END OF TOUR REPORT

Harry C. Minor
Ecologist

August 1, 1972 - September 7, 1975

SOYBEAN RESEARCH PROGRAM

EMBRAPA/USAID/Wisconsin

LOAN AGREEMENT 512-L-077

I. Introduction

This report covers the period August 1972 to September 1975, during which I served as soybean ecologist in the National Soybean Research Program. The basic objectives of the position within the Program was to assist with the development of crop management technology and to train research personnel in the discipline area. This report summarizes the activities developed in an effect to satisfy the objectives of the position.

II. Goals of the Soybean Ecology Program

A first responsibility of the soybean team was to evaluate, on a national level, the status of soybean research at the beginning of the Program and to prepare a suggested program of work. To accomplish this, most of the locations where soybean research was being conducted were visited. Discussions with professional staff at each site, study of research reports and publications and survey of production fields permitted establishment of a course of action for each member of the soybean team. That established by the soybean ecologist is described below. Although the administration of the Program changed substantially during my tenure as the team ecologist in Brazil, the program of work initiated in late 1972 was little altered and received adequate support. My program objectives were:

1. Train additional researchers to adapt/develop soybean management technology for Brazilian conditions. The number of agronomists available to conduct this research was (and still is), extremely limited. Unless the number of trained people could be increased, little of lasting value could be accomplished during the duration of the Program.

2. Determine the research priorities in the area of soybean ecology/crop management and assist with planning of necessary research on a national level.

3. Initiate a research program to provide information relevant to the Brazilian soybean producer and researcher. Because of the nature of the research needs, this program had to be multidisciplinary. Primary attention was focused in the following areas:

A. Interactions among cultural manipulations such as plant population, row spacing, date of planting, choice of variety and soil fertility. Of particular interest was the possibility of compensating, at least partially, for low soil fertility by use of some combination of less costly cultural practices.

B. Ability of the soybean plant to compensate for adverse conditions, such as defoliation or stand loss caused by insects.

C. Exploitation of host plant resistance to reduce damage inflicted to soybeans by velvetbean caterpillars, Anticarsia gemmatalis.

A need to establish a centralized soybean germplasm collection was also recognized. Such a collection was initiated and maintained as a service to all Brazilian researchers.

III. Accomplishments

During my appointment, the Soybean Research Program was headquartered in Porto Alegre, Rio Grande do Sul. Office and laboratory space were provided by IPAGRO (Agronomic Research Institute of Rio Grande do Sul); field research space was provided by UFRGS (Federal University of Rio Grande do Sul) at the Guaiba Experiment Station, 49 km from Porto Alegre. Although ample opportunity was offered for travel to other locations, most of my time was spent on training and research within the framework of facilities available locally.

1. Training

In 1973, a course entitled "Ecology of Cultivated Plants" was developed and offered to graduate students at UFRGS. Responsibility for the course

was shared with Moacir Berlato, IPAGRO ecologist.

More satisfying and more compatible with my overall responsibilities in the National Soybean Program was the opportunity to work as graduate advisor to students with an interest in soybean management. During the period 1972-1975, orientation was provided to eight graduate students. Of these, five completed their thesis before my departure and the other three completed the field research for their theses.

Saccol, A. V. Avaliação de herbicidas no controls de capim arroz (Echinochloa spp.) em arroz (Oryza sativa L.) cultivado em rotação com soja [Glycine max (L.) Merrill], milho (Zea mays L.) e forrageiras. M.S. Thesis. Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, May, 1974.

Gazzoni, D. L. Avaliação do efeito de tres niveis de desfolhamento aplicados em quatro estadios de crescimento de duas cultivares de soja [Glycine max (L.) Merrill], sobre a produção e a qualidade do grao. M.S. thesis, Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, November, 1974.

Neumaier, N. Efeito da fertilidade do solo, epoca de plantio e população sobre o comportamento de duas cultivares de soja [Glycine max (L.) Merrill], M.S. thesis, Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, February, 1975.

Queiroz, E. F. de. Efeito de epoca de plantio e população sobre o rendimento e outras caracteristicas agronomicas de quatro cultivares de soja, [Glycine max (L.) Merrill], M.S. thesis, Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, April, 1975.

