterise differences between pigeonpea lines in ability to nodulate and fix nitrogen, and the effect of different Rhizobium strains (soil populations) on this response (2) Select and cross promising material to see if nodulation and nitrogen fixation can be enhanced. (3) Monitor breeders material for ability to nodulate and fix nitrogen.

Methodology:

(1) Evaluate symbiotic characteristics of breeders crossing block material with single Rhizobium strains, in pot culture. (2) Assess whether a soil inoculum in pot (sand) culture can simulate the competitive effects of Rhizobium populations in soil. Monitor the symbiotic response of selected lines with Rhizobium populations in different soil types and geographical locations (3) Examine nodulation and nitrogenase activity of lines from the pigeonpea germplasm collection grown in the field (4) Determine the heritability of host genes affecting nodulation responses. Select and cross promising material to see if nitrogen fixation can be enhanced and incorporated into lines with other desirable characteristics.

98. Project No: PP-CP-Micr-1(76)

Title: Culture collection of Rhizobium strains nodulating Chickpea and Pigeonpea (80)

Project Scientist: Dr. P.J. Dart

Cooperators: Drs. J.V.D.K.Kumar Rao, O.P.Rupela, P.T.C. Nambiar

Objectives:

To collect, maintain and assess the performance of Rhizobium strains nodulating the legumes of interest to ICRISAT. This collection would serve as a worldwide center for the supply of such strains.

Methodology:

(1) To collect nodules and isolate Rhizobium strains from different pigeonpea and chickpea regions and centres of diversity of these legumes. (2) Obtain strains from existing collection centres the world over. (3) Check cultural purity of the strains and test ability to nodulate and fix nitrogen. (4) Freeze dry pure cultures in ampules. Deposit duplicate set at another centre. (5) Produce a catalogue of the strains with information on characteristics and on usage to data.

99. Project No: PP-CP-Micr-2(76)

Title: Development of Rhizobium inoculants for chickpea and pigeonpea (80)

Project Scientist: Dr. P.J. Dart

Cooperators: Drs. J.V.D.K.Kumar Rao, O.P. Rupela, P.T.C. Nambiar

Objectives:

(1) Develop methods for production of reliable inoculants suitable for use by farmers in the semi-arid tropics, using readily available carrier material for simple, inexpensive and readily fabricated equipment. (2) Develop techniques for monitoring inoculant quality.

Methodology:

(1) Develop procedures for identifying and counting Rhizobium in inoculant carrier material. Serological and dilution - plant infection techniques involved. (2) Examine the survival of Rhizobium in currently used carrier material and develop altenative carriers and find suitable ways of packaging and sterilization. (3) Test the comparative efficiency of inoculants. (4) Monitor Rhizobium survival during inoculant distribution, storage on farm before use, and on the seed after inoculation. (5) Devise standards for inoculants and rhizobia numbers on seed after inoculation that will enable good nodulation. (6) To study the effects of stiching materials, fungicides, insecticides, fertilisers and liming materials on the efficiency of inoculants.

CHICKPEA BREEDING — Sub-program Leader: Dr. J.M.Green (New Chickpea Breeder is being appointed).

100. Project No: CP-brd-1(77)

Title: Development of 'desi' cultivars and superior breeding lines (81)

Project Scientist: Drs. S.C.Sethi & C.L.L. Gowda

Cooperators: Drs. Onkar Singh, M.P.Haware, S.S.Lateef, Umaid Singh M.V.Reddy.

Objectives:

(1) To breed high yielding and disease resistant cultivars with stability of performance and consumer acceptance (2) To supply advanced breeding lines and segregating material to 'desi' chickpea growing countries.

Methodology:

(1) Genetic variability will be created mainly through hybridization by making single and multiple crosses. Introgression of 'yield genes' from desi to kabuli and vice versa will be fully exploited. (2) The classical breeding methods for self-pollinated crops, pedigree method of selection and back cross method, will be utilised. On some material single seed descent method may also be employed (3) The early and advanced breeding lines will be screened in wilt sick nursery. The advanced lines will be screened for protein content (4) Breeding material at various stages of development will be made available to cooperators for evaluation in their local environments.

101. Project No: CP-brd-2(77)

Title: Development of 'kabuli' cultivars and superior breeding material (79)

Project Scientist: Dr. J. Kumar

Cooperators: Drs. Onkar Singh, M.P.Haware, S.S.Lateef, Umaid Singh M.V.Reddy.

Objectives:

(1) To breed high yielding, disease resistant kabuli cultivars with good consumer acceptance (2) To contribute advanced breeding lines and segregating populations to the kabuli producing countries.

Methodology:

(1) Genetic variability will be generated by making single, three way, double, composite, and back crosses. Desi cultivars will be extensively used for transferring 'yield genes' to kabuli types. (2) The pedigree and progeny bulk methods will be used for advancing material. In a few selected crosses, single seed descent method will be used (3) Segregating populations will be screend in wilt-sick nursery. If facilities for screening against Ascochyta blight are made available in future, some selected material will be tested against the pathogen (4) Promising advanced generation lines and segregating populations will be tested over a range of environments to identify elite material.

102. Project No: CP-brd-3(77)

Title: Development of superior cultivars and breeding lines for Northern latitudes (81)

Project Scientist: Dr. Onkar Singh

Cooperators: Drs. S.[illegible], C.L.L.Gowda, J.Kumar, M.P.Haware, M.V.Reddy, UMaid Singh.

Objectives:

The major chickpea growing areas of the world fall between 23°N and 32°N specially in Indian subcontinent. The Hissar centre being located at 29°N can well serve most of these areas. The major objectives of the project are (a) To breed high yielding and disease resistant 'desi' cultivars with acceptable seed size, color and qulaity (b) To breed high yielding anddisease resistant 'kabuli' cultivars with acceptable seed size, color and quality, (c) To contribute advanced breeding lines and segregating populations to the chickpea producing countries throughout the world having comparatively longer growing season.

Methodology:

(1) Genotypic variability will be genrated mainly by making single and multiple crosses (2) The classical breeding methods for self-pollinated crops, pedigree, bulk and backcross methods, will be utilised for developing cultivars (3) Segregating populations will be screened for (a) Disease resistance (b(Protein content (c) Suitability for late planting (4) Promising advance generation lines and segregating populations will be evaluated over a range of environments to recognize elite material.

103. Project No: CP-brd-6(77)

Title: Development of high protein breeding lines (80)

Project Scientist: Dr. J. Kumar

Cooperators: Dr. Umaid Singh

Objectives:

(1) To develop cultivars with higher protein content and better aminoacid profile (2) To breed varieties with better consumer acceptance.

Methodology:

(1) High protein lines will be identified in the chickpea germplasm (2) Approximately 200 advanced generation breeding lines will be analysed for their protein content to isolate any trasgressive segregates if possible (3) High protein lines thus identified will be used in crosses with elite lines and selection among segregates will be made for high protein content and better nutritional quality. (4) Care will be taken that seleded lines possess acceptable seed size and color for consumer preference.

104. Project No: CP-brd-7(77)

Title: Breeding new plant types (81)

Project Scientist: Dr. C.L.L. Gowda

Cooperators: Drs Onkar Singh, N.P. Saxena

Objectives:

(1) Breeding for mid-tall, compact, and high yielding cultivars (2) Developing cultivars suitable for mechanical harvest (3) Searching for new concepts of plant type with higher yield potential.

Methodology:

(1) The backcross-pedigree method with suitable amendments will be used. The tall cultivars will be utilised as donor parents for transferring height and compactness, and the dwarf bushy present day cultivars will be used as recurrent parents (2) Special emphasis will be given to selection for reduced internode length for adding more pod bearing nodes and for lodging resistance. Appropriate crosses will be made to introduce these characters.

105. Project No: CP-brd-8(77)

Title: Evaluation of recurrent selection as a breeding method (80)

Project Scientist: Dr. C.L.L. Gowda

Objectives:

(1) To compare Jensen's diallel selective mating system with classical breeding procedures in developing high yielding cultivars (2) To create 'diverse and dynamic gene pool' populations for distributing to cooperators for their use.

Methodology:

(1) Producing single crosses from a set of selected parents (2) Selecting superior single crosses for making the F_1 diallel (double crosses) (3) Selecting individual plants in F_2s of single crosses and double crosses to be advanced by pedigree method (4) Developing selective mating populations by inter-mating selected plants within and among double cross F_1s. (5) Selecting plants in selective mating populations to be advanced by pedigree method (6) Comparing the F_4/F_5 derived lines obtained by different methods.

106. Project No: CP-brd-9(77)

Title: Comparison of breeding methods

Project Scientist: Dr. S.C. Sethi

Objectives.

To generate information on suitable breeding methods for developing high yielding chickpea cultivars. Information so gathered will be of use to us and other chickpea breeders of the world.

Methodology.

Three experiments have been designed with the objective of (a) Testing the validity of selecting 'kabuli' and 'desi' types in West and East Asia (b) Testing the efficacy of the pedigree method of selection (PMS), single seed descent (SSD), and bulk method of selection (BMS) (c) Testing the validity of rejecting crosses on F_1 performance.

107. Project No: CP-brd-11(77)

Title: International Cooperation (80)

Project Scientist: Drs. J.M. Green & K.B. Singh

Cooperators: Drs. Y.L.Nene, W.Reed, P.J.Dar

Objectives: (1)

(1) To make cultivar introductions into other countries (2) To supply segregating populations to strengthen national and regional programs (3) To identify genotypes with wide range of adaptability for use in international and national breeding programs (4) To release cultivars with special characteristics, eg. disease resistance, high protein etc. to other countreis (5) To promote international cooperatio personal visits, conferences, and information exchange.

Methodology:

ICRISAT is supplying to various countries (a) International Chickpea Cooperative Trials (ICCT) (b) International Chickpea Screening Nursery (ICSN) (c) F segregating populations (d) Microplot yield testing (for countries interested in introducing chickpea as a new crop) (e) cultivars from our crossing block nursery.

108. Project No: CP-brd-12(77)

Title: Genetic studies of qualitative and quantitative characters (81)

Project Scientist: Dr. S.C. Sethi

Cooperators: Drs. J.Kumar, C.L.L Gowda, Onkar Singh

Objectives:

(1) To collect information on mode of inheritance for qualitative and quantitative characters of interest (2) To estimate the numbers of genes governing resistance for diseases (3) To work out correlation and path coefficients between yield and other characters for their direct use in breeding procedures.

Methodology:

(1) Parents, F_1s, F_2s and back-cross generations (BC_1 and BC_2) will be utilised to study the inheritance of characters. (2) The data on diallel cross, and lines x tester will be used to determine the nature of gene action, additive or non-additive, for different characters. Also, the combining ability of the parents and crosses will be determined.

CHICKPEA GERMPLASM Sub-program Leader: - Dr. L.J.G. van der Maesen

109. Project No: CP-gp-1(75)

Title: Maintenance and evaluation of chickpea germplasm (80)

Project Scientist: Dr. A.N. Murthi

Cooperators: Drs. Umaid Singh, M.P.Haware, S.S.Lateef, J.Kumar O.P. Rupela.

Objectives:

(1) To maintain genetic resources of Cicer (2) To evaluate available accessions (3) To document and publish evaluations (4) To distribute germplasm material.

Methodology:

(1) Growing the accessions when needed for renewal of stock (2) Taking appropriate observations (3) Storing in proper containers in proper cold storage (4) Testing of existing classifications and providing updated ones (5) Expulsion f duplicates (6) Preparaion and issue of catalogues, data storage on computer (7) Supply of seeds.

110. Project No: CP-gp-2(75)

Title: Collection of Cicer germplasm and up-dating Cicer Taxonomy (80)

Project Scientist: Dr. L.J.G. van der Maesen

Cooperators: Dr. A.N. Murthi

Objectives:

(1) To obtain new genetic resources in Cicer arietinum and the annual and perennial wild species (2) To document and publish collection details (3) To update intraspecific and interspecific classification for publication and general use.

Methodology:

(1) Collection of Cicer spp. in regions of origin and variability eg. Turkey, Iran, Iraq, Syria, Lebanon, Afghanistan, Kashmir, Ethiopia, Greece, Morocco (2) Collection of Cicer arietinum in regions of distribution et. Tanzania, Malawi, Angola (3) Visit to herbaria not visited so far to study material eg. Leningrad, Moscow, Tashkent, Kyoto (4) Borrowing the material which needs closer examination.

111. Project No: CP-gp-3(77)

Title: Interspecific hybridization in Cicer (82)

Project Scientist: Dr. A.N. Murthi

Objectives:

(1) To elucidate taxonomic relationships on cytological basis (2) To identify methods to overcome interspecific crossing barriers (3) Generated material can become available to breeders

Methodology:

(1) Making of crosses to establish fertility relationships (2) Cytological and genetic studies of IS hybrids to clarify relationships (3) Recognizing barriers, detecting causes and breaking barriers.

CHICKPEA MYCOLOGY Sub-program Leader: - Dr.A.R.Sheldrake (since left)

112. Project No: CP-Phy-1 (75)

Title: Comparison of Chickpea genotypes (78)

Project Scientist: Dr. N.P. Saxena

Cooperators: Drs. S.C.Sethi, J.Kumar

Objectives:

To collect information on growth and development of genotypes differing in plant habit or morphology with respect to desirable and undesirable characteristics for their modification by breeding.

Methodology:

These studies will be made on plants grown in the field and on plants grown in pots. Simple laboratory techniques such as weighings, leaf area determination, chemical analysis for N and P and other laboratory

113. Project No: CP-Phy-2(75)

Title: Response of chickpea to environment and cultural practices (78)

Project Scientist: Dr. N.P. Saxena

Cooperators: Drs. Onkar Singh, C.L.L. Gowda

Objectives:

This project is related to the physiological aspects of Agronomy of Chickpeas, such as the (1) N and P nutrition of chickpeas (2) Effect of environmental conditions such as Hyderabad and Hissar (3) Effect of dates of planting (4) Effects of moisture supply.

