RP 02382

IN-HOUSE REVIEW

FSRP

SOIL FERTILITY AND CHEMISTRY

NOVEMBER 1983

LIST OF PROJECTS

Project No.	Title
Overview	
FS-SFC-1	Characterization of chemical and biological properties of selected SAT soils
FS-SFC-2	Soil fertility management and fertilization investigations in major soils of SAT
FS-SFC-3	Fate and efficiency of fertilizer nitrogen in the SAT soil/crop systems
FS-SFC-4	Diagnosis and prediction of nutrient disorders in Vertisols and Alfisols
FS-SFC-5	Nutrient-water-soil-crop interactions in Vertisols and Alfisols
FS-SFC-6	Phosphorus nutrition of SAT crops: Pigeonpea
FS-SFC-7	C and N turnover in SAT soils
FS-SFC-8	Nutrient balances in different cropping systems

New Interdisciplinary sub-projects

Interdisc. Area	SF&C sub-project
Tillage	Tillage x nutrient interactions
Alt. Agric. Land Use	Nutrient accumulation and redistribution (SFC 8)
Crusting and sealing	Crusting x nutrient interactions

On-Farm Research

Integrated Fertilizer Use in Aurepalle

SOIL FERTILITY & CHEMISTRY

OVERVIEW

Current priorities in the Soil Fertility and Chemistry subprogram are similar to those discussed at the last In-House Review. We attach greatest emphasis to research on nitrogen, but phosphorus is gradually being given more attention. The major changes in the subprogram over the past two years have involved experimental approaches; these will be discussed.

Research on nitrogen has been subdivided also into areas of different priority, based on both the need and the probable time-frame of the research needed. Studies of the efficiency of fertilizer nitrogen have been given greatest priority. In our cooperative project with IFDC, major achievements to date are the demonstration that fertilizer-N can be used effectively by cereals particularly sorghum in the ICRISAT environment, provided that good fertilizer and agronomic management techniques are used; the expertize in the use of ^{15}N has given a preliminary insight into the extent of losses. Residual fertilizer-N had only low availability to a succeeding crop. A separate assessment of our fertilizer-N experiments over the past 6 years has provided us with evidence to extend Dr. Kanwar's comparison of the importance of "Hunger vs Thirst" in SAT soils: on Vertisols with rainfall as assured as the ICRISAT environment (or better), we can state that lack of nutrients appears to be a much more important constraint than the oft-quoted variability in rainfall.

Further studies on nitrogenous fertilizers in the future will need to cover two main aspects - the differences between major soils (e.g. Alfisols vs Vertisols), and nitrogen x water interactions. Our views at this stage, on the basis of a *priori* considerations and limited research data, are that further studies on the efficiency of nitrogen fertilizers should concentrate on the principles affecting efficiency of use for the deeper Vertisols in the assured rainfall areas. It is on these soils, with high assuredness of economic returns from fertilizer inputs, that further increases in the efficiency of fertilizer will encourage more farmers to adopt fertilizer use. On Alfisols, present evidence indicates that responses will be more variable, and risks of loss of investment in fertilizer will be higher than on Vertisols. Characterization of such variability, and the probable responses from N-inputs are desirable; but, it seems that the SAT farmer's tendency to avoid risks will tend to inhibit fertilizer-N use for food grain production on Alfisols. It is on such soils that legume-N inputs offer an attractive means of supplying N inputs to food crops.

Because of potential long-term rises in energy costs, fertilizers may well provide us with an ameliorative for N deficiency for only a short-period, in historical terms. We therefore see legumes playing an important role in improving soil fertility, even for a country as densely populated as India. Two good examples are provided in the present results: a sustained good level of sorghum productivity was achieved in our long-term potassium experiment, merely by using a simple rotation of two improved cereal/legume cropping systems. We estimate the nett input by biological N fixation to be 50-100 kg N/ha, even when N fertilizer is added. These N-fixation values are, at this stage, only tentative estimates; further treatment of the data is still being undertaken. The second experiment shows the residual effects of pigeonpea on an Alfisol of low fertility in the unsprayed area: pigeonpea residues increased sorghum yields from 1100 to 2700 kg/ha; the only inputs were use of improved cultivars, 10 kg P/ha/year, and a single application of zinc.

If the sustainability of improved systems is to be examined thoroughly, assessments of the legume-N inputs need to be made over reasonably long periods. Accurate assessment of the relatively small changes in soil nitrogen is an essential part of the exercise; a long observation period is needed to reduce the error of the estimated input per year, and the measurements require careful attention to detail while being laborious and time consuming. The effort required has deterred most workers. As a result, such data is scarce throughout the SAT, and particularly so in India, where in fact the resources to make such estimates are more plentiful than most other countries.

The use of legumes for inputs of nitrogen will increase the need for studies of the mineralization of soil organic matter and legume residues in soil. The results of our recent studies have given useful results, and indicated leads for future work. Further inputs will be made from the GTZ special project on turnover of carbon and nitrogen in soil.

The long-term phosphorus experiment initially demonstrated efficient use of fertilizer phosphorus on an Alfisol. More recently, we have commenced examination also of the behaviour of P in Vertisols because of indications of a good supply of phosphorus to plants by these soils when their P status, as judged by existing standard soil tests, was rated as very low. The results are showing interesting differences between the Vertisols and Alfisols. The earlier long term experiment, in conjunction with other evidence, also indicated that pigeonpea was a "phosphorus-efficient", plant; these leads encouraged GTZ to fund a special project. Dr. Busch will report on the results.

The maintained emphasis on nitrogen, and concurrent increasing effort on phosphorus, have been associated with other changes involving experimental approaches. Our earlier fairly broad agronomic approach, essential then to assist in defining problems, has led to the more detailed studies of mechanisms of nutrient availability in the soil and/or plant; understanding of these will be essential for future modelling, and the removal of the "site-specific" stigma that is too frequently applied to farming systems research. As part of this approach we are attempting to study the effects of the more easily recognizable components of the environment on nutrient behaviour; for example, by separately studying Alfisols and Vertisols for some of the obvious, yet generally poorly characterized, aspects e.g. soil tests for phosphorus and the behaviour of P in soil, mineralization of N in soil, responses to nitrogen fertilizer Other environmental and management components which require particular attention for their effects on nutrient behaviour are the role of variable rainfall, tillage, crusting, soil water storage, and other intrinsic characteristics of soils. These will be given increasing attention over the next few years, with particular attention to the different needs of our different cropping systems and their components.

In concluding, I must acknowledge the valuable inputs made by our special projects, but note that our substantial increase in the number of scientists has not been accompanied by any increase in the size of our small field crew. It is for this reason that two of the newer projects show less progress than we had expected. Finally, we must acknowledge the valuable inputs made by the several students who conducted higher degree research in the subprogram.

Project No. FS-SFC-1 (82)

ICRISAT PROJECT RESEARCH OUTLINE

1. Program : Farming Systems Research Program

2. Subprogram : Soil Fertility & Chemistry

3. Project title : Characterization of chemical and biological properties of selected SAT soils

4. Project location : ICRISAT and selected benckmark locations

5. Scientific staff

   Subprogram leader : J.R. Burford

   Project scientist : K.L. Sahrawat

   Cooperating scientists : R. Busch, Sardar Singh, T.J. Rego, S.A. El-Swaify

6. Date of start : 1982

   Date of revision : 1984

   Date of completion : 1985

7. Objective and scope:

   Characterization of the chemical and biological properties of selected Alfisols, Vertisols, and associated Vertic soils at ICRISAT Center and appropriate benckmark sites.

8. Techniques in brief

   8.1. Characterize chemical and biological properties of type profiles of major pedological units at ICRISAT Center

   8.2. Asses changes in soil properties with time

   8.3. Conduct surveys of soil fertility status of fields at ICRISAT Center and other benchmark experimental sites

9 Achievements

9.1. Soil Characterizations

9.1.1. Phosphorus

Distribution of phosphorus in the various "Chang and Jackson" fractions were consistent across 4 soils selected to provide a range of available-P contents for each of our benchmark soils, the Kasireddipalli series (Vertisol) and Patancheru series (Alfisol).

Al-P and Fe-P contents of the surface soils (0-15 cm) were rather similar for both the Vertisols (49-56 and 3-5 ppm-P) and Alfisols (46-71 and 2-6 ppm-P). Although the Ca-P fraction dominated in the Vertisols (96-104 ppm), it was small in the Alfisols (8-20 ppm-P). The Available-P, by Olsen's method, was correlated significantly ($P < 0.01$) with Ca-P content for the Alfisols, but not for the Vertisols.

P-sorption capacities of the soil were similar for all 4 Vertisols, but variable across the Alfisols.