Gonçalves, H. M. Relação entre epoca de semeadura de soja [Glycine max (L.) Merrill], e niveis de fertilidade do solo. M.S. thesis, Universidade Federal do Sul, Porto Alegra, RS, June, 1975.

2. Research Conducted and Publications

A major portion of my time was devoted to research. Most of this was conducted at the Guaiba Experiment Station of the UFRGS. Laboratory facilities, when needed were in IPAGRO. Assistance with, and facilities for, data analysis were provided by the Department of Data Processing/EMBRAPA in Brasilia. Experiments conducted and cooperators are listed in Table 1.

Table 1. Research conducted with participation of soybean ecologist, National Soybean Project, 1972-1975.

Experiment or Project Title	Cooperator(s)	Year(s) Established
1. Effect of soil fertility, date of planting and plant population on performance of two soybean cultivars.	N. Neumaier (M.S. thesis study)	1973-74
2. Relationship between date of planting and the response of soybeans to level of soil fertility.	H. M. Gonçalves (M.S. thesis study)	1973-74-75
3. Effects of population on agronomic characteristics of four soybean cultivars at two dates of planting.	E. F. Queiroz (M.S. thesis study)	1973
4. Evaluation of recommended soybean cultivars under conditions of the Central Depression.	N. A. Barni	1973-74
5. Performance of advanced soybean lines and new cultivars in the Central Depression.	N. A. Barni	1973
6. Effects of time and rate of defoliation of soybeans on yield and grain quality.	D. L. Gazzoni (M.S. thesis study)	1973-74
7. Relationship between viability of soybean seeds and productivity of the crop established.	B. H. Souza	1973-74
8. Analyses of the performance of six soybean cultivars in 42 environments of Rio Grande do Sul.	M. Berlato	1973
9. Effects of thinning experimental plots on agronomic variables at harvest (conducted at Guaiba and the Federal University of Santa Maria).	A. Saccol	1973
10. Formation of a soybean germplasm bank	B. H. Souza and H. M. Gonçalves	1973-74

Table 1. Research conducted with participation of soybean ecologist, National Soybean Project, 1972-1975. (continued).

Experiment or Project Title	Cooperator(s)	Year(s) Established
11. Selection for resistance to the velvet-bean caterpillar, Anticarsia gemmatalis, in soybeans.	E. A. Heinrichs	1972-73-74
12. Effect of row spacing and date of planting on six soybean cultivars.	G. Fontana (M.S. thesis study)	1974
13. Efficiency of water utilization as influenced by row spacing and fertilization.	J. M. Santos Filho, M. D. Porto, and N. A. Barni (M.S. thesis study)	1974
14. Effects of nitrogen fertilization on soybean growth and yield.	N. A. Barni and J. Kolling	1974
15. Response of soybeans to foliarly applied phosphorous.	H. M. Gonçalves	1974-75
16. The effect of Brassins when applied to seeds prior to planting on the agronomic characteristics of soybeans grown in Brazil.	B. H. Souza and G. L. Steffens (USDA)	1974
17. Screenings of germplasm for an improved level of resistance to the velverbean caterpillar, Anticarsia gemmatalis, in soybeans.	E. A. Heinrichs	1974
18. Yield of Mexican bean beetle resistant lines, with and without control of Anticarsia gemmatalis (conducted at Guaiba and Julio de Castilhos).	E. A. Heinrichs, V. Zanotelli, E. Ailgert and K. Ruedell	1974
19. Economic injury levels of damage by Elasmopalpus lignosellus (conducted on two soil types at Guaiba).	E. A. Heinrichs	1974

Table 1. Research conducted with participation of soybean ecologist, National Soybean Project, 1972-1975. (continued).

Experiment or Project Title	Cooperator(s)	Year(s) Established
20. Seed size and it's relationship to resistance of soybeans to *Elasmopalpus lignosellus*.	E. A. Heinrichs	1974
21. Comparison of laboratory and field germination of soybean seeds and the effect of fungicide seed treatment on seed from different climatic regions in Rio Grande do Sul.	P. S. Lehman	1974

Results of the research program were disseminated primarily through presentations at regional meetings and at field days. A less formal method of information dissemination was discussions with interested farmers, researchers and representatives of commercial firnms who visited the research plots at Guaiba.