Methodology:

The experiments would be conducted in field and simple observations on weights of plants, soil and plant chemical analysis for N and P would be done.

114. Project No: CP-Phy-3(75)

Title: Source-sink Relationships in Chickpeas (78)

Project Scientist: Dr. N.P. Saxena

Cooperators: Drs. J.M. Green and K.B. Singh

Objectives:

(1) To study the production of photoassimilate in the shoots and their translocation, partitioning and utilisation in sinks such as stems, leaves, roots, nodules and reproductive structures. (2) These studies should provide a deeper understanding of the effects of genotype and of environment on the growth, development and yield of chickpeas. This also eventually would throw light on the competition for light and other factors and on the desirable plant type under a given agroclimatic condition.

Methodology:

(1) Defoliation experiments (2) Shading experiment
(3) Flower and pod removal experiments

115. Project No: CP-Phy-4(77)

Title: Water relations of chickpea, and growth of chickpea under adverse conditions (81)

Project Scientist: Dr. N.P. Saxena

Cooperators: Drs. Onkar Singh, C.L.L. Gowda

Objectives & Methodology:

To study the changes in water status of plants: (a) Diurnally at important stages of growth (b) Differences amongst cultivars varying in growth duration and type (c) Of different ages of leaves on a plant (d) Changes in water status in response to change in environmental condition such as date of sowing.

To study the variability in the germinating ability of seeds under restricted water availability (Lab and Field studies). Also growth development and yield with irrigation and restricted irrigation would be studied in cultivars of interest.

Tolerance level of chickpeas to salinity in different kinds of soil (Heavy black and loamy soils) and screening of cultivars to salinity with respect to germination. Growth and yield studies in susceptible and tolerant cultivars.

CHICKPEA PATHOLOGY

Sub-program Leader: - Dr. Y.L.Nene

116. Project No: CP-Path-1(78)

Title: Studies on Fusarium wilt of chickpea(80)

Project Scientist: Dr. M.P.Haware

Cooperators: Drs. J.Kumar, S.C.Sethi, C.L.L. Gowda, Onkar Singh

Objectives:

(1) Study the survival and spread of the pathogen (2) Study the situation on pathogenic races (3) Further improve screening techniques.

Methodology:

(1) Survival of wilt pathogen in soil in presence and absence of host residues will be studied (2) Collection of isolates of F. oxysporum of chickpea from different chickpea growing areas. Standard procedures for identifying pathogenic races will be followed.

117. Project No: CP-Path-2(78)

Title: Studies on stem and root rots of chickpea (80)

Project Scientist: Dr. M.P. Haware

Cooperators: Drs. J.Kumar, C.C.Sethi, C.L.L. Gowda, Onkar Singh.

Objectives:

Chickpea root rots (Rhizoctonia bataticola, R. solani), collar rot (Sclerotium rolfsii), foot rot (Operculella wilkii), and Sclerotinia stem rot are some of the recognized, important diseases of chickpea in certain areas. The objectives are to: (a) collect more precise information on their prevalence in the chickpea growing areas (b) study the etiology of pathogens leading to unerstanding of epiphytology of diseases (c) develop efficient techniques to screen for resistance.

Methodology:

(1) Surveys will be conducted to collect information on the regional occurrence of various root rot diseases and identification of pathogens. (2) Disease cycle will be studied. Established techniques for studying epiphytology of diseases will be adopted with modifications whenever necessary (3) For each pathogen, separate screening technique will be developed. Priority will be given to Rhizoctonia bataticola.

118. Project No: CP-Path-3(78)

Title: Studies on chickpea stunt and other viral diseases (80)

Project Scientist: Dr. M.V. Reddy

Cooperators: Drs. J.Kumar, C.L.L.Gowda, Onkar Singh, W. Reed.

Objectives:

(1) Identify the causal agents involved in stunt and mosaic (2) Study mode(s) of transmission (3) Developefficient laboratory and field screening techniques (4) To understand the epidemiology of these diseases.

Stunt is one of the major components of 'wilt complex'. Information on the etiology of stunt and mosaic, their mode(s) of transmission and epidemiology is essential to work out suitable control mesures. Reliable screening techniques will enable in identifying resistance sources and developing resistant varieties.

Methodology:

Standard procedures followed in plant virology will be employed in understanding the etiology of the stunt, mosaic, and other possible viral problems. Their mode(s) of transmission such as mechanical, seed, insect, etc., and host range will be studied. The relationships between the pathogens and vectors will be worked out. Both laboratory (mechanical/ insect inoculation) and field (infector row) techniques for screening the germplasm and breeding material will be standardised.

119. Project No: CP-Path-4(78)

Title: Studies on Ascochyta blight (81)

Project Scientist: Dr. M.V. Reddy

Cooperators: Drs. Onkar Singh, J.Kumar

Objectives:

(1) Screen the germplasm and breeding material for resistance (2) Identification of physiologic races (3) Work out methods to eradicate the seed-borne inoculum.

Methodology:

Screening will be carried out by the procedure worked out using isolation plant propagators. Isolates from within India will be studied to ascertain if district physiological races are involved. Fungicides will be tested for the eradication of seed-borne Ascochyta.

120. Project No: CP-Path-5(78)

Title: International Chickpea Disease Nurseries (80)

Project Scientist: Dr. Y.L.Nene

Cooperators: Drs. M.P.Haware, M.V.Reddy, J.M.Green, LJG van der Maesen.

Objectives:

(1) Share promising material with cooperators in different countries. (2) Identify stable sources of resistance for use in breeding program at ICRISAT (3) Get feed-back on susceptibilities of the entries to other locally serious diseases.

Methodology:

(1) The lines/crosses which appear promising against Fusarium wilt and/or root rots in ICRISAT sick plots as well as promising material received from cooperators will be put together into 'International Chickpea Root Rots/ Wilt Nursery (ICRRWN)'. This nursery will be sent to cooperators every year. (2) Likewise lines/crosses which appear promising against Ascochyta blight in net house screening at ICRISAT as well as promising material received from cooperators will be put together into 'International Chickpea Ascochyta Blight Nursery (ICABN)'. This nursery will be sent to cooperators every year (3) A report on the results of nurseries will be prepared annually.

CHICKPEA ENTOMOLOGY

Sub-program Leader: - Dr. W.Reed

121. Project No: CP-Ent-1(77)

Title: Pest distribution and associated crop losses on chickpea in the major producing countries (80)

Project Scientist: Drs. W.Reed, S. Sithanantham

Cooperators: Dr. S.S. Lateef

Objectives:

To determine the arthropod pests of chickpea, their seasonal and geographical distribution.

To determine the damage and losses caused by the pests (a) on and around ICRISAT (b) throughout India (in association with AICPIP) (c) throughout the major chickpea growing areas of the world.

As a result of the findings, we will be able to determine the priorities for pest management research and development.

Methodology:

(1) By recording the populations of the arthropods on chickpea crops throughout each season on and around ICRISAT, identifying and assessing the damage caused and analysing samples of pods collected from trials. (2) By sample surveys of farmers' fields in the major chickpeaareas of India. Counts of the pests and their damage will be recorded from green crops and samples of pods will be taken from mature crops, for analysis at ICRISAT. This work will be carried out wherever possible with the cooperation of AICPIP scientists. (3) By establishing communication with national scientists in the chickpea growing countries and by visits to them.

122. Project No: CP-Ent-2(77)

Title: Host plant resistance to pests in Chickpea (81)

Project Scientist: Dr. S.S. Lateef

Cooperators: Drs. S.C.Sethi, C.L.L.Gowda, J.Kumar

Objectives:

To identify chickpea germplasm that (a) is resistant to individual pest attack (mainly H.armigera) (b) is less susceptible to loss caused by the pest complex (c) is tolerant to pest damage (including the compensatory habit) (d) yields more than the currently utilised cultivars under the farmers' conditions of no, or minimal, insecticide use.

To cooprate with ICRISAT,AICPIP and other national chickpea breeders, by screening their promising material for susceptibility to pests and by supplying seelcted material to them for incorporation into their programs.

To refine screening techniques and trial methodology.

To investigate the effect of the chickpea plant exudate on pests, and its variability between cultivars.

(Cont'd...)

Project No. CP-Ent-2(77)
(Cont'd....)

Methodology:

(1) By screening all available germplasm and breeders' promising material for susceptibility to pests. By selecting within this material and subsequent screening. Most of this work will be on unsprayed fields under natural pest threat, but we will also study the augmentation of attack by the use of infestor rows or crops, laboratory bred pests and the use of portable net houses, in attempts to ensure controlled and even pest distribution on all plants (and so avoid the confusion caused by a preponderance of 'escapes'). (2) Trial designs (R.B.D., Latin squares and Lattices) will be compared for their efficiency in detecting differences in pest susceptibility (3) Antibiosis feeding studies will be conducted in the laboratory.

123. Project No: CP-Ent-3(77)

Title: Integrated pest management of chickpea (80)

Project Scientist: Dr. S. Sithanantham

Cooperators: Drs. B.A. Krantz, S.K. Pal, J.M.Green, S.S.Lateef.

Objectives:

To develop the concept and practice of integrated pest management on chickpea. To identify individual components or practices that will reduce pest caused losses to the crop, and eventually combine these into a practical package for use at the farmer level.

Components that will be investigated initially are: (a) insecticide use, including improved application techniques (b) host plant resistance (c) biological control (d) cultural practices.

Methodology:

(1) Determining the potential return from insecticide use by comparing sprayed and unsprayed trials and establishing the 'economic injury levels' of the major pests. Investigating the effects of minimal insecticide use by applying sprays only at determined 'critical' periods. Testing the new controlled droplet application technique with reduced dosages of non-polluting insecticides. (2) Investigation of the effect of plant spacing and irrigation upon pest populations and damage in insecticide free and treated plots. Effect of the juxtaposition, in time and space, of other crops and host-plants for the chickpea pests and their natural enemies.

CHICKPEA BIOCHEMISTRY & NUTRITION — Sub-program Leader: - Dr. R. Jambunathan

124. Project No. CP-B&N-1(77)

Title: Evaluation of germplasm and breeding material for protein content and limiting amino acids (80)

Project Scientist: Dr. Umaid Singh

Cooperators: Drs. J.Kumar, C.L.L.Gowda, R.P.S.Pundir

Objectives:

(1) To test some of the standard methods for the estimation of protein content and sulphur amino acids and identify suitable method for routine screening purposes (2) Analyse breeding material and germplasm samples for protein content and determine sulphur amino acids on selected samples (3) To study the influece of invironmental factors on the protein content of chickpea in collaboration with breeders.

Methodology:

(1) Determine the protein content by microKjeldahl, dye binding capacity, technicon auto analyser and biuret methods (2) Determine the sulphur amino acids by ion exchange chromatography and microbiological methods and total sulphur using Leco sulphur analyser and wet digestion method. (3) Determine the protein contents of cultivars grown at diferent locations as supplied by the breeders.

125. Project No: CP-B&N-2(75)

Title: Study some of the factors affecting nutritional quality of chickpea including cooking quality (78)

Project Scientist: Dr. Umaid Singh

Cooperators: Drs. J.M.Green, M. von Oppen

Objectives:

(1) To fractionate seed storage proteins of samples collected at different stages of maturation and determine their amino acid composition. (2) To identify protein ffractions with better amino acid composition and develop methods for rapid screening of breeding material for the selection of samples having desirable protein fractions. (3) To study the digestibility of protein and carbohydrates in uncooked and cooked samples (4) Conduct preliminary studies to evaluate the cooking quality of chickpeas.

Methodology:

(1) Use various solvent systems and separate seed proteins into different solubility fractions. (2) Use electrophoretic techniques and amino acid analyser for the identification and characterisation of protein fraction(s) with improved amino acid composition. (3) Use protein and carbohydrate hydrolysing enzymes for in-vitro digestibility study on uncooked and cooked samples.

CHICKPEA MICROBIOLOGY Sub-program Leader: - Dr.P.J.Dart

126. Project No: CP-Micr-1(76)

Title: Cicer Rhizobium populations in soil (80)

Project Scientist: Dr. O.P. Rupela

Objectives:

(1) To determine the numbers of Rhizobium in soil and the effect of season and environment, previous cropping history and soil type and depth on these numbers. (2) To assess the effectiveness of these populations in nodulating and fixing nitrogen with chickpea.

Methodology:

(1) Develop a plant infection technique for large scale counting of Cicer rhizobia. (2) Count rhizobia in selected growing sites throughout the year, to determine the effect of soil physical status, soil depth, soil moisture, temperature, pH and salinity on numbers. (3) Characterise the ability of these populations in fixing nitrogen (a) using soil core techniques with improved and local cultivars (b) by assessing the effectiveness of populations at different soil dilutions (c) by determining the relative effectiveness of the strains forming the most prominet nodules.

127. Project No: CP-Micr-2(76)

Title: Response of chickpea to inoculation with Rhizobium (81)

Project Scientist: Dr. O.P. Rupela

Cooperators: Dr. N.P. Saxena

Objectives:

(1) To select Rhizobium strains that are highly effective in fixing nitrogen are competitive in nodule formation, and are able to move and persist in soils (2) Assess the proportion of nodules formed by the inoculum strain in the field and the effect on this of (a) soil type, pH and salinity (b) field cropping history (c) effectiveness of the existing Rhizobium population. (3) Determine the effect of inoculation on N uptake and grain yield. (4) Assess the persistence and spread of the inoculum strain in the soil.

Methodology:

(1) Isolate and collect Cicer Rhizobium strains and determine their effectiveness in pot trials. (2) Examine the highly effective strains for metabolic and serological identification markers. (3) Produce antibiotic and antimetabolite resistant inoculant strains, and fluorescent labelled antisera for these strains. (4) Inoculate field crops with readily identifiable, effective strains and count the numbers of nodules formed by these strains using markers identified in 2 and 3. (5) Measure N uptake during plant growth and final yield of inoculated and uninoculated plants in the field. (6) Count numbers of nodules formed by the inoculum strains in uninoculated chickpea. crops in subsequent seasons.