9.1.2. Nitrogen

The rates of hydrolysis of urea are markedly different between the type Vertisol and Alfisol, when measured under standard conditions. But, hydrolysis rates for both soils responded similarly to changes in environmental conditions: rates were constant when moisture contents increased above field capacity, and hydrolysis was completely inhibited in air-dry soil (20-30% R.H.). Temperature optima occurred at the high levels of 60-70 °C. The data indicate that urea applied to dry soil, ahead of first monsoon rains, will not hydrolyse until the soil is moistened.

Mineralization of nitroegn: Accumulation of nitrogen over the post-rainy season and first showers of the rainy season (the 'Birch effect') was much greater on an Alfisol than a Vertisol. Biomass-C contents gave a similar result: the Alfisol has a 5-fold greater proportion of its total organic soil carbon contained in the biomass than the Vertisol.

9.2. Changes in soil properties with agricultural Practices

Soil reaction in an Alfisol decreased by only a trivial amount (< 0.10 pH unit) under the relatively-intensive land use consisting of improved cropping-systems and 15 kg P/ha/yr and 120 kg N/ha/yr.

Soil organic carbon contents were lower in the beds than the furrows of the broadbed-and-furrow system on an Alfisol, where inorganic fertilizer had been applied. FYM applications to the beds reversed this pattern.

9.3. Surveys

9.3.1. ICRISAT Center

Checking and compilation of the data from the extensive survey of the general fertility levels of ICRISAT fields has been completed. Features of particular interest were the wide-range in soil reaction of the Alfisols and related soils (pH 5-9), and the range in available-P levels with the highest being found (as expected) in the precision fields. But, the low levels on some Vertisols ('Black' watersheds) with a good history of moderate P inputs raised questions on the possibility of high P fixation in the Vertisols; or, alternatively, that the Olsen-P test may not be applicable to Vertisols. This aspect has been examined in Project FS-SFC-4.

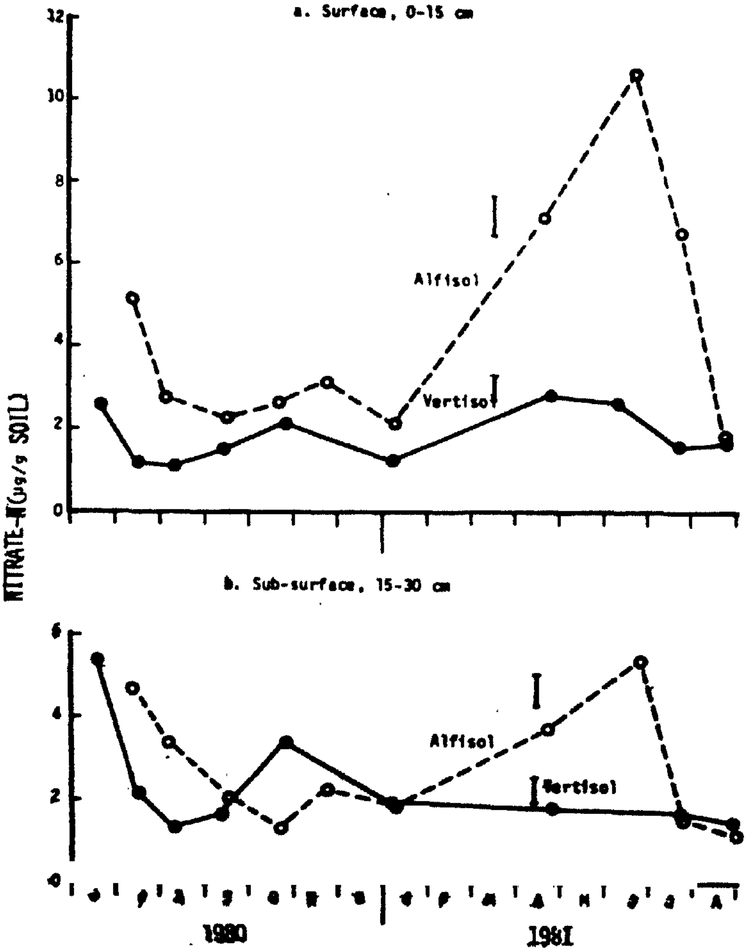
9.3.2. On-farm sites

A thorough field sampling of all fields at Taddanpalle indicated very little variation in soil fertility.

10 Future development

The preliminary characterizations of selected chemical and biological aspects of the benchmark Vertisols and Alfisols on ICRISAT have revealed several important basic differences between the soil which have fairly immediate agronomic application. Examples are the differences in biological activity, and the behaviour of phosphorus.

Future characterization will aim to further increase our basic knowledge of these soils, with the particular objective of assisting in the interpretation of results from field experiments.



Seasonal fluctuations in the nitrate N contents of (a) Surface (0-15 cm) and (b) subsurface (15-35 cm) depths of an Alfisol (o-----o) and a Vertisol (o———o), 1980-1981.

Project No: FS-SFC-2 (75)

ICRISAT Research Project Outline

1. Program	:	Farming Systems Research Program
2. Subprogram	:	Soil Fertility and Chemistry
3. Project title	:	Soil fertility management and fertilization investigations in major soils of the SAT
4. Project location	:	ICRISAT Center
5. Scientific staff		
Subprogram leader	:	J.R. Burford
Project Scientist	:	T.J. Rego
Cooperating scientists	:	K.L. Sahrawat, R.W. Willey, M. Natarajan R.T. Busch, S.A.El-Swaify
6. Date of start	:	1975
Date of revision	:	1984
Date of completion	:	1987

7. Objectives:

General:

To determine, in cooperation with national programs, the biologically and economically optimum soil fertility management and fertilization program for important cropping systems in soils of the SAT.

Specific

a. To study systems of management of residues and organic wastes which will achieve near optimum production with a minimum of chemical fertilizer.

b. To study fertilization of legume- non-legume cropping systems which will facilitate utilization of fixed nitrogen

c. 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.

8 Methodology

The main experimental approaches have been described earlier; in brief, these are:

8.1. Potassium and Residue Management Experiment

A field experiment was established in 1979 with 9 treatments and a simple 2-year rotation of two cropping systems; each cropping system was duplicated to allow measurement of the yield of each in each year. The site was originally prepared by cover-cropping with maize in 1977, and growing establishment crops in 1978 to provide the appropriate crop residues for a residue-return treatment. Soil samples (0-30 cm) were collected from each plot in 1978 and again after 4 years, for chemical analysis. Agronomic measurements included grain yield, stover yield, and uptake of N, P, K.

8.2. Phosphorus experiment

Results of the first four-year cycle of this experiment were presented at the earlier review.

8.3. N-fertilization of millet/groundnut

Agronomic data were presented earlier, but ^{15}N data were not available at that time.

9 Results

9.1. Potassium and Residue Management Experiment

(i) Yield

The grain yield data from the control plots (No-N, No-K) clearly show that, after the first-year, productivity was high and fairly stable. For example, sorghum yield was fairly consistently in excess of 2700 kg grain/ha/yr over the three years 1980-1983.

Responses of cereal to applied N were usually small; this, plus the high cereal yields (especially sorghum) on the Nil-N plots, presumably reflects the residual effects of legume-N input in the previous year (especially by groundnut).

Responses to applied K fertilizer were observed, but the results were generally variable. Sorghum responses were the most consistent; grain yields increased significantly ($P < 0.05$) in the 3rd and 4th year, and stalk yields responded in each year. Sorghum's companion intercrop, pigeonpea, did not show a clearcut response; millet behaved similarly, but pod yields of its component intercrop, groundnut responded in 1980 and 1982. Groundnut stalk yield did not respond to applied K. The N and P uptakes of all crops were not influenced by K fertilization.

Organic residues, e.g. cereal stalk and FYM, when applied to N-fertilized plots, caused responses similar to those for comparable amounts of K applied as inorganic fertilizer. FYM applied without fertilizer-N caused a yield increase similar to that from an application of 60 kg/ha of fertilizer-N.

(ii) Soil Fertility

Soil potassium reserves were depleted unless inputs of K exceeded 80 kg K/ha/yr, under a fertilizer-N input of 120 kg N/ha/yr. Depletion increased with N inputs. Annual Farmyard Manure (FYM) additions were sufficient to prevent depletion, but return of cereal straw residue was not. The large amounts of potassium removed from the soil orginated mainly from the non-exchangeable reserves in the soil; the 'readily-available 'pool' (exchangeable-K) was depleted only a little over the four year period.

Soil organic-carbon content declined on average from 0.40 to 0.32 g C/100 g soil. The decreases for individual treatments were not statistically significant. The C:N ratio of soil narrowed, because total soil-N in the soil did not change over the 4-year observation period.