Research presented formally at joint regional meetings is listed in Table 2. To the extent possible, cooperators, as identified in Table 1, were encouraged to present the results of our cooperative research.

Table 2. Cooperative research results presented at regional meetings, 1974-75.

Minor, H. C. and Berlato, M., 1974. Análise do comportamento de seis cultivares de soja em quarenta e dois ambientes do Rio Grande do Sul. Segunda Reuniao Conjunta da Soja, RS/SC. Porto Alegre, RS. 7p Mimeo. Abstract in Acta da II^{a} Reunião Conjunta de Pesquisa da Soja, Porto Alegre, RS, 1974.

Minor, H. C. and Barni, N. A., 1974. Avaliacao de novas culturas de soja em duas épocas de semeadura, na regiao fisiográfica da Depressão Central. Segunda Reunião Anual Conjunta da Soja. Porto Alegre, RS. 13p Mimeo. Abstract in Acta da II^{a} Reunião Conjunta de Pesquisa da Soja, Porto Alegre, RS, 1974.

Minor, H. C. and Barni, N. A., 1974. Comportamento de variedades de soja na regiao fisiográfica da Depressao Central no Rio Grande do Sul. Segunda Reuniao Anual Conjunta da Soja. Porto Alegre, RS. 8p Mimeo. Abstract in Acta da II^{a} Reuniao Conjunta de Pesquisa da Soja, Porto Alegre, RS, 1974.

Gazzoni, D. L. and Minor, H. C., 1974. Efeito de tres níveis de desfolhamento en quatro estádios de desenvolvimento sobre a producão e qualidade do grão de duas variedades de soja. Segunda Reunião Anual Conjunta da Soja. Porto Alegre, RS. 28p Mimeo. Abstract in Acta da II^{a} Reunião Conjunta de Pesquisa da Pesquisa da Soja, Porto Alegre, RS, 1974.

Souza, B. H. de and Minor, H.C., 1974. Relacão entre poder germinativo de sementes de soja e sua produtividade. Segunda Reunião Anual Conjunta da Soja. Porto Alegre, RS. 12p Mimeo. Abstract in Acta da II^{a} Reunião Conjunto de Pesquisa da Soja, Porto Alegre, RS, 1974.

Gonclaves, H. M. and Minor, H. C., 1974. Relacao entre época de plantio de soja (*Glycine max* (L.) Merrill) e niveis de fertilidade do solo. Segunda Reunião Anual Conjunta da Soja. Porto Alegre, RS. 16p Mimeo. Abstract in Acta da II^{a} Reuniao Conjunte de Pesquisa da Soja, Porto Alegre, RS, 1974.

Neumaier, N. and Minor, H. C., 1974. Resultados preliminares sobre o efeito da fertilidade, época de plantio e densidade de duas variedades de soja. Segunda Reunião Anual Conjunta da Soja. Porto Alegre, RS. 14p Mimeo. Abstract in Acta da II^{a} Reunião Conjunta de Pesquisa da Soja, Porto Alegre, RS, 1974.

Table 2. Cooperative research results presented at regional meetings, 1974-75. (continued).

Fontana, G. and Minor, H. C., 1975. Influência de seccões da fileira na determinacão do rendimento de soja [Glycine max (L.) Merrill]. Terciera Reunião Anual Conjunta da Soja. Porto Alegre, RS. 5p Mimeo. Abstract in Acta da III^{a} Reunião Conjunta de Pesquisa da Soja. Porto Alegre, RS, 1975.

Santos Filho, J. M., Porto, M. C. M., Minor, H. C. and Barni, N. A. Efeito da irrigacão no sub-período reprodutivo sobre o rendimento da soja [Glycine max (L.) Merrill], semeada em três arranjos de plantas. Terceira Reunião Anual Conjunta da Soja. Porto Alegre, RS. 18p Mimeo. Abstract in Acta da III^{a} Reunião Conjunta de Pesquisa da Soja. Porto Alegre, RS, 1975.

Porto, M. C. M., Santos Filho, J. M., Barni, N. A. and Minor, H. C. Efeito da irrigacão e fertilizacão sobre a absorcão de nutrientes pela soja [Glycine max (L.) Merrill]. Terceira Reunião Anual Conjunta da Soja. 7p Mimeo. Abstract in Acta da III^{a} Reunião Conjunta de Pesquisa da Soja. Porto Alegre, RS, 1975.