128. Project No: CP-Micr-3(76)

Title: Nitrogen fixation by chickpea (80)

Project Scientist: Dr. O.P. Rupela

Cooperators: Dr. N.P. Saxena

Objectives:

(1) Measure the nitrogen fixation by chickpea in the field. (2) Assess the ability of chickpea nodules to provide the plants nitrogen requirements for maximum yields. (3) Determine the nutritional and environmental factors limiting nodulation and nitrogen fixation.

Methodology;

(1) Develop a technique for the acetylene reduction assay of nitrogen fixation. Compare these estimates with those obtained from nitrogen balance estimates derived from Kjeldahl N analyses and from use of $^{15}NO_3$ to label the soil pool of available nitrogen. (2) Determine nitrogen uptake and yield of field grown chickpea when uninoculated, inoculated, and inoculated but liberally supplied combined nitrogen. (3) Measure nodulation and nitrogen fixation of chickpeas grown in soils of different nutrient status (particularly for P, Zn, Mo, B, Fe) and determine the fertiliser levels, and methods of application required to ameliorate deficiencies.

129. Project No: CP-Micr-4(76)

Title: Host Rhizobium genetic interactions in nodulation of Chickpea (81)

Project Scientist: Dr. O.P. Rupela

Cooperators: Dr. R.P.S. Pundir

Objectives:

(1) Characterise differences between chickpea lines in ability to nodulate and fix nitrogen, and the effect of different Rhizobium strains (soil populations) on this response. (2) Select and cross promising material to see if nodulation and nitrogen fixation can be enhanced. (3) Monitor breeders material for ability to nodulate and fix nitrogen.

Methodology:

(1) Evaluate symbiotic characteristics of breeders crossing block material with single Rhizobium strains, in pot culture. (2) Assess whether a soil inoculum in pot (sand) culture can simulate the competitive effects of Rhizobium populations in soil. Monitor the symbiotic response of selected lines with Rhizobium populations in different soil types and geographical locations. (3) Examine nodulation and nitrogenase activity of lines from the chickpea germplasm collection grown in the field. (4) Determine the heritability of host genes affecting nodulation responses. Select and cross promising material to see if nitrogen fixation can be enhanced and incorporated into lines with other desirable characteristics.

GROUNDNUT BREEDING — Sub-program Leader: - Dr.R.W.Gibbon

130. Project No: G-brd-1(76)

Title: Breeding for resistance to leafspots (Cercospora arachidicola and Cercosporidium personatum) (79)

Project Scientist: Dr. S.N. Nigam

Cooperators: Drs. P.Subrahmanyam, V.R.Rao, P.Moss

Objectives:

(1) To produce commercially acceptable, high yielding cultivars with resistance to the leafspot fungi (C. arachidicola and C. personatum). (2) To supply advanced breeding material with resistance to leafspots to cooperators.

Methodology:

At Reading University wild diploid species with resistance to the leafspot fungi were crossed with the cultivated tetraploid groundnut. By treating the triploid hybrids with colchicine fertile hexaploids have been produced. These hexaploids have been exposed to leafspot infection at Patancheru and apparently highly resistant lines have been identified. Backcrossing these hexaploids to the cultivated groundnut will eventually produce near tetraploid commercially acceptable leafspot resistant cultivars.

131. Project No: G-brd-2(76)

Title: Breeding for resistance to rust (Puccinia arachidis)(79)

Project Scientist: Dr. S.N. Nigam

Cooperators: Drs. V.R.Rao, P.Subrahmanyam, D.V.R.Reddy

Objectives:

(1) To combine high yield and quality with resistance to rust (2) To study the inheritance of resistance

Rust has become a serious problem in groundnuts particularly when in conjunction with leafspots. In a short space of time rust has spread from the Caribbean and South America, where it is endemic, to all major groundnut producing areas.

Methodology:

(1) Field and greenhouse screening of material using techniques developed by the pathologists. (2) Depending upon the source of resistance either pedigree, backcross or both methods will be used to transfer resistance to high yielding lines. (3) The F_3 resistant lines from Puerto Rico will be advanced by the pedigree method and will also be used as parents in the breeding program.

Project No: G-brd-3(77)

Title: Breeding for resistance to Aspergillus flavus (80)

Project Scientist: Dr. S.N. Nigam

Cooperators: Drs. V.R.Rao, P.Subrahmanyam, D.V.R.Reddy, and USDA scientists, Tifton, Ga., USA., Tropical Products Institute, U.K.

(1) Breeding high yielding cultivars with resistance to A. flavus
(2) To study the inheritance of resistance to this disease.

The fungus is cosmopolitan in distribution and produces a harmful toxin (aflatoxin).

Methodology:

After setting up suitable screening techniques the inheritance of resistance would be studied and appropriate breeding methods would be applied to produce high yielding resistant lines.

Project No: G-brd-4(76)

Title: Breeding for earliness (79)

Project Scientist: Dr. S.N. Nigam

Cooperators: Dr. V.R. Rao

Objectives:

(1) To breed early maturing high yielding cultivars having some dormancy.
(2) To study the inheritance of earliness and dormancy.

Early maturing groundnuts with good quality, yield and dormancy would find a prominent place in the SAT which is characterised by uneven and erratic rainfall. They would also find a place in the different cropping systems used in SAT.

Methodology.

(1) A back crossing program would be used with one parent (Chico).
(2) The pedigree method would be used with other parents such as Robut 33-1, 91176 and 91776.

134. Project No: G-brd-5(76)

Title: Breeding for increased yield and quality (79)

Project Scientist: Dr. S.N. Nigam

Cooperators: . V. Ramanatha Rao

Objectives:

(1) To breed for increased yield potential. (2) To breed for improved quality characters eg., seed size, seed shape, etc. (3) To test for wide adaptability by multilocational trials.

Although the yield potential of present day cultivars may be reasonably high there is still scope for improvement. The production of high potential base material would not only be useful for our disease resistance programs but for areas where some of the usual constraints may not occur.

Methodology;

(1) We will use various breeding methods in this program. For yield increase wide crosses between subsp. hypogaea var hypogaea and subsp. fastigiata var vulgaris seem to offer the most scope for advancement

(2) Multilocational trials will be used to test the material we generate and promising material will be employed in other hybridization program.

GROUNDNUT GERMPLASM Sub-program Leader: - Dr. R.W.Gibbons, Dr. L.J.G.van der Maesen

135. Project No: G-gp-1(76)

Title: Collection of Arachis germplasm; taxonomic classification and documentation of the material (79)

Project Scientist: Dr. V. Ramanatha Rao

Cooperators: Dr. Dr. S.N. Nigam. Dr.A.H.Bunting/IBPGR; International Peanut Program, Florida, USA.

Objectives:

(1) To assemble world groundnut genetic resources at ICRISAT (2) To prepare a set of standard descriptors (3) To classify the available collection on acceptable botanical and agronomic characteristics (4) To document and publish germplasm lists.

Methodology.

(1) Collection of existing Arachis material from Indian research agencies. (2) Transfer of material from known collections abroad (3) Collection of local types from groundnut growing states in India (4) Collection of Arachis germplasm from countries like Argentina, Bolivia, Peru, Brazil, Maracay, Egypt, Zambia, Sudan, South Africa, China and Indonesia as per the recommendations of the IBPGR Advisory Committee (5) Classification of the material based on agronomic and taxonomic traits.

136. Project No: G-gp-2(76)

Title: Maintenance and evaluation of groundnut germplasm (79)

Project Scientist: Dr. V. Ramanatha Rao

Cooperators: Dr.S.N.Nigam, D.V.R.Reddy, P.Subrahmanyam, P.W.Amin. North Carolina State University, USA.

Objectives:

(1) To maintain genetic resources of Arachis (2) To evaluate available accessions (3) To publish evaluations (4) To distribute germplasm material.

Methodology:

(1) Growing the available accessions for renewal and evaluation
(2) Evaluating the accessions for botanical characters, yield and other traits (3) Storing the seed material under recommended conditions
(4) Identifying duplicates and eliminating them from the collection.

GROUNDNUT PATHOLOGY

Sub-program Leader: - Dr. D.V.R. Reddy

137. Project No: G-Path-1(76)

Title: Investigations on bud necrosis or bud blight virus disease (79)

Project Scientist: Dr. A.M. Ghanekar

Cooperators: P.W.Amin, R.W.Gibbons, S.N.Nigam, V.Ramanatha Rao Y.L.Nene, M.C.Padma

Objectives:

(1) To identify the causal agent by employing serology, insect transmission and electronmicroscopy. (2) To develop methods for large scale screening of germplasm and to identify sources of resistance (3) Estimation of yield losses (4) Purification of the virus and production of antiserum.

'Bud necrosis' is the most important local viral disease and is known to occur in all groundnut growing areas in India. In rabi season in some areas the disease is more important than leaf spots and rust. Large scale screening of the germplasm will help in the identification of source of resistance.

Methodology:

(1) Prepartion of suitable buffers for suspending the virus to develop large scale screening methods to identify sources of resistaNce
(2) Purification of the virus employing polyethylene glycol and density gradient centrifugation using sucross solutions (3) Various fixing and staining methods for preparing the virus particles suitable for electron-microscopy (4) Production of antisera in rabbits and mice in the presence of adjuvants. As this virus is unstable frequenthigh virus concentration injections will be needed to obtain high titered antisera.

138. Project No: G-Path-2(76)

Title: Survey for incidence and investigaions on chlorotic spot virus, einbanding diseas peanut mottle virus and other viruses or diseases associated with myco-lasma like agents and R' kettsiae (79)

Project Scientist: Dr. A.M. Ghanekar

Cooperators: Drs. R.W.Gibbons, P.V.Amin, V.Ramanatha Rao. R.I.B. Francki, Cedric W.Kuhn, M.C.Padma.

Objectives.

(1) Identify the causal agent by employing host range, physical properties, transmission, serology and electronmicroscopy. (2) Develop rapid and efficient laboratory and field screening methods (3) Estimation of yield losses (4) Purification of viruses and production of antisera.

Vein-banding disease was detected in several groundnut growing areas of Andhra Pradesh and in some places incidence upto 10% was noticed. If early infection occurs it can cause total loss in yield.

Peanut mottle virus (PMV) has been recorded from almost all groundnut growing areas of the world and yield reduction upto 10% has been reported. In India PMV has not been reported although its presence is strongly suspected. It is extremely important to conduct extensive surveys to detect the occurrence of PMV in India. Once the disease is detected large scale screening of germplasm will aid in identifying resistant sources.

Methodology:

(1) Mechanical transmission employing various buffers and grafting to maintain the cultures. (2) Characterization of viruses employing polyacrylamide gel electrophoresis, computing sedimentation coefficient, serological techniques, transmission characteristics and electronmicroscopy. (3) Production of antisera (4) Simple mechanical inoculation with an atomizer for large scale screening of germplasm if the virus is mechanically transmissible; grafting techniques and vector transmission for screening of germplasm for other diseases.

139. Project No: G-Path-3(76)

Title. Investigations on the biology and epidemiology of groundnut rust and identification of sources of stable resistance (79)

Project Scientist. Dr. T. Subrahmanyam

Cooperators: Drs. R.W.Gibbons, D.V.R.Reddy, V.Ramanata Rao, S.N.Nigam, Y.L.Nene, R.J.Williams.

Objectives:

(1) To study the survival of rust uredospores (2) To search for other stages in the rust life cycle including alternate hosts (3) To identify races, if they exist or develop, on an international basis (4) To develop an efficient and rapid laboratory and field screening technique for rust evaluation (5) To screen germplasm and breeding material for resistance to rust (6) To test the stability of identified resistance through multilocational testing.

(Contd ...)

Project No: G-Path-3(76)
(Cont'd...)

Methodology:

(1) Determine the survival of [illegible] spores at different temperatures and relative humidities and attempt to break dormancy if it exists. (2) Microscopic examination of diseased specimens collected from different genotypes and decomposing infected leaf debris for detecting the telial stage. (3) Check for rust infection on weed plants and cultivated legumes. (4) Identification of races, if any, using differential hosts and also by physico-chemical techniques. (5) Develop an efficient laboratory and field screening technique for screening germplasm and breeding populations (6) Evaluation of the stability of identified resistance through multilocational testing in India and abroad.

140. Project No. G-Path-4(76)

Title: Investigations on leafspots of groundnut caused by Cercospora arachidicola and Cercosporidum personatum (79)

Project Scientist: Dr. P. Subrahmanyam

Cooperators: Drs. R.W.Gibbons, V.Ramanata Rao, S.N.Nigam, Y.L.Nene R.J.Williams.

Objectives:

(1) To identify suitable media for the abudnant growth and sporulation of the leafspot fungi. (2) To develop techniques for screening for resistance to leafspots. (3) To t st the stability of identified resistance through multilocational testing. (4) To obtain information on the world wide distribution and importance of the tw fungi. (5) To search for new sources of resistance in the Arachis germplasm and confirm existing claims of resistance.

Methodology:

(1) To test various culture media and additives for effective sporulation of the fungi. To identify optimal temperatures andalight sources for the production of highly sporulating colonies. (2) To test plants at different growth stages, temperatures and humidities for abundant production of leafspot symptoms. (3) To expose sources of resistance at multilocational sites under heavy inoculum loads to test for stability of resistance.

141. Project No: G-Path-5(77)

Title: Investigations on Aspergillus flavus and other fungal diseases of groundnut (80)

Project Scientist: Dr. P. Subrahmanyam

Cooperators: Drs. R.W.Gibbons, V.Ramanatha Rao, S.N.Nigam, Y.L.Nene, R.J.Williams, R.Jambunathan.