The nett accretion rate of N in the system has been estimated from careful measurement of soil-N changes in association with N-offtakes and N-inputs; this is an estimate of the rate of biological N fixation if we ignore (for convenience at this stage), the gain in rainfall and the losses by leaching, runoff, and gaseous transfers. The values obtained indicate an annual legume-N input of 100 kg N/ha in the no-N treatment, and 50 kg N/ha where inputs of fertilizer-N to the cereals were quite high (60-120 kg N/ha/year).

Available-P (Olsen) declined from the high and variable levels (7-17 ppm) at the beginning of the experiment to a fairly consistent 6-8 ppm in 1983. Although depletion of the available-P "pool" may have contributed to the high apparent recovery of added fertilizer-P (crop removal was approximately the same as fertilizer inputs), high recoveries of applied-P were also observed in the long term phosphorus experiment.

Exchangeable calcium increased by 260 ppm, and exchangeable magnesium by 28 ppm; the pH was not appreciably altered.

9.2. Long-term phosphorus experiment

Results from the first 4-year cycle were presented at the last review. The experiment is half-way through the next 4 year cycle; results over these 2 years are in agreement with those obtained earlier.

9.3. Millet/groundnut intercrop

The ^{15}N data showed that very little of N fertilizer, applied to the single row of millet in the 1:3 millet:groundnut intercrop, was taken up by groundnut; groundnut in the row adjacent to the millet obtained less than 0.5% of its nitrogen from the fertilizer.

9.4. Conclusions

The Potassium and Residue Management experiment is providing particularly valuable information on the sustainability of a simple 2-year rotation, which consists of alternately cropping with two of ICRISAT's improved cropping systems (sorghum/pigeonpea and millet/groundnut).

Superficially, the consistently good yields on the control plot are impressive because of the low inputs required - only phosphorus fertilizer with no inputs of fertilizer potassium or nitrogen. However, the equally important information is the data provided by the nutrient removals, and the carefully-conducted detailed soil examinations. These allow early interpretation for the potential long term benefits, and the costs.

The benefits indicated are an input by nitrogen fixation of up to 100 kg N/ha/year - which in itself is a considerable benefit, and apparently sufficient to maintain the soil nitrogen status at its present level. However, there are also costs: the obvious one is for fertilizer phosphorus (15 kg P/ha/yr) which could perhaps be increased because crop off-take is at a similar level, and a hidden cost in terms of the removal of potassium (ca 55 kg K/ha/yr) from the soil's capital reserves. These costs can be readily assessed, and some alleviation made by use of low cost resources e.g. FYM.

Special attention is drawn to the importance of the estimates of N-inputs by fixation, particularly because of the scarcity of such data for our improved cropping systems under natural rainfall. With reference to this, we wish to point out the need for particularly careful attention to many aspects of methodology in what is a particularly laborious exercise.

10 Future development

10.1. The potassium and Residue Management Experiment needs to be continued for at least a further 4 year cycle, for two main reasons:

(a) To allow more accurate assessments of the inputs by biological N fixation, and the effects of the various treatments on this; extending the duration of experimentation is one of the usual ways of assisting in reduction of the error associated with the estimate of N-inputs.

(b) To accumulate annual observations on the occurrence of potassium deficiency because the present data do not allow a clear separation between the annual variation in the severity of K deficiency, and the increasing severity due to gradual depletion of the "readily-releasable" reserves of potassium in the soil.

10.2. The long-term Phosphorus Experiment needs to be continued for another 2 years to complete the present 4-year cycle.

11 Publications

Listed at end of SF&C project presentations.

Table 1. Potassium and Residue Management Experiment, 1979-1983: grain/pod yields (kg/ha) control (No-N and No-K) treatment.

Crops	Year			
	1979	1980	1981	1982
Sorghum	1896	2780	2771	3183
Pigeonpea	423	318	903	857
Millet	601	614	635	826
Groundnut	1322	960	850	1188

Table 2. Potassium and residue Management Experiment 1979-1983: Changes in soil exchangeable K[*]

Tr.	[+]Treatments			Exchangeable K (ppm)		Change
No.	N	K	Organic	1979	1983	(ppm)
1	0		0	65	49	- 17
2	50		0	53	49	- 4
3	120		0	54	48	- 6
4	120		[#]Residues	58	56	- 2
5	120		F Y M	59	52	- 7
6	0		F Y M	56	56	0
7	120	30	0	60	57	- 3
8	120	60	0	62	72	+ 10
9	120	120	0	61	84	+ 24
	SE			5.8	4.0	6.2
	CV%			24.5	16.9	2378.6

[*] 0-30 cm, sampled at beginning of each season

[+] Basal application of 15P to all treatments

[#] turn of cereal straw

Table 3. Potassium and residue management experiment 1979-1983: Potassium balance

Treat. No.	*Treatments N	K	Organic	K - balance (kg/ha) Removal herbage A	Added as fert. or O.M. B	Calculated nett input to soil C = B-A	Sources of K removed (kg/ha) +Exch. K D	Non-Exch. K E = C-D
1	0		0	221	0	- 221	- 71	- 150
2	60		0	234	0	- 234	- 17	- 217
3	120		0	252	0	- 252	- 25	- 227
4	120		#Residues	299	191	- 108	- 8	- 100
5	120		F Y M	320	400	+ 80	- 29	+ 109
6	0		F Y M	303	400	+ 97	0	+ 97
7	120	30	0	302	120	- 182	- 13	- 169
8	120	60	0	327	240	- 87	+ 42	- 129
9	120	120	0	355	480	+ 125	+101	+ 24
	SE			10.5			26.0	
	CV%			6.9			237u.6	

*Basal application of 15P to all treatments

#Return of cereal straw

+Data not yet corrected for bulk density

Table 4. Potassium and residue Management Experiment 1979-1983: Changes in soil Organic Carbon*

Tr. No.	+Treatment N	K	Organic	Organic Carbon (ppm) 1979	1983	Change (ppm)
1	0		0	0.37	0.29	- 0.08
2	60		0	0.37	0.30	- 0.07
3	120		0	0.36	0.31	- 0.05
4	120		#Residues	0.41	0.32	- 0.09
5	120		F Y M	0.44	0.33	- 0.11
6	0		F Y M	0.43	0.32	- 0.11
7	120	30	0	0.40	0.29	- 0.11
8	120	60	0	0.41	0.35	- 0.06
9	120	120	0	0.38	0.33	- 0.05
	SE			0.03	0.01	0.03
	CV%			20.5	10.5	106.11

*0-30 cm, sampled at beginning of each season

+Basal application of 15P to all treatments

[illegible]rn of [illegible]l str[illegible]

Table 5. Potassium and Residue Management Experiment 1979-1983: <u>Changes in Total Soil N</u>[*]

Tr. No.	‡Treatments N	K	Organic	Total soil N (ppm) 1979	1983	Change (ppm)
1	0		0	458	474	+ 16
2	60		0	495	493	- 2
3	120		0	483	498	+ 15
4	120		#Residues	545	548	+ 3
5	120		F Y M	505	524	+ 19
6	0		F Y M	477	517	+ 40
7	120	30	0	500	489	- 11
8	120	60	0	487	522	+ 35
9	120	120	0	513	531	+ 18
	SE			6.8	15.1	18.5
	CV%			10.1	7.3	315.4

[*] 0-30 cm; sampled at beginning of each season

‡Basal application of 15P to all treatments

#Return of cereal straw

able 6. Potassium and Residue Management Experiment 1979-1983: <u>N Balance</u>

Tr. No.	*Treatments N	K	Organic	Δ Soil-N⁺ − (kg/ha)	Fert-N − (kg/ha)	Org-N + (kg/ha)	Crop-N (kg/ha)	= Nett Accretion: Total over 4 yrs (kg N/ha)	Average per year (kg N/ha)
				Total over 4 years					
1	0		0	+ 67	- 0		+ 339	= 406	101
2	60		0	- 8	- 150		+ 372	= 214	54
3	120		0	+ 63	- 300		+ 400	= 163	41
4	120		#Residues	+ 13	- 300	- 62	+ 412	= 63	16
5	120		F Y M	+ 80	- 300	- 314	+ 466	= - 66	- 16
6	0		F Y M	+168	- 0	- 314	+ 398	= 252	63
7	120	30	0	- 46	- 300		+ 428	= 82	20
8	120	60	0	+147	- 300		+ 431	= 278	70
9	120	120	0	+ 76	- 300		+ 439	= 215	54
	SE			79.6			10.5		
	CV%			315.40			6.3		