Barni, N. A., Minor, H. C. and Kolling, J. Efeitos de níveis de nitrogênio sobre o crescimento, rendimento e caracteristicas agronimicas da soja. Terceira Reunião Anual Conjunta da Soja. Porto Alegre, RS. 12p Mimeo. Abstract in Acta da III^{a} Reunião Conjunta de Pesquisa da Soja. Porto Alegre, RS, 1975.

Queiroz, E. F. de and Minor, H. C. Efeito de populacao sobre o rendimento de quatro cultivares de soja [Glycine max (L.) Merrill], em duas épocas de plantio. Terceira Reunião Anual Conjunta da Soja. 25p Mimeo. Abstract in Acta da III^{a} Reunião Conjunta de Pesquisa da Soja. Porto Alegre, RS, 1975.

Queiroz, E. F. de and Minor, H. C. Efeito de populacão sobre a morfologia de quatro cultivares de soja [Glycine max (L.) Merrill], plantadas em duas épocas. Terceira Reunião Anual Conjunta de Soja. 15p Mimeo. Abstract in Acta da III^{a} Reunião Conjunta de Pesquisa da Soja. Porto Alegre, RS, 1975.

Three major field days were organized during 1974-75. Two of these were attended primarily by research and extension leaders, however, the third was attended by technical representatives of commercial companies as well. These field days provided an opportunity to discuss both the production technology under study and the organizational concepts of interdisciplinary research. As in the case of publication of results, cooperators were given encouragement and support to present their work at these field days.

3. Important Research Results

For most of the trials conducted, detailed data on many agronomic characteristics were recorded. In this section, however, only the most

important findings in those areas of study specified under "Goals of the Soybean Ecology Program": will be summarized.

A. Interactions among cultural manipulations such as plant population, row spacing, date of planting, choice of variety and soil fertility.

In many experiments conducted throughout southern and central Brazil, the effects of individual cultural practies on performance of soybeans have been studied; in some cases, interactions among cultural practices have been considered, but generally much less is known about interactions than simple effects of the individual practices. Our research concentrated on definition of optimum combinations of practices.

In terms of gross yield, cultural practices currently recommended in Rio Grande do Sul appear to produce near optimum yields. While manipulation of row width, plant population, and variety can result in significant increases in yield in late plantings, results of a two-year experiment suggests that these increases are small relative to those to be gained for providing a recommended level of soil fertility. Further the crop grown under a low level of soil fertility was less able to compensate for such factors as a low plant stand (Neumaier, N. Efeito da fertilidade do solo, epoca de plantio e populacao sobre of compartmento de duas cultivares de soja |Glycine max (L.) Merill|, M.S. thesis, UFRGS, Porto Alegre, RS, 1975).

Because fertilizers - primarily phosphorus - constitute a substantial percentage of the production cost of soybeans, in 1974 an experiment was initiated to determine whether or not the phosphorus requirements of soybeans could be fulfilled through foliar applications. Eleven combinations of plant growth stage and dosage of phosphorus in the form of ammonium phosphate were tested on soybeans at three levels of soil fertility (low, adequate, high phosphorus). Table 3 shows the mean

performance of the soybeans at each level of soil phosphc

Table 3. Mean response of soybeans, cultivar planalto, to level of soil phosphorus, Guaiba, 1974.

Level of Soil Phosphorus	Plant Height (cm)	Yield (kg/ha)	Pods/pl	Seeds/pd	Wt/seed (mg)	Oil (%)	Protein (%)
F_0(6ppm)	48	1388	12.4	1.8	144	26.8	36.3
F_1(19ppm)	66	2562	20.0	1.9	169	26.7	37.0
F_2(30^+ppm)	70	3060	23.2	1.9	179	26.1	37.6

Figure 1 depicts the response to foliarly applied phosphorus at each of these soil fertility levels. Significant yield increases were only obtained when soil phosphorus was low and then only when application of foliar phosphorus coincided with the initiation of flowering (growth stage 4).