Objectives:

(1) To select an efficient and rapid method for the analysis and estimation of aflatoxins. (2) To investigate effective and rapid laboratory techniques for screening against A. flavus invasion and toxin production. (3) Screening of germplasm and breeding material for resistance (4) Testing of identified resistance under field conditions (pre-harvest & post-harvest) (5) To obtain a complete picture on the relative importance of variuos fungal diseases in India. (6) To identify and maintain cultures of various pathogenic fungi.

Methodology:

(1) An effective and rapid method of analysis and estimation of aflatoxins will be selected out of methods available at present. (2) Isolation and maintenance of A. flavus from groundnut kernels collected from different localities (3) Screening of A. flavus isolates for aflatoxin production. (4) Investigations on an effective and rapid laboratory technique for screening for resistance to A. flavus invasion and toxin production. (5) Screening of germplasm and breeding material for resistance both at ICRISAT and abroad. (6) Survey of groundnut growing areas in Inida in different seasons to identify fungi of economic importance. (7) Identification and maintenance of cultures of pathogenic fungi.

GROUNDNUT ENTOMOLOGY Sub-program - Dr.R.W.Gibbons
Leader: Dr.P.W.Amin

142. Project No: G-ent-1(77)

Title: Groundnut Entomology (79)

Project Scientist: Dr. P.W. Amin

Cooperators: Drs. D.V.R. Reddy, V.Ramanatha Rao, W.Reed, J.C.Davies.

Objectives:

(1) To determine the harmful and beneficial arthropods of groundnut and to study their seasonal distribution, their levels of economic importance and the role of predators and parasites in goerning the pest populations. (2) To determine the role of insects in cross pollination of groundnuts. (3) To study the role of disease vectors (4) To cooperate with the plant protection unit in pest management of groundnuts at ICRISAT.

Methodology:

(1) Arthropods will be surveyed by smapling and trapping techniques to ascertain their seasonal distribution patterns and will be rared as necessary in the laboratory. (2) Insect visitors to flowers will be collected, identified and pollen from those implicated will be identified. This project will work in close collaboration with the breeders who are assessing rates of out-crossing in groundnuts. (3) Disease vectors will be collected rared and used in tests to determine their role and method of transmitting viruses and disease organisms.

GROUNDNUT MICROBIOLOGY — Sub-Program Leader: Dr.P.J.Dart

143. Project No: G-Micr-3(76)

Title: Nitrogen fixation by groundnut (80)

Project Scientist: Dr. P.T.C. Nambiar

Cooperators:

Objectives:

(1) Measure the nitrogen fixation by groundnut in the field. (2) Assess the ability of groundnut nodules to provide the plants nitrogen requirements for maximum yields. (3) Determine the nutritonal and environmental factors limiting nodulation and nitrogen fixation.

Methodology:

(1) Develop a technique for the acetylene reduction assay of nitrogen fixation. Compare these estimates with those obtained from nitrogen balance estimates derived from Kjeldahl N analyses and from use of $^{15}NO_3$ to label the soil pool of available nitrogen. (2) Determine nitrogen uptake and yield of field grown groundnut when uninoculated, inoculated and inoculated but liberally supplied combined nitrogen. (3) Measure nodulation and nitrogen fixation of groundnuts grown in soils of different nutrient status (particularly for P, Zn, Mo, B, Fe) and determine the fertiliser levels, and methods of application required to ameliorate deficiencies.

144. Project No: G-Micr-4(76)

Title: Host plant - Rhizobium genetic interactions in nodulation of groundnut (80)

Project Scientist: Dr. P.T.C. Nambiar

Cooperators: Dr. V. Ramanatha Rao, Dr. R.W. Gibbons.

Objectives:

(1) Characterise differences between groundnut lines in ability to nodulate and fix nitrogen, and the effect of different Rhizobium strains (soil populations) on this response. (2) Select and cross promising material to see if nodulation and nitrogen fixation can be enhanced. (3) Monitor breeders material for ability to nodulate and fix nitrogen.

Methodology:

(1) Evaluate symbiotic characteristics of breeders crossing block material with single Rhizobium strains, in pot culture. (2) Assess whether a soil inoculum in pot (sand) culture can simulate the competitive effects of Rhizobium populations in soil. Monitor the symbiotic response of selected lines with Rhizobium populations in different soil types and geographical locations. (3) Examine nodulation andnitrogenase activity of lines from the groundnut germplasm collection grown in the filed. (4) Determine the heritability of host genes affecting nodulation responses. Select and cross promising material to see if nitrogen fixation can be enhanced and incorporated into lines with other desirable characteristics.

PRODUCTION ECONOMICS — Sub-program - Dr.J.G.Ryan Leader:

145. Project No.: EC-Prod-1(74)

Title: Studies of Traditional Farming Practices and Resource Availabilities in SAT India (77)

Project Scientists: H.P.Binswanger, N.S. Jodha.

Cooperators: Drs. M.von Oppen, V.S.Doherty, R.D.Ghodake, B.A.Krantz J.Kampen, J.C.Davies, V.S.Bhatnagar, W.Reed, R.W.Willey P.J.Dart, LFA Oyen, S.V.R.Shetty, G.E.Thirstein, Harbans Lal, P.N.Sharma, A.R.Sheldrake, Y.L.Nene; AICRPDA Scientists from Akola, Rahuri & Parbhani.

Objectives:

(1) To understand the reasons why SAT farmers farm the way they do and to identify constraints of a physical, biological and economic character which dictate what they can do. (2) To use the information in (a) to devise ways and means via research at ICRISAT, AICRPDA and elsewhere and via policies, which will alleviate these constraints and increase the pace of agriculture development in the SAT.

Methodology:

(1) Locate Investigators in each of two villages in each of the three chosen districts for a period of at least two years to monitor farming opeations in these areas by way of frequent visits to the selected farmers and landless labourers. (2) Carry out analyses of the collected data to provide answers to the hypotheses which have been formulated about the reaosns why farmers farm the way they do. (3) Complement the village studies with research at ICRISAT and in farmers' fields to find solutions to the constraints facing famrers.

EC-Prod-1(74) - Sub-projects

(i) Sub-Project No. EC-Prod-1(74)A

Title: Traditional farming practices

Sub-Project Scientists: Drs. N.S.Jodha, H.P.Binswanger

EC-Prod-1(74)A-I - Weed Research

Methodology: Tabulation of VLS data and budgeting of alternative weed control methods. Observational experiments in farmers fields to determine pay off to additional weed control.

EC-Prod-1(74)A-II - Resource base as a determinant of Cropping pattern.

Methodology: Tabulation of 1975-76 plot-wise collected cropping pattern data of sample farms in six villages during 1975-76 crop year. The cropping patterns were analysed with reference to the resource base of farmers and regions.

ii) Sub-project No - EC-Prod-1(74)B

Title: Resource availabilities and their allocation.

Sub-project Scientist: Mr. R.D. Ghodake

EC-Prod-1(74)B-1 - Rural Labor Markets

Methodology: Labor utilisation data from the cultivation and labor schedules in the village studies for 1975-76 were analysed to determine the seasonal deamnd for male and female labor on farms and also the seasonal supplies. The seasonal probabilities of employment were derived alongwith seasonal wage notes and opportunity costs of labour.

iii) Sub-project No. - EC-Prod-1(74)C

Title: Economic Performance of Traditional Farming Systems.

Sub-project Scientist: Dr. N.S. Jodha

Methodology: Household level income - expenditur data about various crop and other farm enterprises will be analysed. A comparative study of profitabilities of farming systems in different agro-climatic zones and across farm size gorups will be made.

iv) Sub-project No. - EC-Prod-1(74)D

Title: Diagnostic Technical/Biological Investigations at the Farm Level.

Sub-project Scientists & Cooperators: : Scientists from other programs and various Economics Staff.

Methodology:

Under the supervision of other ICRISAT scientists, the investigators in the villages have been undertaking a wide range of observations and measurements in farmers' fields. The aim has been to gain a better understanding of the incidence of pest, diseases and weeds, to study the extent of modulation of legumes, the reasons for poor chickpea germination, attitude to and performance of improved implements at the farm level.

v) Sub-project No. - EC-Prod-1(74)E

Title: The Social organisation of Economic Relationships in Indian SAT villages.

Sub-project Scientist: Dr. V.S. Doherty

Methodology:

Collect data concurrently with the VLS in economics, and at the same level of intensity, to enable anthropological and cross-disciplinary analysis of farmers' and agricultural labourers' economic strategies.

146. Project No: EC-Prod-2(74)

Title; Implications of Human Nutritional Status in the SAT for Research Strategies and Policies (78)

Project Scientist: Dr J.G. Ryan

Cooperators: Drs. V.S.Doherty, R.Jambunathan, Drs.S.G.Srikantia & Prahalada Rao of NIN Mrs. (Dr.) P. Pushpamma of HSC.

Objectives:

(1) To determine the existing availability of nutrients in the diets of people living in the SAT by utilising primary and secondary data. (2) To determine if the nutritional status of farmers and labourers varies seasonally and how this affects their health, labour utilisation pattern, and farming system. (3) To determine whether subsistence farmers are better off nutritionally than people with similar incomes who are not farmers. (4) To measure time allocation in rural households for activities related to food and fuel gathering and processing.

Methodology;

(1) In 1976-77 more secondary data from diet surveys were assembled and analysed to examine the present nutritional status of people living in SAT and to evaluate the impact of the green revolution in wheat in India on the production of pulses and nutrients. (2) In addition a major primary survey of the diet, nutrition and health status of the 240 families cooperating in the village studies was initiated in September 1976, with the collaboration of the National Institute of Nutrition and the Home Science College of APAU. Todate three rounds of data collection have been completed and several hundred goodgrain samples analysed by ICRISAT Biochemistry lab for protein content to enable precise estimates of consumption of this nutrient to be made (3) Medical doctors have examined the family members for evidence of clinical nutritional deficiency symptoms and have taken their anthropometric measurements and data on morbidity. (4) The diet survey team also have taken data on the household time allocation at the same time as they visit each household to obtain data on individual dietary intakes.

147. Project No: EC-Prod-3(75)

Title: Risk and Uncertainty in Semi-Arid Tropical Agriculture (77)

Objectives:

(1) To test the hypotheses that risk leads to severe under-investment in the semi-arid tropics (2) To suggest means for preventing under-investment if the hypothesis is true.

EC-Prod-3(75) - Sub-Projects

i) Sub-project No: EC-Prod-3(7_)A

Title: Objective Risk and I[n]put Use (78)

Project Scientist: Dr. B.C. Barah

Cooperators: Drs. H.P.Binswanger, NGP Rao, B.S.Rana, S.M.Virmani Robert Willie.

A-1 : Riskiness of Traditional and Modern Cultivars with All India Coordinated Sorghum Project Data: (a) Are modern cultivars more risky than traditional varieties? (b) Are hybrids more or less risky than varieties? (c) How large is weather risk as a component of total risk?

A-2 : Riskyness of Farming as a whole using district level data: (a) Classify areas on the basis of variability of gross returns of farming. (b) Decompose total variability into yield and price variabiiity. (c) Compute insurance component provided by diversified cropping. (d) Measure impact of infrastructure investments such as irrigation on riskyness.

A-3 : Intercropping and Risk: (a) Identify mechanism by which intercropping reduces risk. (b) Where and for whom is intercropping most powerful as risk reducer?

Methodology:

A-1 : Application of variance and covariance analysis models to AICRPDA sorghum yield trial data for 1972 to 1976 on around 60 cultivars and 50 locations, use of the same models on other yield testing data as they become available.

A-2 : Application of a variance decomposition model developed by B.C. Barah to adjusted production, yield and price data for Indian districts from the mid-fifties to the mid-seventies. Use of regression techniques on derived statistics to measure risk reduction effect of infrastructural investments.

A-3 : Use of a variance decomposition model in combination with experimental data on single crop yields over time and effects of stands on yields.

ii) Sub-project No: EC-Prod-3(75)B

Title: Attitudes and Behaviour(77)

Project Scientist: Dr. B.C. Barah

Objectives:

B-1 : Measurement of Risk Attitudes of Rural Households: (a) How are risk attitudes distributed? (b) Are poor people more risk averse than rich ones and by how much? (c) Are people in risky areas more risk averse than in assured areas? (d) Does risk aversion increase with the size of investment?

B-2 : Verification of Risk Attitude Results: (a) Are the measured attitudes correlated with farming behaviour (Intercropping, Commercialisation, Debt/Equity Ratio).

B-3 : How do farmers form Subjective Probability Distributions? (To be developed)

Methodology:

B-1 : Observe a sequence of real choice among a specified set of risky monetary payoff alternatives over 6 weeks. The alternatives are designed to classify individuals into 6 risk aversion classes. Regress the individual risk aversion scores on household characteristics.

B-2 : Test the consistency of the resulting risk aversion classification with real agricultural choices in the village level studies.

B-3 : Not yet determined.

iii) Sub-project No: EC-Prod-3(75)C

Title: Self-Insurance and Risk Diffusion(78)

Project Scientist: Dr. N.S. Jodha

Cooperators: Drs. H.P. Binswanger, V.S.Doherty

Objectives:

(1) What are the existing self-insurance and risk diffiusion mechanism (a) Cropping system (b) Credit (c) Storage (d) Asset Cycles (e) Relief Works (f) Social Structure.

(2) How good are they (a) for large farmers (b) small farmers (c) for laborers?

(3) Which ones can be strengthened at low cost?

Methodology:

Tabulation of results from Village Level Studies and other micro studies.

iv) Sub-project No: EC-Prod-3(75)D

Title: Research Investment and Institutional Implications(78

Project Scientist: Dr. H.P. Binswanger

Cooperators: Drs. B.C.Barah, N.S.Jodha

Objectives:

This is not a real project but mainly a write-up job. It will involve fitting the results of subprojects A to C together and into the risk literature.