*Basal application of 15P to all treatments

#Return of cereal straw

⁺Amts [illegible]t yet [illegible]rected for bulk density

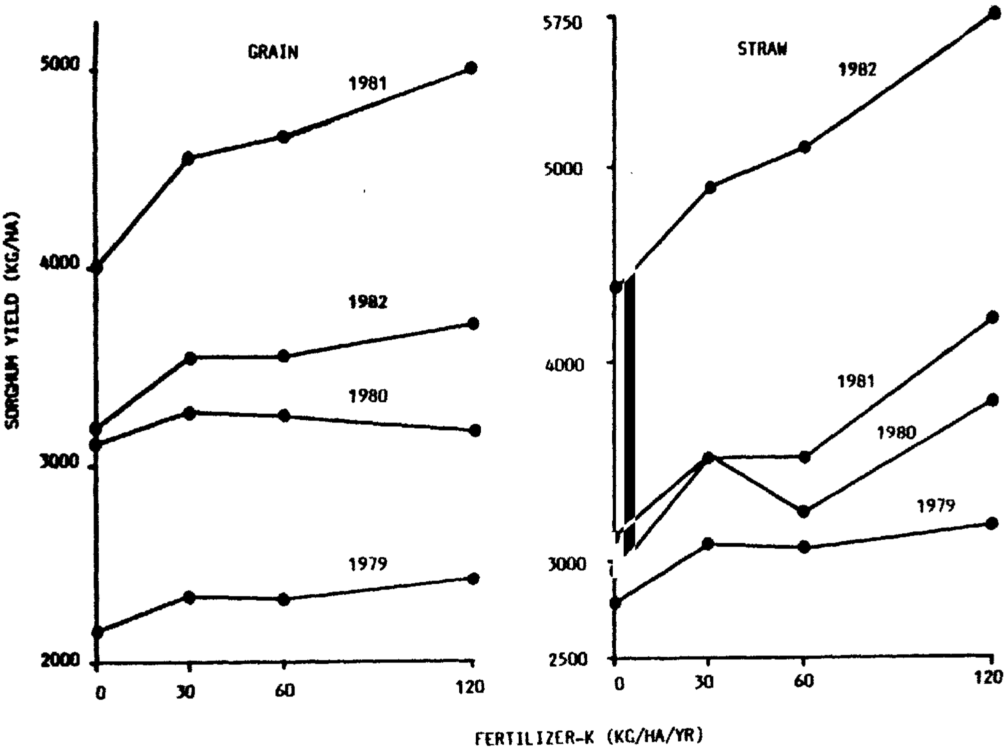


Figure 1. Response of rainy season sorghum to fertilizer-K additions, Alfisol, 1979-1982.

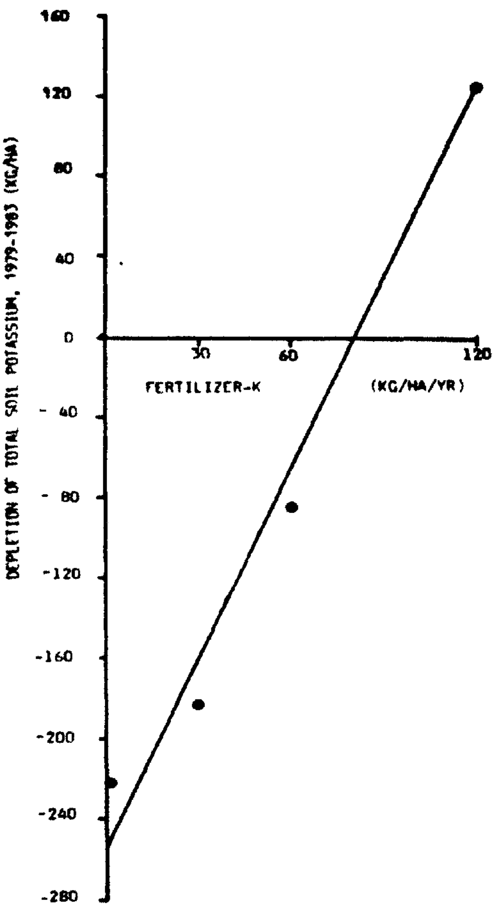


Figure 2. Effect of fertilizer-K inputs on depletion of total soil potassium reserves, Alfisols, 1979-1982.

Project No. FS.SFC.3/80

1.	Program	:	Farming Systems
2.	Sub-Program	:	Soil Fertility & Chemistry
3.	Title	:	Fate and Efficiency of Nitrogenous Fertilizer in the SAT
4.	Project Location	:	ICRISAT Center
5.	Scientific Staff:		
	Sub-program leader	:	J.R. Burford
	Project Scientists	:	C.W. Hong, previously J.T. Moraghan (1980-82)
			T.J. Rego, K.P.R. Vittal
	Cooperating Scientists:		
	ICRISAT	:	Sardar Singh, K.L. Sahrawat
			M.S. Reddy, M. Natrajan, V. Mahalakshm
	IFDC	:	P.L.G. Vlek, R.J. Buresh
	Completion	:	1987
6.	Start	:	1980

7. Objectives:

- To collect the baseline information on the fate and efficiency of fertilizer N in soil and crop systems of SAT
- To identify the factors influencing the fate and efficiency of fertilizer N in different soil and crop systems
- To find out the improved fertilizer application methodologies in terms of application method, sources of N, modification of fertilizer.

8. Techniques:

The ^{15}N tracer method has been used for the measurements of fertilizer-N recoverable in the crop and the soil. The unrecovered ^{15}N is regarded as loss from soil/crop systems. Two levels of ^{15}N enrichment are being used for this study; 5 and 1.5 percent atom excess. The former is being used for the fate and efficiency study, while the latter is being used for crops actual recovery study.

Different methods of application with urea, modified ureas such as supergranule urea, PPD-urea (nitrition inhibitor), and DCD-urea

(urea hydrolysis inhibitor), different sources of N, and different cropping systems are compared for the fate and efficiency of N.

9. <u>Achievements:</u>

<u>1980-81 Seasons</u>

- o Micro-plot (2.25m x 2m) techniques have been successfully established in field trials with ^{15}N for studies of N-balances in the soil/crop system.
- o Baseline data on the fate of urea-N in sole sorghum crops on both a deep Alfisol and a deep Vertisol were obtained; under band-split application, 50-60% in the plant 30-40% in the soil (after crop harvest) and 10-15% unaccounted for (Table 1).
- o When rainfall was not excessive (550mm between planting to harvest), the methods of application did not influence the crop recovery of applied urea. On the other hand, when rainfall was high (880mm between planting and harvesting), band split application was significantly better than all basal application or broadcasting, further, losses of N in the broadcast application were as high as 30%(Table 1)
- o Modified ureas (USG, PPD-urea, DCD-urea) gave similar results to ordinary urea (Tables 2 and 3).
- o Improvement in the analytical method for determination of total soil N; pretreatment of Vertisol soil samples with water resulted in an increased recovery of total soil N significantly, where the salicylic-acid variant of the Kjeldahl method was used (Table 4).

<u>1982 Season</u>

Analysis for ^{15}N both for soil and plant samples is in progress. From agronomic data, following could be mentioned.

- o On a deep Vertisol, different sources of N (Urea, KNO_3, Nitro-phosphate, NH_4NO_3 and USG) are equally effective when rainfall was not excessive, under bandsplit application (Table 5).
- o In a relatively shallow Alfisol, the yield of millet in a millet/groundnut intercropping system, was higher in the 1:3, 1 millet:

3 groundnut row arrangement than in 2:6 row arrangement, in spite of the fact that in the latter the applied fertilizer N to millet could be expected to be better utilized by millet (Table 6).

- On a deep Vertisol, in a sorghum-safflower double cropping system, the residual effect of fertilizer N applied to the rainy-season sorghum crop did not significantly increase yields of the subsequent postrainy season safflower crop. Thus, in this double cropping system, if safflower yield is to be increased, adequate amount of fertilizer N should be allocated to safflower too. Bare-fallowing of the soil markedly increased yields of the postrainy season crop. (Table 7).
- Strategy for the nitrogen research in the SAT soil-crop systems was developed in a meeting (Dec. 1-3 1982).

1983 Season

- In accordance to the research strategy developed earlier, a number of experiments were planned for the broadening of data base; some have commenced and some are to be intitiated.

10. Future Course of Development:

The baseline data on the fate and efficiency of fertilizer N on some typical soils are being obtained; future effort will be focussed on the broadening of data base under diverse soil, climate and biological regimes.