B. Ability of the soybean plant to compensate for adverse conditions.

Insects can cause severe defoliation of soybeans at various times during the growth cycle of the crop. The velvetbean caterpillar, Anticarsia gemmatalis, is a common defoliator in southern Brazil and achieves, at specific times during the season, population levels sufficien to completely strip the soybean crop of leaves in 5-10 days. Research initiated by D. L. Gazzoni (Avaliacao do efeito de tres niveis de desfolhamento aplicado es em quatro estadios de crescimento de duas cultivares de soja |Glycine max (L.) Merrill|, sobre a producao e a qualidade do grao. M.S. thesis, UFRGS, Porto Alegre, RS, 1974) showed that yield reductions due to defoliation are severe only from the time of flowering onward. In both years during which the trial was conducted, yields were reduced 80% by complete defoliation during the pod filling stage (growth stage 8). Yield data are illustrated in Figure 2; the

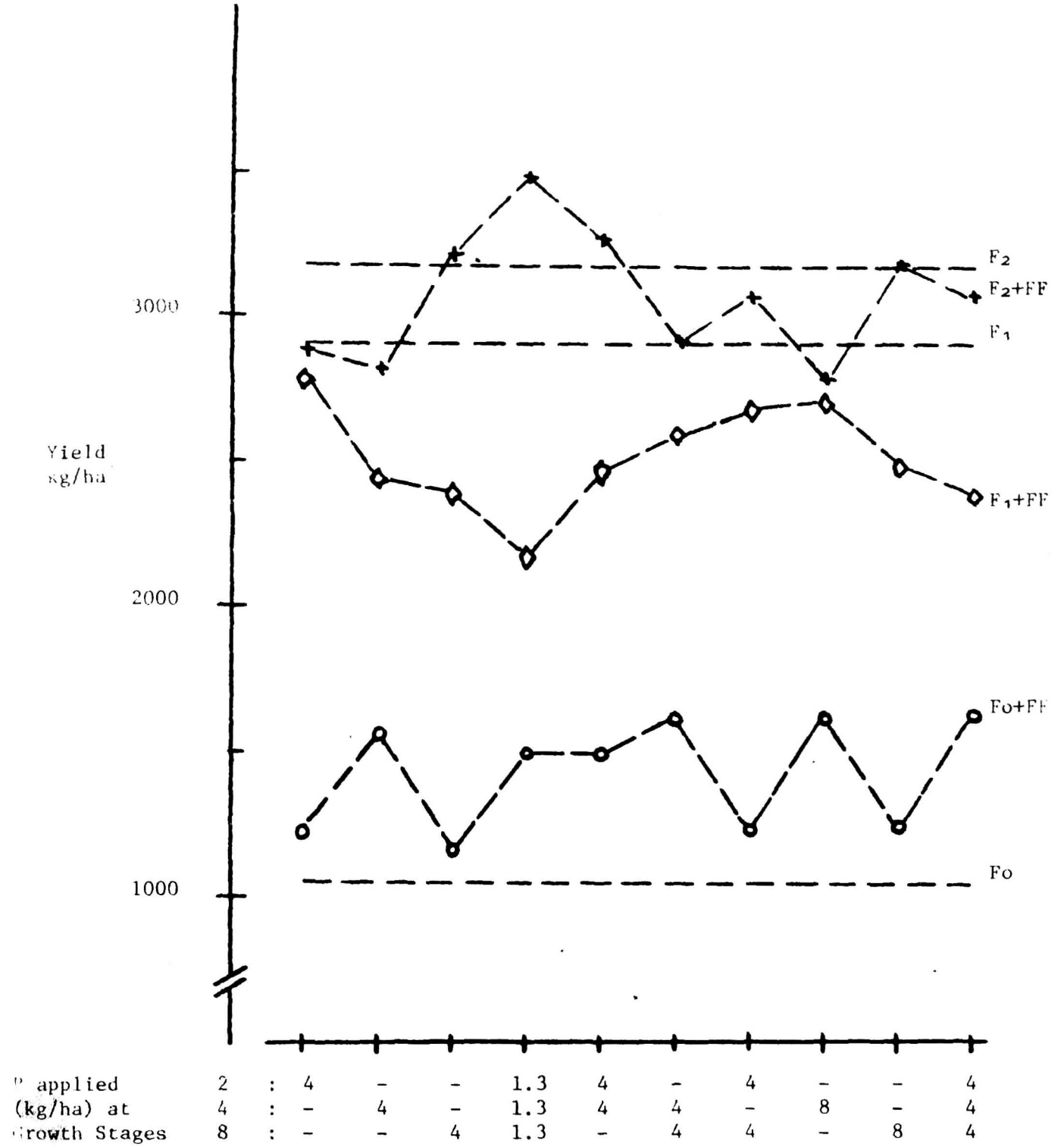

Figure 1. Influence of foliarly applied phorphorus (FF) at various rates, soybean growth stages and levels of available soil P(Fo, F_1, and F_2) Guaiba, 1974.

"Prolonged defoliation" imposed as a treatment in 1974 was repeated defoliation to the specified level for a period of 10 days. These results, which largely confirmed those obtained in the United States, provided support for the insect control recommendations developed by the team entomologist and cooperators in 1974-75.