148. Project No: EC-Prod-4(74)

Title: Economic comparison of Human, Animal and Mechanical power sources (77)

Project Scientists: Drs H.P. Binswanger, G.E. Thierstein

Cooperators: Dr. J.G. Ryan, R.D. Ghodake, Harbans Lal

Objectives:

(1) Assessment of economic studies on mechanisation in developing countries with special emphasis on SAT areas. (2) Characterise power and implement situation in VLS villages. (3) Linear Programming Analyses of Demand for various equipment in SAT.

Methodology:

Literature surveys, historical studies, visits to Agricultural Engineering Departments and agricultural Engineering Departments and agricultural machinery firms, linear programming studies, analysis of VLS data.

149. Project No: EC-Prod-5(74)

Title: Economics of Prospective Technologies for SAT(78)

Project Scientist: Dr. J.G. Ryan

Cooperators: Drs. M.Pereira, R.Sarin, B.A.Krantz, J.Kampen, S.M. Virmani, P. Pathak, M.von Oppen, H.P.Binswanger.

Objectives:

(1) The aim is to carry out economic analyses of experiments conducted at ICRISAT and elsewhere on small plots and on larger catchments with a view to identifying promising technologies and practices and to guide decisions about future experimetns. Particular stress is laid on the watershed experiments and those related to 'Steps in improved technology"
(2) To assess the potential for water harvesting and supplementary irrigation using empirical models derived from results of agronomic and hydrologic experiments at ICRISAT and elsewhere.

(Cont'd...)

Project No: EC-Prod-5(74)
(Cont'l. .)

Methodology.

(1) The Research Technician at Patancheru with the assistance of the Farming Systems Scientists and their field supervisory staff, continuously monitors inputs-outputs involving materials, human and bullock labour, mechanical power etc., on the large watershed based experiments. The collected data are summarised weekly by the research technician, then checked by the Farming Systems scientists and then analysed. This year samples of the produce were regularly taken to the market to obtain more accurate information on prices for use in the economic assessments. (2) The rainfall-runoff portion of the model is derived from experimental results and historical rainfall distributions are used to generate a distribution of runoff availabilities for different soils throughout the year over a long period of years. Agronomic experiments and crop cutting data from the Bureau of Economics and Statistics are used to derive the relationships between crop yields and moisture stress. Then historical rainfall distributions are used to derive distributions of stress. When integrated with the runoff distributions the distribution of payoff from water harvesting and supplementary irrigation can be calculated.

150. Project No: EC-Prod-6(74)

Title: History and Economics of Existing Tank Irrigation In India (77)

Project Scientist: Dr. M. von Oppen

Cooperators: Drs. K.V.Subba Rao, S.M.Virmani, J.Kampen, H.P.Binswanger.

Objectives

Explanation of regional differences in the density of existing tank irrigation as a function of physical, historical and economic features of the region; measurement of the economics of traditional tank irrigation systems, and evaluation of the possibilities for technical and economic improvements in these traditional systems.

Methodology:

Tanks are selected from areas with different rainfall, soil, history and economic conditions. Collection of data on water management practices, production economics, and details about the history, size and cost of construction of each tank, Calculation of benefit-cost ratios of selected tanks. Regression analysis of district-wise data to explain density of tank irrigation as a function of such variables as soils, geology, rainfall distribution, history, land tenure systems, etc.

EC-Prod-6(74) - Sub-projects

i) Sub-project No: EC-Prod-6(74)A

Title: History and Determinants of Tank Density in SAT India (77)

Project Scientist: Dr. M. von Oppen

Methodology:

Multivariate regression analysis with density of tank irrigation expressed as a function of physical variables, using data of 166 districts in SAT India; subsetting of data for districts formerly under princely rule and under British rule and F-test of the significance of difference.

ii) Sub-Project No: EC-Prod-6(74)B

Title: Economics of Existing Tank Irrigation in SAT India.

Project Scientist: Dr. M. von Oppen

Methodology:

Interviews of 8 randomly selected farmers from each of 32 tanks surveyed in Telangana, Rayalaseema and Maharashtra; collection of secondary cost of tank construction, size of the tanks, utilisation of the command area and rainfall over ten years.

151. Project No: EC-Prod-7(75)

Title: Approaches to group action and organisation for improved land and water resource utilisation in the SAT (77)

Project Scientist: Dr. N.S. Jodha

Cooperators: Drs. V.[illegible]Doherty, B.A.Krantz, J.Kampen, P.N.Sharma.

Objectives:

Examine the feasibility and means of implementation of group action and organisation for improved watershed-based farm technology in SAT areas, with special reference to India. To identify those components of prospective catchment-based systems which require group action and those which do not. To identify the elements for incorporation in the prospective technology which can induce group action. To identify technological and institutional alternatives to voluntary group action if the latter's transactions costs prove to be excessive.

(Cont'd...)

Project No: EC-Prod-7(75)
(Cont'd...)

Methodology:

Literature review of the theoretical aspects of group action problems as well as of case studies of successful and unsuccessful group activities in the past. Inventory of requirements of prospective new technology and the existing economic and institutional factors dictating land and water management at present. Case study micro-analyses of actual watersheds will be made where watershed-based systems are superimposed on existing land use patterns to examine the implications of adoption of such a system on land tenure, benefit-cost sharing etc., and to judge the value and desirability of group action to adequately harness the full benefits. Collaboration with DPAP, AICRPDA and other agencies which are implementing watershed-based systems will enable field-level observations on group action problems and potentials. Economic and anthropological analysis will be used.

MARKETING ECONOMICS — Sub-program Leader: - Dr. M. von Oppen

152. Project No: EC-Mark-1(74)

Title: Evaluation of relevant economic characteristics of legumes and cereals in the SAT (78)

Project Scientist: Dr. M. von Oppen

Cooperators: Drs. R.Jambunathan, H.P.Binswanger, J.G.Ryan, L.R.House, D.J.Andrews, J.M.Green.

Objectives:

Identification of relevant quality characters and quantification of their impact on consumer preferences for four ICRISAT food grains in India and in other countries, in order to develop screening methods for qualities, which ensure good consumer acceptance of new varieties.

Methodology:

(1) Ranking of samples by consumer panels (2) Hypothetical pricing of grains by traders. (3) Analysis of market samples explaining variability of prices as a function of variations in quality characteristics.

153. Project No: EC-Mark-2A(75)

Title: All India market channels (78)

Project Scientist: Dr. V.T. Raju

Cooperators: Drs. J.G.Ryan, H.P. Binswanger

Objectives:

To describe the market channels of the five ICRISAT crops in different regions of India and to compare and analyse typical features; to measure marketing costs, identify services and to determine efficiency criteria; to explain market efficiency as a function of organisational, infrastructural and other factors.

Methodology:

Surveys are conducted in 35 markets in 9 SAT States which are determined statewise on the basis of proportional production of ICRISAT crops and sampled randomly for each state according to the probability proportional to size and such that at least about 25% of market arrivals is from ICRISAT crops. Collection of secondary data from the market committees and traders interviews generates information and commodity flows, costs, prices and operation of market committees.

154. Project No: EC-Mark-2B(75)

Title: Rural marketing system in Mahbubnagar district (78)

Project Scientist: Dr. F. Pesneaud

Cooperators: Drs. T.V.Rao/AERC, J.G.Ryan, H.P.Binswanger.

Objectives:

Assessment of the influence of market access on economic performance of farmers of different size groups, within the network of 3 selected markets in Mahbubnagar district.

Methodology:

After having surveyed the district, three markets in adjacent areas were selected and their catchment areas determined. On the basis of village-wise data on cropping systems, about 30 villages of similar size, soil and irrigation conditions will be selected strategically in different locations to these markets. Surveys of the villages and farm surveys in a selected sub-sample of the villages will generate the information needed on input use, adoption of new technologies and productivity.

155. Project No: EC-Mark-3(75)

Title: Estimates of supply and demand elasticities of ICRISAT crops in India (78)

Project Scientist: Dr. S.L. Bapna

Cooperators: Dr. H.P.Binswanger

Objectives:

To estimate the regional and aggregate demand and supply elasticities of SAT crops with special reference to sorghum, pearl millet, pigeonpea, chickpea and groundnut in eight SAT states of India.

Methodology:

Multiple regressions using various price, weather and technological variables on the pooled data of time series of different districts. Estimation method is generalised least squares using error component model. This method is expected to give relatively precise estimates of supply response parameters if compared to any other of the approaches that have been used in the past.

156. Project No: EC-Mark-4(76)

Title: Agricultural marketing, Regional specialisation and Aggregate productivity (79)

Project Scientist: Dr. M. von Oppen

Cooperators: Drs. J.W.Estes, J.G.Ryan, H.P.Binswanger, S.L.Bapna, V.T.Raju, B.C.Barah.

Objectives:

(1) Quantification of the effects which restrictions of the flows of foodgrains among separate regions have on crop allocation, and on aggregate productivity. (2) To develop methods for measuring the degree to which aggregate agricultural productivity in a particular set of regions (e.g. districts) depends upon the prevailing infrastructure and organisational framework which determines the functioning of the marketing system.

Methodology:

(1) Mathematical formulation of spatial equilibrium models, involving different regions with different comparative advantages for growing several crops. (2) In a first approach aggregate yield of foodgrains in districts of Andhra Pradesh was explained as a function of inputs as well as of density of markets and of roads.

FARMING SYSTEMS

AGROCLIMATOLOGY

Sub-program Leader: Dr.S.M.Virmani

157. Project No: FS-Cl-1(77)

Title: Collection and Interpretation of Climatic Data of Semi-arid Tropics (80)

Project Scientist: Dr. S.J. Reddy

Cooperators: Drs. S.M.Virmani, M.V.K.Sivakumar, C.Charreau

Objectives:
(1) Collection of the basic meteorological data for research stations that are of interest to ICRISAT research programs. (2) Collection, computerisation of long period base line data. These are needed for (a) Characterisation of the moisture environment, (b) Climatic classification studies of semi-arid tropical regions.

Methodology:

(1) Collection of basic meteorological data for some research stations tat are of interest to ICRISAT - At present the following elements are being collected at ICRISAT research center: (a) Rainfall data over the farm (40 gaingauges), (b) Air temperatures (Max, Min, Dry-wet bulb, Thermograph), (c) Relative humidity (Hygropgrah), (d) Hours of bright sunshine, (e) Wind speed and direction, (f) Open pan evaporation, (g) Dew, (h) Soil temperatures, (i) Microclimatic measurements (dry and wet bulb tempratures), (j) Global radiation, net radiation, automatic wind recording instruments in very near future.

(2) Long term climatic data (a) Rainfall, (b) Pan evaporation, (c) Temperature, (d) Relative humidity, (e) Sunshine (f) Wind speed) will be acquired from the National and International agencies for the semi-arid tropics of concern and will be stored on tapes at ICRISAT computer system.

(3) A quantitative understanding of the climate of different agroclimatic regions is essential for establishing guiding parameters for developing sound farming systems and crop improvement research. In order to deliniate homogeneous zones (climatic classification) for five ICRISAT crops (bio-climatic classification) methodologies are being developed.

158. Project No: FS-Cl-2(77)

Title: The quantification of moisture environment for crop growth(80)

Project Scientist: Dr. S.M. Virmani

Cooperators: Drs. S.J.Reddy, M.V.K.Siva Kumar, M.B.Russell, J.Kampen, J.G.Ryan, H.P.Binswanger, N.S.Jodha.

Objectives:

To prepare and evaluate computer simulation techniques to quantify moisture environment from the rainfall, evapotranspiration and soil factors for prediction of optimal cropping systems in semi-arid tropical areas.

Project No: FS-C1-2(77)
(Cont'd...)

Methodology:

A computer simulation technique to quantify the moisture environment from precipitation, ET and soil moisture storage capacity data has been tested for one season (1976-77). The model is now being refined by improving the water balance components.

Project No: FS-C1-3(77)

Title: Microclimatological and crop phenological investigations in the crop canopies (80)

Project Scientist: Dr. M.V.K. Sivakumar

Cooperators: Drs. S.J.Reddy, Sardar Singh, N.Seetharama, G.Alagarswamy, S.M.Virmani, R.W.Willey, F.R.Bidinger, M.B.Russell.

Objectives:

(1) To collect and maintain data on the microclimatic parameters in crop canopies under different treatments. (2) To study the thermal characteristics of different crop canopies under varying degrees of moisture stress. (3) To evaluate the degree of differences in the light attenuation patterns in different crop canopies in the watersheds. (4) To characterise and quantify moisture stress effects using plant water stress indicators such as leaf-water potential, stomatal conductance and leaf-area. (5) To ascertain the relationship between ET/Eo and leaf-area index and dry matter. (6) To evaluate different methods of measuring evapotranspiration under field conditions. (7) To develop crop growth stage coefficients in the caseof intercrop situation.

Methodology:

(1) Measurements of Albedo, photosynthetically active radiation and net radiation incident on the crop surface will be made during the crop growing season. (2) Extinction of photosynthetically active radiation and net radiation with height in a crop canopy will be followed at several stages during the growing season. Using leaf area index values, light models will be developed for possible use in total crop models and crop growth stage coefficients. (3) Vertical profiles of temperature, relative humidity and wind will be monitored during the growing season. Measured soil heat flux values will be used with the above measurements to estimate actual evapotransipiration by the energy balance appraoch. Evapotranspiration would also be estimated by means fo the resistance approach, and the degree of errors involved in different methods would be ascertained. (4) Detailed measurements on the seasonal and diurnal variations in the stomatal conductance leaf-water potertial and the seasonal variations in leaf area; would be used to quantify the effects of water stress. (5) The simple ratio of evapotranspiration to Open Pan Evaporation (ET/Eo) would be used along with growth indices such as leaf-area index and dry matter production to develop simple methods of predicting relative water use patterns of different crop canopies.