11. Publications:

- Effect of water pretreatment on total nitrogen analysis of soils by Kjeldahl method (Soil Sci Soc. of Am. J; 1983, March)
- Labelled nitrogen fertilizer studies on Vertisol in the SAT (submitted to Plant & Soil)
- Labelled nitrogen fertilizer studies on Alfisol in the SAT (in preparation)

Table 1. Effect of urea under different methods of application in different soils and seasons, with sorghum, at 80 kg N/ha.

	Alfisol		Vertisol	
	Broadcast all basal	Banding split	Broadcast all basal	Banding split*
1980				
Grain yield (kg/ha)	6120	6570 (175)	4420	4290 (180)
Fertilizer recovery (%)				
In plant	53.1	65.5 (1.11)	50.6	-
In soil	65.9	68.1 (4.20)	60.6	-
1981				
Grain yield (kg/ha)	4660	6040 (320)	4260	5220 (225)
Fertilizer recovery (%)				
In plant	49.5	62.5 (1.96)	29.6	55.0 (1.55)
In soil	33.7	27.1 (2.56)	45.2	38.6 (2.69)
Loss (%)	16.8	10.4	14.1	6.4

*^{15}N was not used in this treatment
Figures in parenthesis refer to SE

Table 2. Effect of N transformation inhibitors on sorghum yield on Alfisol (1980).

	Check	Urea	Urea-DCD	Urea-PPD	SE
Grain yield (kg/ha)	5230	6580	6600	6500	179

N rate; 80 kg/ha

Table 3. Effect of urea super-granule (USG) on sorghum yield (kg/ha).

	*Alfisol	+Vertisol
Urea broadcast	4660	5650
Urea band split	6060	5250
USG	5170	5530
SE	320	180

*1981 season (80 kg N/ha)
+1982 season (60 kg N/ha)

Table 4: Influence of modifications of macro-Kjeldahl method on the recovery of nitrogen from surface layer of Vertisol.

Modification	N(ppm)	Increase(%)
None	447 (1)	-
S.A. /1	477 (8)	6.7
S.A. of 50ml of H_2O /2	568 (3)	27.1
H_2O - $KMnO_4$ - Fe /3	563 (3)	26.0

/1, /3. Bremner /2. Ashton
S.A. Salicylic Acid

Table 5: Sorghum yield under different sources of N on a deep Vertisol (1982).

N Sources	Grain yield (kg/ha)
Check	2880
Urea	5250
KNO_3	5390
Nitro-Phosphate /1	5490
USG	5530
NH_4NO_3	5540
SE	180

/1. Nitro-phosphate: 20-20-0
All are applied as band-split, except USG, which was point applied as 1 granule/2 plants.

Table 6: Yield of millet and groundnut under different crop row arrangements in millet/groundnut intercropping at a land allocation ratio of 1 (millet) : 3 (groundnut), on Alfisol (1982).

Treatment		Grain Yield (kg/ha) Millet	Groundnut	LER
Sole millet	0 N	2020	-	-
1 M / 3 G	0 N	761 (0.38)	1530 (0.80)	1.17
2 M / 6 G	0 N	607 (0.30)	1515 (0.79)	1.09
Sole millet	40 N	2250	-	-
1 M / 3 G	40 N	850 (0.38)	1487 (0.77)	1.15
2 M / 6 G	40 N	768 (0.34)	1470 (0.76)	1.15
1 M / 3 empty rows	0 N	1164 (0.38)	-	0.58
2 M / 6 empty rows	0 N	862 (0.43)	-	0.43
1 M / 3 empty rows	40 N	1141 (0.51)	-	0.51
2 M / 6 empty rows	40 N	881 (0.39)	-	0.39
Sole groundnut	0 N	-	1925	-
SE		56	46	

Figures in parenthesis refer to LER for individual crop.

Table 7: Sorghum and safflower yields under different N fertilization in Sorghum-Safflower double cropping on Vertisol (1982).

Treatment		Yield (kg/ha)	
Rainy Season	Post-rainy Season	Rainy Season	Post-rainy Season
Sorghum 0 N	Safflower 0 N	3720	628
Sorghum 60 N	Safflower 0 N	4890	721
Sorghum 30 N	Safflower 30 N	4710	996
Sorghum 60 N	Safflower 30 N	5180	1048
Sorghum 90 N	Safflower 0 N	5290	861
Fallow	Safflower 0 N	-	1470
Fallow	Safflower 60 N	-	1916
SE		175	90

Project No. FS-SFC-4 (82)

ICRISAT PROJECT RESEARCH OUTLINE

1. Program	:	Farming Systems Research Program
2. Subprogram	:	Soil Fertility & Chemistry
3. Project title	:	Diagnosis and prediction of nutrient disorders in Vertisols and Alfisols
4. Location	:	ICRISAT Center, and at on-farm research locations
5. Scientific staff		
Subprogram leader	:	J.R. Burford
Project scientist	:	K.L. Sahrawat
Cooperating scientists	:	R.F. Busch, J.M. Peacock, J. Williams, T.J. Rego, S.K. Sharma, Y. Nishimura, Y.L. Nene, M.V.K. Sivakumar
6. Date of start	:	1982
Date of revision	:	1984
Date of completion	:	Continuing

7. Objectives and scope

1. To determine the most effective methods for diagnosis and prediction of various nutrient disorders particularly P, Zn and Fe in selected SAT soils and cropping systems
2. To determine critical limits for tissue tests and soil tests for different nutrients in SAT crops and soils
3. To investigate simple models for predicting the amount of nutrients to add to selected SAT crops and soils
4. To assist in predicting nutrient requirements at on-farm transfer-of-technology experiments.

8 Achievements

8.1. Phosphorus

Vertisols and Alfisols appear to differ in their soil-test/crop-response relationships for phosphorus applied to sorghum.

A limited number of experiments on Vertisols showed that appreciable responses were obtained only when the available-P content by the standard Olsen's method was less than about 2 ppm. In contrast, on an Alfisol with an initial available-P content of 3 ppm, the average response to P over the first four year cycle of our long-term P experiment exceeded 100%.

More critical comparisons were possible in pot experiments in the glasshouse. We examined the response of sorghum to applied P for 4 soils chosen to provide a range in available-P content from each of the benchmark soils for the Vertisols and Alfisols at ICRISAT - the Kasireddipalli and Patancheru series. The results are in agreement with the field results except that responses were larger in the pot experiment, as expected.

However, the mechanisms responsible for the different behaviour of P in Alfisols and Vertisols are not yet fully understood. Our earlier hypotheses on the best indices for assessing P availability appear to be incorrect; assessments based on capacity to supply P were thought to be most important, but it now appears then an index based on intensity may be better.

8.2. Groundnut

The chlorosis in groundnut at ICRISAT Center has been investigated because of the variability of occurrence in both space and time, and uncertainties over the cause. One major cause is iron deficiency, which is due not to unavailability of iron in the soil but to an interaction between other soil factors (cold, wet conditions) and the plant's ability to maintain iron in the reduced (ferrous) form. Basically, cold wet conditions promote uptake of iron, but also cause a lesser proportion of this iron to remain in the ferrous form.

Previous attempts at diagnostic tests for iron deficiency have failed because they were based on assessments of total iron content of the plant. By utilizing an extractant specific for ferrous iron (o-phenanthroline), we have been able to establish a basis for a diagnostic tissue test. In general, chlorosis only occurs when the o-phenanthroline extractable iron content of the youngest leaves is less than 6 ppm.

Further work showed the wide variability in the ability of different groundnut cultivars to maintain adequate concentrations of ferrous iron in the plant.