Another insect of concern is Elasmopalpus lignosellus, which bores into the stem of the plant near ground level. If the plant is young at the time of attack it dies; plants which are older are weakened and frequently fall over later in the season. An experiment providing for artifical removal of plants to simulate attack by E. lignosellus indicated that 50% of a recommended stand could be lost early in the season (three trifoliolate leaf stage) without reduction in yield. As the plant developed further, the percentage of the stand which could be loss before a yield reduction occurred was less than 50%. Under farm conditions, the stand remaining rather than the number of plants killed should be counted and a decision to replant made on the basis of this count.

C. Exploitation of host plant resistance to reduce damage inflicted to soybeans by velvetbean caterpillars, Anticarsia gemmatalis.

In 1972, 7 F_2 populations of soybeans having either PI 171,451 or PI 229,358 as a parent were provided by Dr. R. L. Bernard, U.S. Regional Soybean Laboratory, Urbana, Illinois, to begin a selection program for resistance to A. gemmatalis. In 1973, approximately 250 advanced lines were provided by Dr. S. G. Turnipseed for the same purpose. PI 171,451 and PI 229,358 were used as "resistant" parents because of the limited preference of the Mexican bean beetle, Epilachna varivestis, for them.

Resistant plants were advanced by selecting the best plants from those lines showing the highest level of resistance. At the end of three cycles, approximately 25 lines having a good degree of resistance as