160. Project No: FS-C1-4(77)

Title: Studies on crop-weather interactions; sorghum, pearl millet, chickpea, pigeonpea and groundnut(80)

Project Scientist: Dr. M.V.K. Sivakumar (Dr. A.K.S.Huda)

Cooperators: Drs. S.M.Virmani, S.J.Reddy, J.Kampen, B.A.Krantz, R.W.Willey

Objectives:

(1) The main objective of the crop-weather interactions project is to provide basis for crop-weather modelling program. (2) Development and validation of simulation models based on available field data regarding the physiological response of field crops to changing crop climatic environment.

Methodology:

(1) Climatic data collected for various ICRISAT crop growing areas around the globe will be analysed for important constraints and growth limiting factors. (2) Detailed phenological data available at ICRISAT and elsewhere, will be used to illustrate the effect of climatic factors on ICRISAT crops productivity. (3) Yield data available at several locations will be used to examine the yield fluctuations with regard to changes in important climatic parameters.

SOIL PHYSICS

Sub-program Leader: Dr.M.B.Russell (Acting)

161. Project No: FS-SP-1(77)

Title: Physical characterization of red and black soils (80)

Project Scientist: Dr. Piara Singh

Cooperators: Drs. Sardar Singh, J.Prabakar.

Objectives:

(1) To determine the bulk density, the moisture characteristic curve and unsaturated hydraulic conductivity throughout the zone of rooting for the principal soils of the ICRISAT station. (2) To evaluate alternative methods for in-situ measurement of soil moisture. (3) To evaluate alternative methods of determining the $K = f(\psi)$ function under field conditions.

(Cont'd...)

Project No. FS-SP-1(77)
(Cont'd...)

Methodology:

The bulk density and volumetric water content and their standard deviations have been detemrined to a depth of 180 cm in the ceep Vertisol in the pre-monsoon period. Similar measurements will be made at the end of the monsoon and at the end of the rabi season.

Tensiometers have been installed at 30 cm intervals to depth of 180 cm to measure the seasonal changes in the hydraulic gradients at various depths during the monsoon and post-monsoon periods in both the deep Vertisol and the deep red soil at the ICRISAT station.

Extensive sampling with the hydraulic coring machine have been made in the deep black soil in an effort to improve the calibration of the neutron probe. Similar work is planned for the deep red soil.

The moisture characteristic curve in the zero to 0.5 bar range will be established by in situ measurements of soil moisture tension and volumetric water content.

Alternative methods will be evaluated for root sampling of soil moisture in very wet and in gravelly and stony soil profiles.

Alternative methods for in situ measurement of the $K = f(\theta)$ function will be evaluated.

162. Project No: FS-SP-2(77)

Title: Soil-plant-water relationship and water blance studies.(80)

Project Scientist: Dr. Sardar Singh (Vertisols
Dr. Piara Singh (Alfisols)

Cooperators: Drs. F.J.Bidinger, J.Kampen, M.V.K.Sivakumar, P.Pathak.

Objectives:

(1) To make a detailed seasonal water balance of a deep black soil and of medium deep red soil. (2) To determine direction and magnitude of moisture flux at various depths in red and black soils. (3) To determine relationships between ET/EO and soil and water potentials. (4) To study the relationship between ET/EO and dry matter, L.A.I. and plant height for kharif and rabi crops.

(Cont'd...)

Project No. FS-SP-2(77)
(Cont'd...)

Methodology:

A. Alfisols - All the plots will be diked by 6" high bunds to completely check the runoff. Each plot will have four access tubes and tensiometers upto 180 cm. depth. Periodic observations - will be taken of soil moisture and soil moisture tension at various depths. Rainfall will also be recorded to have complete information on various water balance components. Sorghum will be planted. Plant samples will be taken periodically to determine the dry matter production as a function of time in various treatments. This will be compared to fallow.

B. Vertisols ; Five plots 19 m x length of row (about 75 m) on 150 cm beds in BW3 will be selected for the experiment. The cultivation, fertilisation and other cultural operations would be the same as in other areas of the watershed BW3. Runoff will be measured from each plot by V-notch wiers and water stage recorders. 24 access tubes in each plot - 4 in each (9 x 20 meter sub-plot) and 3 sets of tensiometers 15, 30, 60, 90, 120, 150, 180 cm depth in each plot - centered in 3 of the sub-plots will be installed.

For the kharif the five plots (2 maize, maize + pigeonpea, sorghum and fallow) will be treated as whole plots for water balance studies. In rabi the sub-plots with tensiometers will be used for the + irrigation treatments.

During the rainy season $O_V f(z, t)$ will be measured with probe during profile recharge phase and with tensiometers thereafter. 0-20 cm layer will be sampled gravimetrically. Dry matter, LAI are being determined at various physiological stages of the crop. Similar observations on moisture, dry matter and LAI will be continued in rabi season.

SOIL FERTILITY & CHEMISTRY — Sub-program Leader: Dr.B.A.Krantz

163. Project No: FS-SFC-1(78)

Title: Nitrogen balance investigations in major soils of SAT(80)

Project Scientist: Dr. T.J. REgo

Cooperators: Drs. K.L.Sahrawat, M.B.Rusell, J.Kampen, P.J.Dart.

Objectives:

(1) To study the annual nitrogen inputs into the soil-plant-water system including nitrogen fixation, mineralisation of plant residues and nitrogen application. (2) To investigate the fate of nitrogen including utilisation by plants, losses by runoff, leaching and denitrification. (3) To develop management systems which will minimize losses, minimize fertiliser nitrogen utilisaion and better crop production.

(Cont'd...)

Project No: FS-SFC-1(78)

(Cont'd.)

Methodology:

(1) A few selected treatments of 'steps in improved technology' experiments will be sampled at biweekly intervals during the crop season up to a depth of 90 cm in addition to the sampling of before and end of the crop season. These samples will be subjected to various chemical analysis like available N, No_3 - N, mineralisable N_{15} . These values will be correlated with crop growth. Based on the above results N enriched residues will be used for further detailed study in this direction. (2) Analyze runoff samples to assess differential nutrient losses under different management system. (3) Develop experiments to test possibleways of minimizing nutrient losses and maximizing utilisation nitrogen utilisation in crop production.

164. Project No: FS-SFC-2(75)

Title: Soil fertility management and fertilisation investigations in major soils of the SAT (80)

Project Scientist: Dr. T.J. Rego

Cooperators: Drs. M.B.Russell, R.W.Willey, K.L.Sahrawat, S.K.Sharma J.G.Ryan.

Objectives:

General: To determine, in cooperation with national programs, the biologically and economically optimum soil fertility management and fertilisation program for important cropping systems in soils of the SAT.

Specific: (1) To study systems of management of residues and organic wastes which will achieve near optimum production with a minimum of chemical fertilizer. (2) To study fertilisation of legume - nonlegume cropping systems which will facilitate utilisation of sixed nitrogen. (3) To determine the amount of the N fixed by pigeonpea, chickpea and groundnut that contribute to companion intercrops or sequential sorghum, millet or maize crops.

Methodology:

(1) Experimetns would involve management of crop residues and organic wastes in different intercropping systems involving legume and nonlegumes as components of system at different fertility levels. (2) Field trials also will be conducted to find out the response of sorghum and millet to different levels of N in an intercropping system with legumes such as pigeonpea and grounndut. (3) In order to find out the N fixed pigeonpea, chickpea and groundnut experiments will be established on both Alfisols and Vertisols and after their harvest sorghum and millet will be grown with eifferent rates of N to assess the nitrogen contribution of the legume. (4) Trials are in progress involving low cost plant nutrient materials like rockphosphate, FYM etc. (5) Pot culture studies will also be conducted to supplement the above field trials.

FARM POWER & EQUIPMENT

Sub-program Leader: Dr.G.E.Thierstein

165. Project No: FS-FPE-1(77)

Title: Machinery Management for Improved Farming Systems (80)

Project Scientist: Dr. Harbans Lal

Cooperators; Drs. M.C.Klaij, R.K.Bansal, B.A.Krantz, J.G. Ryan

Objectives:

(1) To determine the factors effecting field efficiencies of various machines. (2) To determine the factors effecting field capacities of various machines. (3) To determine the operating and owning costs of various machines. (4) To assess the feasibility of using very simple, low cost machines for improved management systems.

Methodology:

(1) Experiments are being conducted to quanitfy the effects of various parameters such length of run, bullock size, draft etc., on the actual field capacities of various machines. The available mathematical models will be tested to predict the field capacities of different machines based on the results of the above experiments and if required new models will be developed. (2) Time study experiments will be conducted under controlled condition for various operations, to obtain reliable economic information on the number of hectares which can be handled by one or two tool carriers and one set of attachments. (3) Experiments are being conducted to determine the feasibility of using simple locally available to implement the wide bed system.

166. Project No: FS-FPE-2(77)

Title: Development of improved tillage, planting and intercultural practices (80)

Project Scientist: Dr. M.C. Klaij

Cooperators: Drs. M.B.Russell, F.P.Huibers, S.V.R.Shetty, Harbans Lal, R.K.Bansal.

Objectives:

(1) To establish tillage requirements for improved cropping systems with special reference to seedbed preparation. (2) To evaluate tillage practices in terms of (a) soil reaction to tillage tools (b) Plant-soil interactions (c) Efficiency of tillage operations and tools. Traditionally, tillage is a high user of energy and time in the production of annual crops. Intensification of crop production using comparatively high value inputs must go hand in hand with alternative tillage practices that are time and energy saving.

Methodology:

(1) Comparing seedling emergence of a set of either controlled or known environmental pertinent soil data with actual field emergence obtained by different seeding practices. (2) To monitor pertinent soil parameters throughout the year on watersheds. (3) To measure the amount and nature of soil manipulation and the forces to cause it. (4) To assess the effect of different primary tillage methods and subequent mechanical seeding on crop response. (5) Laboratory and field tests of planters and fertiliser distributors.

167. Project No: FS-FPE-3(78)

Title: Harvest and Post-Harvest Technology (80)

Project Scientist: Dr. O.P. Singhal

Cooperators: Drs. Harbans Lal, R.K.Bansal, M.C.Klaij, S.K.Sharma, D.A.Krantz.

Objectives:

To solve the problems of early and quick harvesting and on farm storage of rainy season crops related to intercropping, relay cropping and sequential cropping and also those of post-rainy season crops to facilitate early tillage during the dry season.

Methodology:

(1) Climatic and soil moisture data will be analysed to determine probable effective field working days available for the removal of crops and conditions favouring crop preservation. (2) Physical properites affecting harvesting and threshing of crops used in the FSRP will be assessed. Machinery will be evaluated accordingly. (3) Preservation and on farm storage of crops will be investigated with emphasis on cost and loss reduction

168. Project No: FS-FPE-4(77)

Title: Design and Development of Farm Machinery (80)

Project Scientist: Dr. R.K. Bansal

Cooperators: Drs. M.C.Klaij, Harbans Lal

Objectives:

(1) Modify existing equipment to improve its functional capabilities
(2) Modify existing equipment to utilise locally available material.
(3) Design and construct prototypes of selected equipment
(4) Design and construct testing equipment.

Methodology:

(1) The performance of each machine under consideration will be scrutinised and modified accordingly to improve its functional capabilities. The modified equipment will be evaluated both in red and black soils. (2) Locally available materials will be incorporated in all designs wherever possible keeping in view cost, strength, weight and durability. (3) Machines which have shown potential will be redesigned to be made with the local materials and manufacturing techniques. The prototypes will be further evaluated both in red and black soils. (4) New machines/attachments will be designed and after drawings are completed prototypes will be built and tested.

CROPPING SYSTEMS — Sub-program -Dr. R.W.Willey Leader:

169. Project No: FS-Crop.Sys-1(77)

Title: Crop physiology studies in intercropping (80)

Project Scientists: Drs. M.S.Reddy, M. Natarajan

Cooperators: Drs. M.B.Russell, Piara Singh, Sardar Singh, M.V.K.Sivakumar.

Objectives:

To examine patterns of growth and development and the use of growth resources by intercropping situations to identify ways of bringing about yield improvements. Combinations to be studied in 1978 - sorghum/pigeonpea, pearl millet/groundnut.

Methodology:

Detailed growth studies measuring T.D.M., L.A.I. and root distribution at weekly intervals; also measurement of nutrient uptake light interception and water use.

170. Project No: FS-Crop.Sys.2(76)

Title: Agronomic studies in intercropping (80)

Project Scientist: Dr. M.R. Rao

Cooperators: Drs. B.A.Krantz, D.J.Andrews, J.M.Green, R.W.Gibbons, L.R.House, D.Sharma, P.J.Dart, T.J.REgo.

Objectives:

To examine the agronomic relationships of plant population/spacing, nutrient and water availability, genotype, N.fixation and yield stability in intercropping: Four intercropping situations will be studied : Sorghum/pigeonpea, pearl millet/groundnut, pearl millet/sorghum, and sorghum/chickpea.

Methodology:

Field experimentation, putting considerable emphasis oni mproving experimental designs and field layout.

171. Project No: FS-Crop.Sys.3(75)

Title: A study of double cropping by means of relay, sequential or ratoon systems (80)

Project Scientist: Dr. M.S.Reddy

Cooperators: Drs. B.A.Krantz, T.C. Jain.

Objectives:

To examine the feasibility of taking two crops per year on both Vertisols and Alfisols.

Methodology:

Field experimentation with small plots, but which are large enough to give reasonably valid estimates of yield in the vairous systems.

PRODUCTION AGRONOMY — Sub-program Leader: Dr. B.A.Krantz

172. Project No: FS-Prod.Agron.1(78)

Title: Investigations on the factors affecting Crop-Weed balance (80)

Project Scientist: Dr. S.V.R. Shetty

Cooperators: Drs. R.W.Willey, M.B.Russell, M.V.K.Sivakumar, [illegible].Huibers, T.J.Rego.