8.3. On-farm studies

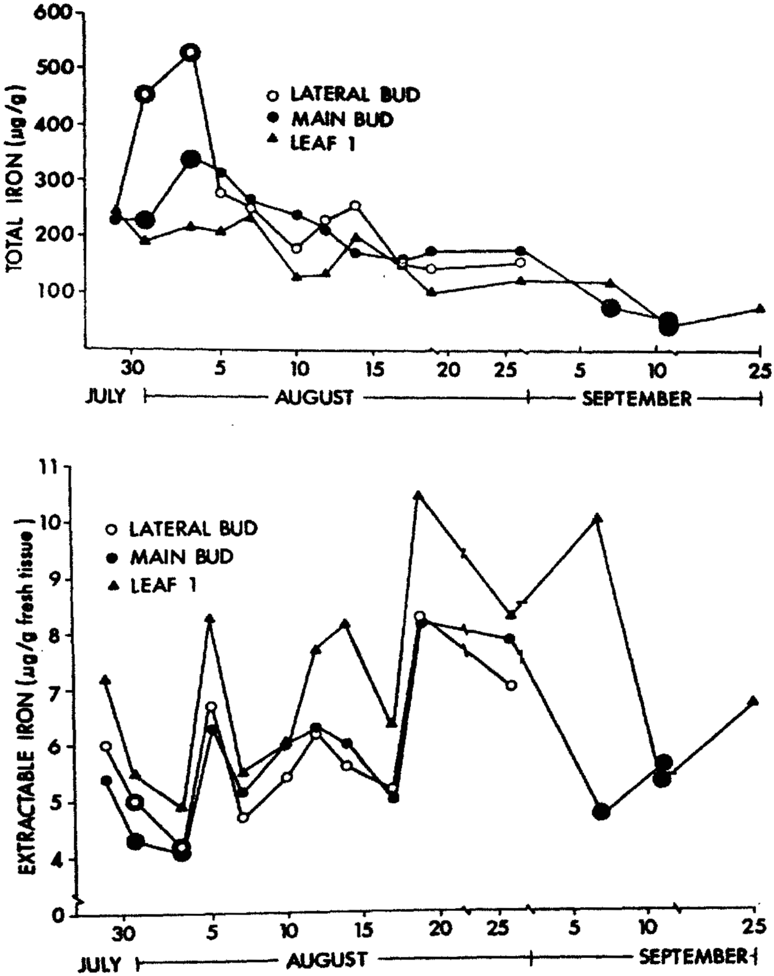
Examination of the soil at Taddanpalle, prior to the first On-Farm Verification Trial (OFVT), showed that the standard predictive soil-test for zinc failed to predict the occurrence of zinc deficiency in maize.

A more thorough pre-OFVT testing was therefore undertaken for the Begumgank OFVT. A large bulk soil sample was brought to ICRISAT Center for conducting a standard nutrient-screening pot experiment, using the single nutrient-omission method. The only serious soil deficiencies for both maize and soybeans were N and P; the absence of N caused very severe deficiency in soybeans, despite the inoculation with Rhizobia.

Future development

The limited work conducted to date indicates the usefulness of stratifying the environment e.g. on the basic differences in soil characteristics. Despite the often-quoted need for this, few examples have so far been reported. Continuation of this approach is needed, with highest priority being given to N and P on Vertisols and Alfisols.

The variability in groundnut germplasm, with respect to 'iron-efficiency' provides a rare opportunity for breeding cultivars which are tolerant induced iron deficiency.



Temporal variations in the total and extractable iron contents of young leaf material of TMV-2 groundnut. Encircled points indicate occurrence of chlorosis.

Project No. FS-SFC-5

ICRISAT Research Project Outline

1.	Program	:	Farming Systems Research Program
2.	Subprogram	:	Soil Fertility and Chemistry
3.	Project title	:	Nutrient-water-soil-crop interactions in Vertisols and Alfisols
4.	Location	:	ICRISAT Center
5.	Scientific staff		
	Subprogram leader	:	J.R. Burford
	Project scientist	:	T.J. Rego
	Cooperating scientists	:	Scientists from Cropping Systems, Agroclimatology, Soil Physics and Conservation, and Physiology subprograms.
6.	Date of start	:	1982
	Date of revision	:	1985
	Date of completion	:	1987

7. Objectives:

To study the nutrient-water relationships for major SAT soils and cropping systems. Particular emphasis will be given to determining the optimum amounts of nutrient and required the best method of application, as affected by

(i) time of seeding (especially dryseeding for deep Vertisols)
(ii) variable rainfall during rainy season
(iii) season (postrainy vs rainy season)
(iv) toposequence position

8. Technique in brief

Field experiments were examined to determine the responses to N and/or P, as affected by

(i) date of planting for rainy season sorghum (before or after first monsoon rains), and the receding moisture regime of postrainy season sorghum.

(ii) additional "rainfall" during rainy season (by irrigation)

(iii) inter-seasonal effects

9 Achievements

(i) In the 1982 rainy season, N response curves were sensibly identical for sorghum planted either dry, or 10 days after the emergence of the dryseeded crop. In 1981, the response to applied N was much lower for the late-planted sorghum than for that dry-planted (earlier) due to heavy infestation by grain mould. Response of sorghum grain yield to fertilizer-N were greater in rainy-than postrainy-season (in a fully replicated experiment).

(ii) Additional rainfall (by irrigation) during the 1982 rainy season reduced sorghum grain yield at all levels.

(iii) Comparison of responses to N on deep Vertisols in each of the past 6 years indicates, as expected, marked contrasts in the responsiveness to the first increment of fertilizer-N applied.

However, the maximum yield in these small plot experiments was consistently in excess of 5,000 kg grain/ha. The data thus indicate very clearly that rainfall was not a limiting factor to high yields on Vertisols: an adequate supply of nitrogen was much more important. Further, one factor determining the maximum responsiveness to N fertilizer is the yield without added N fertilizer; this presumably is largely determined by the supply of N from the soil.

10 The relevance of rainy season rainfall needs more critical attention than has been possible to date; the interaction of this with soil depth will be particularly important. Soil supplies of nitrogen will be examined under other projects (FS-SFC-1,4).

11 Publications

List supplied at end of SFC project presentations.

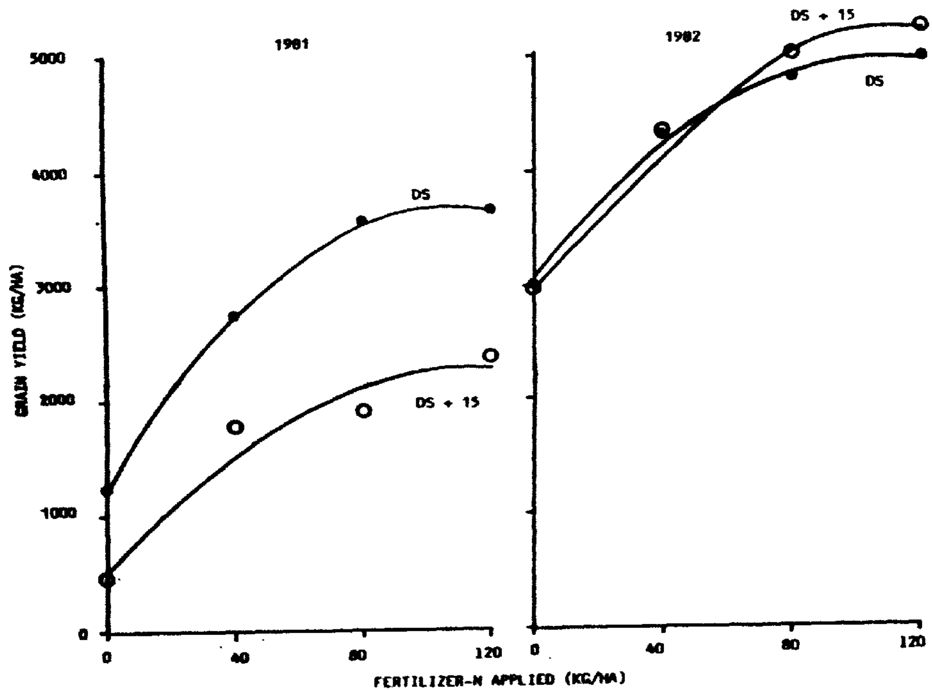


Figure 1. Effect of date of seeding on a deep Vertisol on the response to fertilizer-N of rainy-season sorghum grain yield (DS, dry sown; DS + 15, sown 15 days after first monsoon rains).

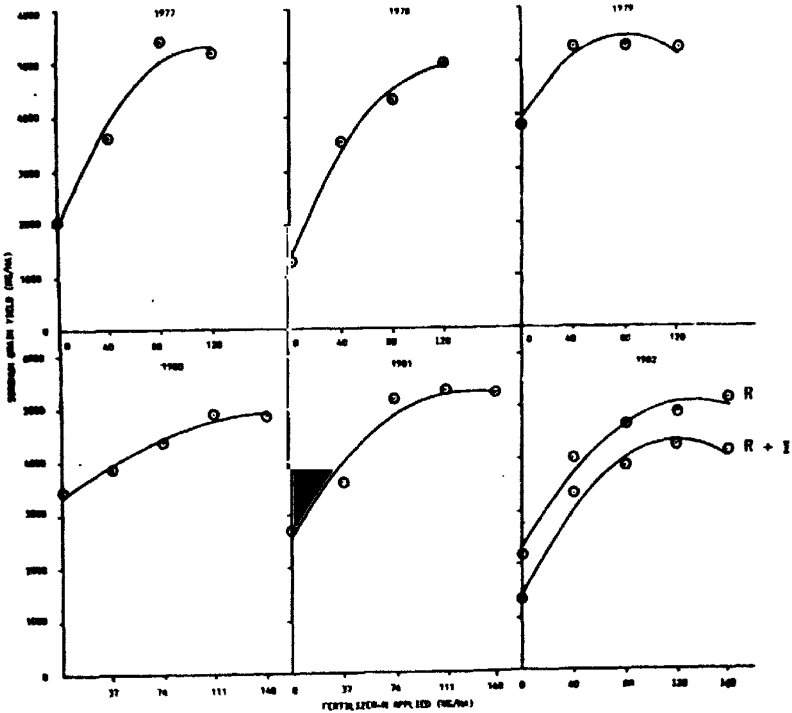


Figure 2. Inter-seasonal variations in grain yield responses of rainy season sorghum to applied fertilizer nitrogen, Vertisol 1977-1982.