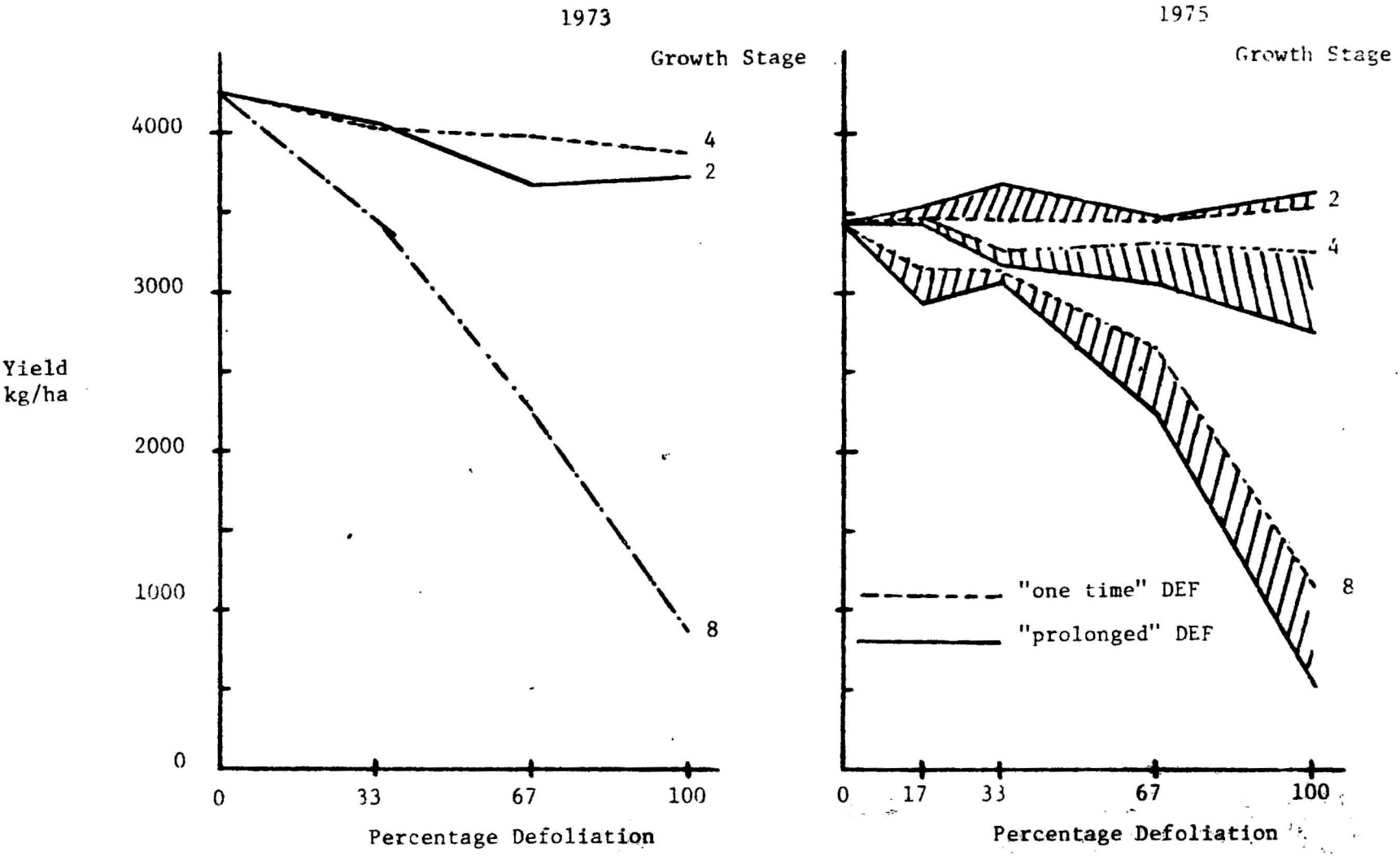

Figure 2. Effects of defoliation at three growth stages on yield of Bragg soybeans, Guaiba, 1973/74 and 1974/75.

compared to the cultivar Davis, were retained. With few exceptions, all plants retained had PI 171,451 in their background. Since PI 229,3[illegible] is more tolerant to the Mexican bean beetle than PI 171,451, our results suggested that resistance to this insect did not necessarily imply resistance to A. gemmatalis. We therefore permitted A. gemmatalis to feed freely on the germplasm bank until flowering. PI 159,097 appeared to have a higher level of tolerance to A. gemmatalis than any other line in the collection, which was composed of all accessions in maturity groups VIII, IX and X of the USDA soybean germplasm collection.

Although not a research activity, an effort was made to initiate a well organized germplasm bank. Existing collections were poorly described and maintained by annually multiplying all entries to maintain viability. A need to provide soybean researchers in various disciplines with a reliable, accessible source of genetic variability for conduct of basic studies was preceived. Such a resource would increase the efficiency of the individual researcher and enhance his potential for producing research results of value to the country.

In excess of 600 entries were obtained to initiate the germplasm bank. These included much of the late maturing germplasm in the USDA collection. The collection was carefully described, harvested and stored. During 1973-74-75, all requests for germplasm present in the bank were filled. In mid-1975, a sample of each accession was supplied to the new National Soybean Research Center in Londrina, Parana.

4. Research Support

As indicated previously, support for the program was adequate. However, the level of support finally achieved was not easy to obtain and included contributions in material or funds from many organizations, both public and private. These were:

DNPEA,MA (National Department of Agricultural Research)

EMBRAPA (Brazilian Enterprise for Agricultural Research)

UFRGS (Federal University of Rio Grande do Sul)

IPAGRO (Agronomic Research Institute)

FAPERGS (Research Foundation of Rio Grande do Sul)

INSTISOJA (Private Institute for the Support of Soybeans)

CRA ("Riograndense" Fertilizer Company)

TREVO

IPB (International Plant Breeders)

USDA (U.S. Department of Agriculture)

5. Research Consultant

Dr. Edgar E. Hartwig served as consultant to the Program during a three week period in January-February, 1974. His objectives were 1) to assist with the evaluation of research activities and to access their meaningfulness in light of production problems encountered in the field, and 2) to advise on soybean breeding objectives and procedures. To meet these objectives, all major research locations in south-central Brazil were visited. Without exception, every research worker contacted appeared to have benefited from the visit and, as a result, linkages between the National Research Center and other stations were strengthened.