Objectives:

General: To quantify the effect of physical, cultural and biological factors affecting Crop-Weed associations in the semi-arid tropics.

Specific: (1) To classify the plant associations and to determine the trends of total weed populations under different improved management systems, in comparison with traditional systems. (2) To investigate various processess involved in the perpetuation of weed species in different farming systems - Factors affecting weed seed germination and seedling establishment. (3) To investigate the affect of environmental factors such as light and water upon selected weeds of SAT.

Methodology:

Field and laboratory studies to study the biology of weeds in alternate crop, soil and water management systems:
(a) Phyto-sociological studies on SAT weeds through field weed surveys with quadrats in different crop fields and the calculation of abundance, density and frequency of occurrence of different weeds in different seasons.
(b) Long term monitoring of the weed populations in contrasting management systems in the field, as well as in the lab by taking soil samples each year during the dry season and growing out as many seedlings as will germinate over a prolonged period with repeated soil disturbance and alternate wetting and drying.
(c) Laboratory studies on weed seed germination under varying conditions (water supply, temperature, light etc.) to determine possible cause of dormancy - permeability of seed coats, temperature and light requirements, germination inhibitors etc. Evaluation of various methods to enhance the germination of weed seeds.
(d) Field studies involving varying levels of shading with different crop combinations as well as artificial means (Bamboo thatches) to determine the effect of light on the growth of some selected weeds associated with crops.

173. Project No: FS-Prod.Agron.2(75)

Title: Development of effective weed management systems for the semi-arid tropics (80)

Project Scientist: Dr. S.V.R.Shetty

Collaborators: Drs. R.W.Willey, M.R.Rao, M.S.Reddy, G.E.Thierstein, L.R.House, J.M.Green, K.B.Singh, R.W.Gibbons, D.J.Andrews, J.G.Ryan.

Objectives:

General: To develop effective alternate improved weed management systems for the major SAT crops and Cropping systems.

Specific: (1) To further examine the possibility of the use of pre-emergence herbicides and other physical and biological methods on the deep Vertisols during monsoon season. (2) To evaluate the relative merits and demerits of the available hand weeding tools in respect to weed spectrum, weed size, stimulations of further weed germination, soil type, soil wetness and their relative ease of operations. (3) To determine the weed competitiveness and herbicide tolerance of different cultivars of major ICRISAT crops. (4) To develop information and understanding ofcrop, soil, climatic and social situations in which improved weed management could have t-e greatest impact in SAT world.

Methodology:

(1) Conduct field experiments to evaluate different methods of weed control - physical, biological and chemical, on different cropping systems - inter, sequential and ratoon cropping. (2) Conduct field experiments to examine the weed competitive ability of different cultivars of major ICRISAT crops (initially, sorghum and groundnuts) and cropping systems. The treatments include varying densities of crop and weed population. (3) Conduct herbicide screening trials to identify the optimum rates of commonly used herbicides on SAT crops and cropping systems and to determine the susceptibility of major weeds to herbicides. (4) Survey on-farm weed situations in agroclimatically different locations. Various treatments will be superimposed on the farmers' fields; the treatments include farmer's method, improved weed management method and weed free environment. (5) Collection of the available hand weeding tools and implementing time and motion study with these tools under different conditions.

Project No: FS-Prod.Agron.3(77)

Title: Forage, Fodder and fuel crops investigations (80)

Project Scientist: Mr. S.K. Sharma

Cooperators: Drs. R.W.Willey, G.E.Thierstein, P.J.Dart, LJG van der Maesen.

Objectives:

General: To develop a forage, fodder and fuel crop program to complement [illegible] improvement and resource management program in ICRISAT.

Specific: (1) To evaluate promising forage legumes and grasses for longevity, rapidity of regrowth at start of monsoon, soil erosion control, production of palatable forage, and ability to tolerate grazing pressure during the dry season. (2) To determine the biological and economic feed value of crop fodders from under various farming systems. (3) To study the annual and long term shifts in grasses, legumes and other species in the natural revegetation plots in RW3A (Alfisols) BW-11A(Vertisols)

Methodology:

(1) Evaluation of promising grass and legume species adapted to SAT conditions (a) A nursery with 214 entries (grass and legume) was planted in a Vertisol in December 1976. (b) A similar nursery was planted in an Alfisol in early monsoon season of 1977. (c) Laboratory studies on forage seed dormancy and longevity will be started in 1978.

(2) Preliminary trials using three levels of grazing pressure will be established in the waterways of Alfisols and Vertisols watersheds during the dry season to determine the ability of various species to withstand grazing.

(3) In the natural revegetation plots (RW3E and BW-11A) the following investigations will be conducted: (a) Identification of all species and approximate proportion of each by transect methods at three permanent marked locations in each watershed unit. These readings will be taken twice a year (May and September). (b) Total dry weight of biomass taken at random spots at the end of the rainy season. (c) Detailed photographic record taken in May and September each year. (d) Small plots were established at the onset of the monsoon in 1977, to study effect of phosphorus application and forage crop management upon possible shift in botanical composition of native vegetation.
These plots would occupy only a small proportion of the watershed units so that it would not have any appreciable effect upon hydrologic measurements involving runoff and soil erosion.

(4) In cooperation with the farm power and equipment sub-program, investigation will be initiated to develop the improved methods of harvesting and handling fodder in various farming systems.

(5) Information on desirable fuel, fodder and lumber of trees will be obtained from national programs when needed.

175. Project No: FS-Prod.Agron.4(75)

Title: Agronomy investigations on an operational-scale (80)

Project Scientist: Mr. S.K.Sharma

Cooperators: Drs. J.Kampen, J.G.Ryan, S.M.Virmani

Objectives:

General: To develop information on the effect of stepwise implementation of various facets of improved technology as a means of making the best use of the available water under rainfed conditions of various areas of the semi-arid tropics.

Specific: (1) To investigate the effect of stepwise increments of various facets in the transfer of improved technology o f the red and black soils at ICRISAT. (2) To perform complete economic analyses on practices, inputs and outputs involving the implementation of various steps in the transfer of technology. (3) To explore new production practices for possible inclusion for the implementation of improved technology for SAT. (4) In cooperation with national programs at suitable 'bench mark' locations to investigate the important steps in technology for the given agroclimatic region.

Methodology:

Experiments to be conducted in 1978-79 season:

(1) Experiment involving steps in technology viz., varieties, fertilization, soil and crop management and water management in red soils (RW3 F&G) using sorghum and pigeonpeas in an intercrop system.

(2) Experiment on black soils (BW8C) involving steps in technology with using maize and pigeonpeas as the test crop.

The treatment combinations were worked out coopratively with the Economics staff and economic analyses will be made by Economic staff. The crops grown will be rotated to avoid build up and diseases and insects to provide information on a variety of crops. Large scale plots will be used to allow for bullock operations with both improved and local implements and to facilitatte economic analysis.

Operational scale trials using bullock drawn implements will be established within watershed units. The investigations will study optimum means of establishment of relay, sequential or intercrop systems on an operational scale.

LAND & WATER MANAGEMENT

Sub-Program Leader: - Dr. J. Kampen
Dr. M.B.Russell (Acting)

176. Project No: FS-LW-1(75)

Title: Resource utili . ion under present management practices (80)

Project Scientists: Drs. F.P.Huibers, P.Pathak

Cooperators: Drs. J.Kampen, B.A.Krantz, S.K.Sharma

Objectives:

General: To study crop production potentials under presently applied land and water management and utilisation practices; an evaluation of the effects of these practices on runoff, soil erosion, drainage, water conservation and rainfall use efficiency in a few distinct agroclimatic regions.

Specific:

To determine the effects of the existing practices of contour bunding by (a) establishing the relation between extent of water-ponding near bunds and the crop-yield in kharif and rabi season (b) executing a water balance-study near one contour bund. (c) looking at the influence of water ponding on groundwater level across a bund.

To evaluate the efficiency of traditional water storage facilities (tanks) and to determine alternative strategies for improvement of existing tanks and water utilisation. (a) To measure the water storage and water use efficiency of existing irrigation tanks. (b) To generate technology facilitating more efficient storage and utilisation of existing runoff water storage facilities.

Methodology:

A. Moisture conservation effects of contour bunding and the relationships thereof to yields:

It is assumed that the moisture conservation effects of bunds are highest near the bunds and decrease at greater distance from the bunds. Therefore, the moisture status and yields are evaluated in relation to the distance to the contour bund; yield samples are taken at places which represent the spreage affected area below a bund, the borrowpit area, the temporarily submerged area, the area near the submerged zone and the area in which there are presumably no moisture conservation effects. Because in some cases more than one crop is grown above the same bund the yields of different crops are converted to money - value for comparison. The sample size is 1.5 x 4 m. The average yields in the bund affected areas are determined and the reduction or increase in yield level calculated in relation to the yields measured outside the affected zone.

The effects of contour bunds are expected to vary greatly under diverse agroclimatic conditions. Therefore, similar investigations in other environments have been initiated. Initially the drier zones on black soil and wetter areas on black soil have been selected.

(Cont'd....)

Project No: FS-LW-1(75)

(Cont'd ...)

Methodology:

Water-balance study will be executed. Volume of stagnating water will be measured near all bunds; evaporation pans are placed near 2 bunds and a line of 14 piezometers at depths of 1.50 m and 2.50 m placed across one bund in which will indicate the influence of the stagnating water on the (perched) water table.

B. Evaluation of existing tanks:

The collection and use of collected runoff water is an important area for research. Tanks are widespread in the Indian semi-arid tropics. Water balance investigations of existing runoff collection facilities and studies on the utilisation of available water resources in selected catchments under on-farm conditions will, in cooperation with the Economists of ICRISAT, be initiated soon. The components of the water balance will be measured using rainguages, flumes, evaporation pans etc. Yields will be determined through sampling.

Project No: FS-LW-2(75)

Title: Development of improved land and water management technology (80)

Project Scientist: Dr. F.P. Huibers

Cooperators: Drs. B.A.Krantz, J.Kampen, P.Pathak, Piara Singh, S.K.Sharma, S.V.R.Shetty.

Objectives:

General: The development of a Land Management System which increases and stabilizes agricultural production by improving the crop-environment and the workability of the soil. A controlled runoff, causing an increased infiltration and a decreased soil-loss is part of this objective. This experiment covers three different soil types at ICRISAT site.

Specific: The infiltration, water retention and runoff characteristics are different for red and black soils. Efforts will be made to identify the land management practices for each of these soils with the objective of creating optimum soil and moisture conditions for plant growth.

Methodology:

The three different land treatments are compared at a field scale and in 4 replications in the deep and medium deep to shallow black soils: (a) Flat planting, with the direction of planting at an average grade of 0.6%. (b) Broad beds of 150 cm width at an average grade of 0.6% with planting on the beds (introduced 1976-77) (c) Ridges and furrows (75 cm between ridges) laid out at an average grade of 0.6% with planting on the ridges.

(Cont'd...)

Project No. FS-LW-2(75)
(Cont'd...)

Methodology:

In the red soils, the following treatments are proposed: (a) Flat planting, with the direction of planting at an average grade of 0.4%, 3 replications (b) Broad beds of 150 cm width at an average grade of 0.4% with planting on the beds, 3 replications. (c) As (b), including tied ridging in the furrows to increase surface storage capacity - to be introduced in 78-79.

Treatment with narrow ridges and furrows was abandoned after 1975-76 season.

From the 1977 monsoon-season on, half of the plots rotate in respect to their management on an yearly base. This is to exclude differences between the plots and to determine carry-over effects of treatements.

The different systems are compared in respect to runoff, infiltration, soil loss, plant-growth, workability, weed growth, yield of kharif and rabi-crop.

178. Project No: FS-LW-3(74)

Title: Runoff collection and storage; groundwater recovery(80)

Project Scientist: Dr. P. Pathak

Cooperators: Drs. J. Kampen, B.A.Krantz

Objectives:

General: The generation of nrew systems for surface runoff collection and storage as well as methods of groundwater development to increase the available water resources on a watershed basis.

Specific: (1) To develop technically and economically superior design criteria for runoff collection and storage and to test these on ICRISAT watersheds. (2) To improve upon the use and development of groundwater resources in conjunction with surface water.

Methodology:

Several tanks with different design and sizes have been constructed in Alfisols and Vertisols and are being evaluated in technical and economical terms on the different watersheds.

Materials like low density polythene etc., are being tried in Alfisols tank to evaluate their effectiveness in controlling the seepage.

179. Project No: FS-LW-4(74)

Title: Land management effects upon surface and groundwater hydrology (80)

Project Scientist: Dr. P. Pathak

Cooperators: Drs. S.M.Virmani, B.A.Krantz, J.G.Ryan.

Objectives:

(1) To determine the effects of various watershed management treatments and cropping systems on surface and groundwater hydrology. (2) To develop the hydrologic models and simulation programs for the interpretation and extrapolation of hydrologic research findings to major agroclimatic zones. (3) To develop methodology, and equipment for hydrologic research.

Methodology:

Twenty watershed unts are being hydrologically monitored on Vertisols are differently treated in terms of land and water management and cropping systems; these include broad ridges at different grades, contour bunds with flat planting, monsoon fallow treatments, graded bunds with flat planting and traditional field bunds.

In Alfisols the treatments being monitored for different hydrological components inlcude, broad ridges tie ridging, contour bunds with flat planting, graded bunds with flat planting, traditional field bunds, land under uncontrolled and controlled grazing.

180. Project No: FS-LW-5(76)

Title: Conveyance and optimum use of supplemental water (80)

Project Scientist: Dr. R.C. Sachan

Cooperators: Drs. B.A.Krantz, J.G.Ryan

Objectives:

The development of technically and economically viable techniques for the withdrawal and conveyance of collected runoff water and available groundwater supplies and the application of water to agricultural crops under conditions of limited water supplies:

(1) (a) To determine the quantities of water to be applied to monsoon season crops under condition of drought, weather uncertainity and limited water supplies. (b) To determine the quantities and timing of water to be applied to post-monsoon season crops under conditions of limited and decreasing water supplies.