Profect - No. FS-SFC-3 (82) GTZ

Program - FSRP

Subprogram - SFC

Title: Phosphorus nutrition of SAT crops: Pigeonpea and nutrient demand of different types

Project location: ICRISAT Centre, field and glasshouse

Scientific Staff:

Subprogram leader : J.R. Burford

Project Scientist : R. Busch

Cooperating Scientists: J.R. Burford

Supporting staff: 2

Start: 1984 Completion: 1984

Objectives: Comparison of the responsiveness of the three pigeonpea types- short,medium,long duration- in regard to P-uptake and fertilizer efficiency.

It should be of value to know in which way the concentration of the soil solution has to be adjusted at different uptake pattern of these genotypes.

Techniques: Pot trial and field trial with 7 pigeonpea genotypes and three rates of phospahte. with an Alfisol.

Publications: The early duration cultivars are more demanding, because the nutrients have to be taken up within a shorter time. Although there is no publication available on this yet, it is the position of knowledge now.

Project - No. FS-SFC-3 (82) GTZ

Program - FSRP

Subprogram - SFC

Title: Phosphorus nutrition of SAT crops : Pigeonpea and mycorrhizza

Project location: ICRISAT Centre, Greenhouse

Scientific staff:

Subprogram leader : J.R. Burford

Project Scientist : R. Busch

Cooperating ScientistK.R. Krishna was asked to cooperate, no reaction yet in handing over data

Prof. Dr. K. Mengel

Supporting staff (Nos) 2

Start: 1983 Revision: all the time Completion : 1984

Objecitves: a) In which way can the concentration of the soil solution be lowered when myc. comes into play

b) In which way can Fe-P and Al-P compounds be utilized by myc. in comparison to Ca-P

Techniques: Pot experiment withpigeonpea as test plant under way in regard to the question which impact myc has on the P uptake during the vegetation period.

Test on P-sources will be started in January 1984

Achievements: Plant growth without myc. shows the optimum with a P-release of 1,8 mg P-EUF, with myc the P release could be lowered to o,8 mg P-EUF/100g, the pot experiment is still growing

Future course of development: A field trial without myc. in microplots would be very useful

Publications: No publications are available on EUF and myc, however it is known that the contribution of myc is the highest the lower the P content of soil

Proj.-No. FS-SFC-3(82) GTZ

Program - FSRP

Subprogram - SFC

Title: Phosphorus nutrition of SAT crops : Pigeonpea

Project location: ICRISAT Centre

Scientific staff:

Subprogram leader : J.R. Burford

Project Scientist : R. Busch

Cooperating Scientists: Prof. Dr. K. Mengel,
S.M. Virmani
J.R. Burford
T.J. Rego

Supporting staff (Nos) 2

Start: 1982 Revision: all the time Completion: 1984

Objectives: Verification of the P/N ratio on yield formation and the S/N ratio on yield formation

Techniques: Field experiment in RP 19 and BW6 with different P-treatments and different S treatments (BW6 only). The concept is based on work done in 1982 (Seminar paper R B)

Achievements: Crop is still growing, marked visible differences in vegetative growth and flowering depending on the P supply of the soil

Future course of development: A P-content of the soil beyond the requirement of the plant has to be balanced with N-fertilization. One has to place the pigeonpea within a rotation at the end.

Publications: No publications are available on the P/N ratio and nutrient r·tios in general .

Project No. FS-SFC-7 (82)/GTZ

ICRISAT Research Project Outline

1. Program : Farming Systems Research Program
2. Subprogram : Soil Fertility and Chemistry
3. Project Title : C and N turnover in SAT-Soils
4. Project Location : ICRISAT Site
5. Scientific staff
   - (a) Sub-program Leader : J.R. Burford
   - (b) Project Scientist : M. Wurzer
   - (c) Cooperating Scientist(s) : H.W. Scharpenseel, H.N. Neue, S.M. Virmani, J.R. Burford, M.V.K. Sivakumar, T.J. Rego
6. (a) Date of start : January 1982
   - (b) Dates of Revision : Continuing
   - (c) Date of completion : 1984

7. Objectives and Scope:

To study the turnover rates and pathways of C and N in soil organic matter in Vertisols and Alfisols, and to assess the effects of environmental factors on turnover for possible consequences in organic matter management to maintain/improve soil fertility, and for the utilization of organic matter as a factor for the recycling of nutrients.

8. Technique in brief (Methodology)

Development of preparation - and analysis facilities for radiochemistry to carry - out field experiments with plant material uniformly labelled with the isotopes ^{14}C and ^{15}N. The various aspects included are:

- Installation of a "WEISS-Growth Chamber" for the labelling of cultivated plants with isotopes and the associated apparatus for monitoring and controlling the environment inside the growth chamber.
- Installation of equipment to analyse water-, gas- and soil samples for their isotopic content. This requires high vacuum glass lines, pyranimanometer, oxidizers and a liquid scintillation counter.

- Development of techniques for growing plants (Sorghum, Pigeonpea, Sesbania, Cowpea, in culture solution under intermittent aeration, to evaluate their possible future cultivation in the growth chamber.

9. - The full operational stage of the growth chamber device for labelling the cultivated plants will be reached at the end of this year. Test runs with the programmed machine unit were done continuously for a number of weeks.

- The installation of the manufactured high vacuum glass lines with the high vacuum measuring system has been accomplished.

- The set up of the measuring-and supply line for the growth chamber, necessary for a continuously sealed run of the chamber over a period of several months has been done.

10. Publications

Ample attention has been paid for ascertaining the dynamics of organic matter decomposition in temperate areas. But no critical data are available of the turnover of ^{14}C labelled plant material in SAT soils where organic carbon and nitrogen contents of the soils are particularly low where there has been a long history of human occupation. We are facing the problem of decreasing soil organic matter levels because of increased cropping intensities and introduction of varieties with higher yield potentials and higher nutrient requirements under a high temperature regime with a limited recycling of organic matter to the cultivated soil.

Studies in this field require the use of the isotopes of C and N (^{14}C and ^{15}N) so that these elements added in organic materials can be clearly identified from the much larger amounts already present in the native soil organic matter.

11. Availability of training facility

When the instruments are brought to an operational stage, we will be able to provide a training facility of the use of isotopes in organic matter studies especially.

Project No. FS-SFC-8

ICRISAT RESEARCH PROJECT OUTLINE

1. Program		Farming Systems Research Program
2. Subprogram		Soil Fertility & Chemistry
3. Project title		Nutrient balances in different cropping systems and alternate land use management syst
4. Project location	:	ICRISAT Center
5. Scientific staff		
Subprogram leader	:	J.R. Burford
Project scientist	:	T.J. Rego
Cooperating scientists	:	K.L. Sahrawat, M. Natarajan, R.W. Willey, Sardar Singh, S.A.El-Swaify, S.P. Wani, J.V.D.K. Kumar Rao, F.R. Bidigner
6. Date of start	:	1982
Date of revision	:	1984
Date of completion	:	Continuing

7. Objectives:

To describe the behaviour of nutrients especially nitrogen in major cropping systems and soils of the SAT, using both short-term and long-term studies with particular attention being given to assessments of the magnitude and consequence of inputs by biological nitrogen fixation.

8. Techniques in brief

This project covers interdisciplinary inputs in other projects where studies are required of some aspect of nutrient balances in various cropping systems. Measurements will include offtake of nutrients in herbage, inputs in rainfall, and change in content of organic and total nutrients (especially nitrogen) in the soil profile over a period of time. Attempts will be made to estimate of the less commonly-studied aspects of N balances, e.g. losses in leachate, runoff and gaseous, and inputs by sorption of gases.

Groups with whom we are collaborating are the Cropping Systems, Soil Physics and Conservation, Microbiology (Cereals and Pigeonpea) and Millet Physiology subprograms.

9 Achievements

9.1. Comparison of sorghum and pigeonpea cropping systems on an Alfisol in the unsprayed area

Comparisons of sole-, inter-, and rotationally- cropped combinations of sorghum and pigeonpea have encountered the not-unexpected difficulties due to the combination of droughtiness after seeding and attacks by pests.