(2) To determine water-yield response relationship under conditions of limited water supplies.

(3) To characterise the duration and severity of wilting symptoms at various stages of crop growth in each irrigation treatment to find simple and practical criteria for the optimum timing of 'supplemental' irrigation.

(cont'd...)

Project No: FS-LW-5(76)
(Cont'd..)

Methodology:

(1) Various types of low cost pipe systems are being compared with gravity channels and water transport in containers by labourers. Specific items for consideration are: initial investments and maintenance costs, conveyance efficiency and equipment availability and flexibility. (2) Experiments involving supplimental irrigation on red and black soils are being conducted during the rainy season. (3) Experiments on lengthening of the growing season through supplemental water on red soils and black soils are being conducted during the post rainy season.

CROPPING ENTOMOLOGY — Sub-program Leader: - Dr. J.C.Davies

181. Project No: FS-Ent-9(77)

Title: Intercropping of pigeonpea under sprayed/unsprayed conditions on red and black soils.(79)

Project Scientist: Dr. V.S. Bhatnagar

Cooperators: Drs. W.Reed, S.S.Lateef.

Objectives:

(1) To determine pest build up in intercropping situations with and without insecticidal appliation. (2) To assess losses in yield due to different pest levels. (3) To determine natural parasitism levels and compare them with those obtained where sprays are used.

Methodology:

(1) This is an extension of the work already in progress - but with fewer main treatments and larger plots (50 m x 50 m). If approved, and different plant populations are used 4 ha. each of black and red soil would be required. This type of trial can only be done if collaborative research projects are agreed in view of the resources required.

(2) Plots (50 x 50 m) of 4 intercrop/monocrop treatments will be sown in random design in black and red soil areas and pest numbers, parasite ratios and loss assessments under unsprayed condition will be carried out by the already standardised techniques. Data will be compared with sprayed blocks.

182. Project No: FS-Ent-12(78)

Title: Pest monitoring by light traps (80)

Project Scientist: Dr. V.S. Bhatnagar

Cooperators: Dr. W. Reed

Objectives:

(1) To study seasonal/annual abundance of phototropic insects of importance in SAT. (2) To compare the trap data with other locations.

Methodology:

At ICRISAT Center two traps are in operation. Data will be compiled yearly and if possible compared with other locations.

183. Project No: FS-Ent-13(77)

Title: Survey of Parasites, predators and microbial control agents of Heliothis armigera (Hubner) (79)

Project Scientist: Dr. V.S. Bhatnagar

Cooperators: Scientists from BTI, COPR & CIBC

Objectives:

(1) Survey of parasites, predators and diseases of H. armigera in relation to cropping systems in SAT. (2) To explore the possibility of utilising them in subsistence and mixed cropping systems, particularly in agricultural belts growing ICRISAT five crops. (3) To develop new concepts of pest-parasite relationships in cropping systems.

Methodology:

(1) Initially the project will involve survey in Andhra Pradesh and provision of transport for making contacts with local entomologists in other states so that facilities are provided for breeding work to be completed at several locations. (2) Survey from selected centres will be obtained and incubated for combined parasite/disease study.

CORRIGENDUM

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6	S-brd-Path.1(74)	Development of sorghums with quality grains resistant to grain moulds(79)	Dr. D.S. Murthy
8	S-brd-Phy.1(77)	Breeding for drought resistance (82)	Dr. Belum V.S.Reddy
9	S-brd-Q&N-1(74)	Breeding and evaluation of sorghums with good food quality and nutritious grains (79)	Dr. D.S. Murthy
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41	M-brd-Phy.1(75)	Screening for drought resistance and maintenance of a nursery of contrasting morphological variability (80)	Dr. B.S. Talukdar Dr. K.Anand Kumar
42	M-brd-Q&N-1(74)	Selection for improved nutritional quality and acceptance (79)	Dr. K.Anand Kumar
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Note: On page-82 of the booklet, the Sub-Program 'Soil Physics' should be read as 'Environmental Physics'

ADDENDUM

TO THE BOOKLET

'AN OUTLINE OF APPROVED CURRENT RESEARCH PROJECTS - 1973'

INTERNATIONAL CROPS RESEARCH INSTITUTE FOR THE SEMI-ARID TROPICS

HYDERABAD : INDIA

NEW PROJECTS

184.. Project No: S-brd-2(77)

Title: BREEDING FOR SORGHUM TYPES SUITABLE FOR RABI CONDITIONS (81)

Project Scientist: Dr. Belum V.S. Reddy

Cooperators: Other disciplines

Objectives & Scope:

Scope: More than half of the sorghum growing area in India is sown in the rabi season.

Objectives:

i) To understand the developmental rhythms of the genotypes suited for rabi conditions.

ii) To breed the genotypes suitable for rabi conditions.

Methodology:

i) Screening: Various dates of sowing to study the response of genotypes under rabi conditions.

ii) Breeding: (a) Pedigree: Selection in rabi conditions from single, 3-way crosses. Backcrossing may be attempted to the selected exotic type.
(b) Later on, as more information is available, composites will be developed for a population breeding approach.

185. Project No: S-brd-Path-2(77)

Title: BREEDING FOR CHARCOAL ROT RESISTANCE (81)

Project Scientist: Dr. Belum V.S. Reddy

Cooperators: Drs. K.N. Rao & R.J. Williams

Objectives & Scope:

Scope: Of late, the disease seems to be spreading rather quite rapidly in India, Thailand, Tanzania, Ethiopia, etc.

Objectives:

i) To determine the importance of the disease in the SAT region.
ii) To understand the factors influencing the development of the disease.
iii) To screen the lines to identify the sources of resistance.
iv) To study the inheritance of resistance.
v) To breed genotypes with resistance and other stability traits.

Methodology:

a) Screening of germplasm and other breeding lines by artificial inoculations.
b) Breeding: (i) Selection from single, 3-way and double crosses under artificial conditions; (ii) As more information is available composites will be developed.

186. Project No: S-brd-Path-3(78)

Title: DOWNY MILDEW RESISTANCE (81)

Project Scientist: Dr. K.V. Ramaiah

Cooperators: Drs. S.R.S. Dange & R.J. Williams

Objectives & Scope:

i) To develop improved source material for resistance to downy mildew.
ii) To determine nature of inheritance.
iii) To incorporate resistance into elite breeding stocks.

Methodology:

i) Intercross resistant lines to improve the source.
ii) Cross resistant lines to adapted parents from different country programs to incorporate resistance in them.
iii) Cross resistant lines to susceptible ones and backcross to both the parents for determining inheritance.

187. Project No: S-brd-Phy-2(79)

Title: BREEDING FOR GRAINS FREE FROM GRAIN WEATHERING, COLOURED SPOTTING AND GERMINATION/LOSS OF VIABILITY (81)

Project Scientist: Dr. D.S. Murthy

Cooperators: Drs. R.K. Maiti & F.R. Bidinger

Objectives & Scope:

i) Identification of grain types which are (a) Free from coloured spotting and weathering due to wet weather (b) Resistant to physiological breakdown - due to loss of viability and/or germination.
ii) Incorporation of source into agronomically elite material.

Methodology:

Identification of source; collaborate with physiologists in the investigation of seed germination, viability and weathering problems and breed for desirable types by conscious selection in segregating crosses - establish selection methods by studying the nature of genetic variability and heritability.

PROJECTS UNDER ICRISAT-ICARDA COLLABORATION

CHICKPEA BREEDING — Sub-Program Leader: Dr. J.M.Green (Acting)

188. Project No. ICRISAT/ICARDA CP-brd-1(78)

Title: DEVELOPMENT OF KABULI CULTIVARS AND SUPERIOR BREEDING MATERIAL (81)

Project Scientist: Dr. K. B. Singh

Cooperators: Pathologist; Entomologist; M.C.Saxena; Biochemist; Rafiq Islam.

Objectives:

a) To breed stable high yielding, disease resistant Kabuli cultivars with good consumer acceptance.
b) To breed for adaptation to winter planting in areas where the climate will permit that are now spring-planted.
c) To develop cultivars suitable for mechanical harvest.
d) To contribute advanced breeding lines and segregating populations to breeders in the Kabuli producing countries.

Methodology:

a) Identify desirable parents among released cultivars and in the germplasm by screening for resistance and desirable agronomic characters.
b) Generate genetic variability through the use of various crossing systems and introduction of hybrid material from the Hissar location.
c) Select for drought tolerance by studying comparative performance with different moisture regimes.
d) Screen parents and breeding material for resistance to Ascochyta blight.
e) Select for adaptation to winter planting.
f) Develop tall types and investigate agronomic practices needed to permit efficient mechanical harvest.
g) Furnish promising breeding material to local breeders through the International Cooperative Project.

189. Project No. ICRISAT-ICARDA-CP-brd-2(78)

Title: INTERNATIONAL COOPERATION (81)

Project Scientist: Dr. K. B. Singh

Cooperators: Pathologist; Entomologist; Rafiq Islam

Objectives:

a) To determine and characterize the different environments in which kabuli chickpeas are grown.
b) To provide parent material with special characters to local programs.
c) To provide segregating populations and advanced breeding lines for strengthening local programs.
d) To conduct international trials for identifying genotypes with wide as well as specific local adaptation.
e) To conduct multi-location trials for Ascochyta blight resistance.
f) To promote international cooperation through personal visits, conferences, information exchange, and training.

Methodology:

ICARDA will supply the following materials to cooperators in the countries - Iran, Iraq, Jordan, Syria, Lebanon, Turkey, Afghanistan, Algeria, Tunisia, Morocco, Egypt, Sudan, Cyprus, Spain, Greece and Italy. In addition, countries in Latin America like Mexico, Chile, Peru, and Argentina will be served:

a) Chickpea Adaptation Trial
b) Chickpea International Ascochyta Blight Nursery
c) Chickpea International Screening Nursery
d) Chickpea International Yield Trial.

In addition, parent lines, F_3 bulks, and other breeding material will be furnished.

COOPERATIVE PROJECTS UNDER ICRISAT-ICAR COLLABORATION

CEREAL COOPERATIVE PROJECTS
GRAIN LEGUME COOPERATIVE PROJECTS

The cooperative projects under ICRISAT-ICAR collaboration form part of the projects listed under various crops and are being operated in cooperation with the respective Universities at Hissar, Bhavanisagar, Gwalior, and Dharwar in the case of Cereals and at Hissar, Gwalior, and Srinagar for Pulses.

AGRO-ECONOMICS COOPERATIVE PROJECTS

These projects also form part of the projects listed under Economics Program and are being operated in cooperation with Agricultural Universities and Government of India and ICAR institutions.

FARMING SYSTEMS COOPERATIVE PROJECTS

190. Project No. FS-1

Title: RESOURCE DEVELOPMENT, CONSERVATION AND UTILIZATION WITH REFERENCE TO SOIL AND WATER (INTER-TERRACE LAND TREATMENT

Scientists: Scientists of ICRISAT and ICAR Research Stations at Bellary, Bangalore, Ranchi, Indore, Sholapur, Akola, Hyderabad.

Objectives:

To develop a research program for testing the bed and furrow system of cultivation and its modifications under several agroclimatic conditions and also to quantify the production effects of presently accepted soil and water conservation practices.

191. Project No. FS-2

Title: HYDROLOGIC STUDIES TO IMPROVE LAND AND WATER UTILIZATION IN SMALL AGRICULTURAL WATERSHEDS IN THE SEMI-ARID TROPICS OF INDIA

Scientists: Scientists of ICRISAT and ICAR Research Stations at Bangalore, Sholapur and Hyderabad.

Objectives:

To derive, for small agricultural catchments, region-specific design criteria for improved resource management which more effectively conserves and utilizes the rainfall and the soil and which, when integrated in new crop production systems increases productivity and assures dependable harvests.

192. Project No. FS-3

Title: HYDROLOGIC AND ECONOMIC STUDIES TO IMPROVE WATER MANAGEMENT AND UTILIZATION IN WELL AND TANK IRRIGATED AREAS OF THE INDIAN SEMI-ARID TROPICS

Scientists: Scientists of the Andhra Pradesh State Irrigation Development Corporation (APSIDC) with technical help from ICRISAT & Other ICAR organisations.

Objectives:

To study the present water utilisation patterns and to determine viable methods to improve the water storage and the water use efficiency, the economic benefits and the role of user organisations of small irrigation systems resulting in increased and more stable agricultural production in the command areas; to generate water management technology facilitating more efficient use of natural resources in the Indian SAT.

Studies have been undertaken initially in Anantapur District.

VILLAGE LEVEL STUDIES

193. Project Title: ON FARM RESEARCH ON WATERSHED MANAGEMENT - VILLAGE STUDIES - Phase-2.

Scientists: Scientists of ICRISAT Farming Systems & Economics Programs, and scientists of AICRPDA and Agricultural Universities.

Objectives:

To measure the performance of prospective watershed technology on farmers' fields to increase and stabilize agricultural production in semi-arid tropical areas and to examine the need and feasibility of group action for adoption of watershed based systems of resource use and management.

Field experiments under this project are being conducted in cooperation with the farmers on their fields in Aurepalle(Mahabubnagar), Kanzara (Akola) and Shirapur (Sholapur) villages.

194. Project Title: EXTENSION OF VILLAGE STUDIES TO OTHER DISTRICTS

Scientists: Scientists of ICRISAT Economics Program

Objectives:

1. To identify and understand the institutional, economic and technical constraints conditioning the traditional farming system in SAT areas of north-west India.
2. To evaluate alternative means of alleviating these constraints via technological and/or institutional means.

Preliminary work in terms of analysis of secondary data is under progress. Selection of centres (villages) for experiments is under consideration in the chickpea, pigeonpea and groundnut growing areas of north-west India.

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