Good crops in 1982 provided good comparisons of the effect of previous crops; the residual effect of pigeonpea lifted yield of sorghum grain on the no-N plots from 1110 kg/ha (after sole sorghum) to 2720 kg/ha (after sole pigeonpea). The yield of sorghum after intercropped pigeonpea was only 1420 kg/ha, a value that was disappointly low but in agreement with previous results on Vertisols.

9.2. Cropping systems for Deep Vertisols

In close collaboration with Cropping Systems, we are conducting a detailed experiment to assess the long term yield benefits of a range of cropping systems, to assess the consequences for soil fertility - since this will ultimately be a determinant of their viability.

The agronomic aspects of the experiment are described under FS-CS-9 A very detailed soil sampling (plot basis) was made on its commencement in 1983.

9.3. Other long-term experiments

Detailed soil samplings have been made, to facilitate interpretation of long term experiments initiated by Cereal Microbiology group.

10 Future development

The demonstration of a very promising residual effect of sole pigeonpea indicates the need for a greater emphasis on legume-N inputs, especially for Alfisols. 'Free' nitrogen sources, such as legume-N inputs, are usually more acceptable by farmers than fertilizers in the marginally N-responsive situations.

There is need for a new experiment to assess a range of sequences of improved Cropping Systems. The existing sorghum-pigeonpea experiment on the unsprayed Alfisol has encountered in only its third year, a very serious nematode problem. This may have been aggravated by the narrow scope of this experiment in only examining various combinations of pigeonpea and sorghum.

Table 1 . Rotation experiment - Unsprayed area, Alfisol: Crop yields, 1982.

Fert-N* (kg/ha)		Crops and sequences				
	1981:	S	S/PP	PP	S	PP
	1982:	S	S/PP	S	PP	PP
			Sorghum-Grain (kg/ha)			
0		1110	1420	2720	-	-
30		2320	2300	2790	-	-
60		2870	2420	3390	-	-
		SE	231	CV	19%	
			Sorghum-straw (kg/ha)			
0		3120	3240	6190	-	-
30		4820	4540	5730	-	-
60		7490	4680	7100	-	-
		SE	476	CV	18%	
			Pigeonpea - Grain (kg/ha)			
0		-	930	-	1360	1170
30		-	860	-	1370	-
60		-	1030	-	1530	-
		SE	124	CV	18%	

*Applied to sorghum only

Sub-Project No: FS-SFC-

ICRISAT PROJECT RESEARCH OUTLINE

1.	Program	: Farming Systems Research Program
2.	Subprogram	: Soil Fertility & Chemistry
3.	Project title	: Tillage x nutrient interactions (Sub-project within interdisciplinary Area: "Tillage")
4.	Project location	: ICRISAT Center
5.	Scientific staff	
	Sub-Program Leader	: J.R. Burford
	Project Scientist	: K.L. Sahrawat
	Cooperating Scientists	: T.J. Rego, S.A.El-Swaify, R.W. Willey, Sardar Singh, C.W. Hong
6.	Date of start	: 1983
	Date of revision	: 1985
	Date of completion	: 1985

7. Objectives

To examine tillage x nutrient interactions, especially to assess the tillage needed maximizing the use of natural resources and minimizing losses.

8. (a) Background

Previous studies in two stages, made in both 1976 and again in 1980, have established that substantial amounts of nitrate-N accumulated during the postrainy season in an Alfisol; much smaller amounts accumulated in a Vertisol. A single primary cultivation did not markedly affect the extent of mineralization; but this cultivation did increase crop yields and nutrient uptake on both the Vertisol and the Alfisol. Fertilizer-nitrogen applied to sorghum on the Vertisol did not eliminate the response to tillage.

It is clear that further investigations into the nutritional consequences of tillage are essential to provide a fuller interpretation of the effects of tillage, on physical properties of soils.

(b) Techniques (in brief)

Initially, experiments will be conducted to examine:

(i) Effect of tillage during the post-rainy season on accumulations of mineral-N in soil

(ii) Effect of thoroughness of primary and subsequent tillage on the responsiveness to applied nutrients, primarily nitrogen.

Sub-Project No: FS-SFC-

ICRISAT PROJECT RESEARCH OUTLINE

1. Program	:	Farming Systems Research Program
2. Subprogram	:	Soil Fertility & Chemistry
3. Project title	:	Nutrient accumulations and redistributions (Sub-project within the interdisciplinary Area: Alternative land-use management systems)
4. Project location	:	ICRISAT Center (initially)
5. Scientific staff		
Sub-Program Leader	:	J.R. Burford
Project Scientists	:	T.J. Rego
Cooperating scientists	:	K.L. Sahrawat, S.A. El-Swaify, R.W. Willey, Sardar Singh, C.W. Hong
6. Date of start	:	1983
Date of revision	:	1986
Date of completion	:	Continuing

7. Objectives

To assess the potential of a wide range of alternative crops to accumulate or redistribute nutrients.

9. (a) Background

Species vary very widely in their capacity to accumulate nutrients as a result of differences in nitrogen fixation capability and rooting patterns. Screening for these effects will be essential to provide basic nutrient data for the eventual combining of attributes of various 'crops' proposed, for alternative land management systems.

(b) Technique

The initial approach will be the culture of a range of diverse species, in pure stands in replicated experiments. So that we [illegible] ure nutrient accumulations or redistributions. Some studies of sampling techniques will be required, because of the regular heterogeneity we know will develop under some species.

This data will be an essential pre-requisite, along with that being gathered in the two other sub-projects, to the formulations of possible alternative land-use systems for Alfisols and related soils.

Sub-Project No. FS-SFC-

ICRISAT PROJECT RESEARCH OUTLINE

1. Program	:	Farming Systems Research Program
2. Subprogram	:	Soil Fertility and Chemistry
3. Project title	:	Crusting x nutrient interactions (Subproject within interdisciplinary Area: Crusting)
4. Project location	:	ICRISAT Center
5. Scientific staff		
Subprogram leader	:	J.R. Burford
Project scientist	:	C.W. Hong
Cooperating scientists	:	T.J. Rego, K.L. Sahrawat, Sardar Singh, S.A.El-Swaify
6. Date of start	:	1983
Date of revision	:	1984
Date of completion	:	1985

7. Objectives

To assess the importance of crust x nutrient interactions, especially with reference to nitrogen.

8. Techniques

(a) Background

Crusting is one of the physical characteristics of some Alfisols that may severely affect the availability of nitrogen to plants because of its effects on the soil moisture regime. The prevention of crust formation, by mulches or artificial aggregating agents, may substantially increase the proportion of rainfall that percolates into the soil. But the consequences vary widely. During droughty periods, crust prevention will improve the moisture regime of the soil; but, at times of excessive moisture, this structural improvement may be a disadvantage because excessive leaching could result. These aspects need to be examined to provide basic information needed for the development of models.

(b) Methodology

By simple experiments, in close collaboration with Soil Physics and Conservation, to measure the effects of severities of crust formation and rainfall inputs on nitrogen movement in the soil.

Project-No. : New Project

Program - FSRP

Subprogram - SFC

Title: Integrated Fertilizer Use in Aurepalle

Project location: A Farm in Aurepalle , well selected

Scientific staff:

Subprogram leader: J.R. Burford

Project Scientist: [illegible]

Cooperating Scientists: S.M. Virmani

J.R. Burford

M. von Oppen

Supporting staff 2 plus labourers at Aurepalle

Start: 1984 Completion: 1989

Objectives: Increasing the farm output by means of integrated fertilizer use on Alfisols in SAT areas

Techniques: a) As a first approach it is intended to simulate a government subsidy (revolving fund) in form of fertilizer (Complete package) of a definded area of land of a farm. The increased output in the first year will be used to provide fertilizer for an extended area of land until the full area is fertilized.

This will be achieved by providing a basic fertility to the soil with P,K,Mg,Zn according to the soil analysis, N will be applied according to individual judgement and rainfall pattern. The crops have to be grown in a rotational system with improved varieties. The sequence of the crops is determined by association with mycorrhizza and market value.

The commercial bussiness of sale of the product and buying of fertilizers will be taken over by ICRISAT.

b) A factorial experiment on N,P and a side experiment with micro-nutrients to support the project by diagnostic work.

Future course of development: The experiment should lead to a formation of a cooperative of mutual help. Once the farmer is in the position to pay the subsidy back it could be given to others.

Publications: Not available for this particular project.

ICRISAT had to withdraw previously because of lack of improved seed and lack of fertilizer .

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