Our program at Guaiba was also discussed in detail with Dr. Hartwig. His advise on handling of insect resistance lines was followed. Also, research on relationship between seed size and susceptibility of soybeans to attack by Elasmopalpus lignosellus was initiated. His questioning of the validity of results from plots which are not end trimmed prior to harvest stimulated research in the area of experimental plot technique.

6. Other Activities

A major activity during a period of approximately 60 days in mid-1974 was participation in a study-group which evaluated potential locations for the new National Soybean Research Center to be established by EMBRAPA. The group prepared a detailed analysis of those locations which appeared to be most suitable, within the context of the Center's objectives, as defined by EMBRAPA, along with suggested personnel and infrastructure requirements.

IV. PROBLEMS ENCOUNTERED

Others in the National Soybean Program who have submitted reports before me have adequately described the administrative problems encountered by the team. These problems resulted from the lack of an administrative structure in DNPEA (National Department of Agricultural Research) with sufficient flexibility to provide, in a timely fashion, the support stipulated under the loan agreement. With the transfer of responsibility for agricultural research from DNPEA to EMBRAPA, the support situation continued during a period of uncertainty relative to our role in the new system. This ended in late 1974.

Even though the soybean team was much more restricted in its role in shaping national soybean research programs than originally planned, valuable contributions in training and research information were made. Several of those staffing the ecology/cultural practice program at the new Center worked with us at Guaiba, hopefully perfecting the skills needed to produce valid research results of consequence to soybean production in Brazil. Their continual involvement in my planning responsibilities certainly enhanced their capabilities for assuming such duties at the Center.

The system for classifying research priorities, which members of the National Soybean Program developed during its initial analysis of soybean research and research needs, was an important contribution. The system, which forces its users

into an objective analysis of information needs and current level of available knowledge, has been adapted by EMBRAPA for defining research priorities. Such accomplishment overshadow, at least for me, the inconveniences faced during reorganization of the research system.

V. RECOMMENDATIONS

Research priorities established for the area of ecology/cultural practices are published in EMBRAPA's planning guide. In planning sessions held before my departure, details of several experiments which would permit detection of management practices most limiting to soybean productivity were discussed. These studies included a fertility variable and would be most appropriate for conditions in states other than Parana. For Parana, ways to access the importance of such factors as lodging were reviewed. Under high yield environments such as found in much of Parana, combinations of practices which favor lodging may be imposing a yield barrier. The above research was only partially initiated during the first year of work at the Center.

1. Future Research: Recommended Guidelines.

If the program is to contribute to a sustained increase in soybean productivity, it must have two phases, both of which can be carried on simultaneously. The first phase includes a careful examination of the effects of new (as well as traditional) production methods on soybean productivity. This phase should include the "screening" of new production concepts for applicability to Brazilian conditions and adaptive research where usefulness is indicated. It also includes an appraisal of the sensitivity of the soybean plant to widely spaced levels of management practices. Obviously, there is little need to spend a great deal of effort identifying the optimum level of a factor if soybean yield is similar over a wide range of levels of that factor. This phase of the research program would be concentrated at one or, at most, two

or three locations which represent the broad range of conditions found in Brazil's soybean production region.

In "first phase" experiments, the number of times an experiment will be repeated should not be pre-established. If no encouraging results are obtained after conducting the trial once, drop the experiment or make modifications as suggested by the results. It is senseless to continue an experiment unless a fruitful result can be anticipated (this is not intended to imply that every result must be of immediate economic value).

The second phase of the program should include multi-location testing of proven production practices. Its objectives would be many-fold, but would include: 1) test validity of research results from only one to three locations (phase I) over a wide range of environmental conditions; 2) extension of new technology to regional research groups; 3) refine recommendations for regional "pacotes de praticas". This part of the program can be largely conducted by cooperators under guidance of staff at the Center.

In designing the program, researchers should be aggressive to find ways to work cooperatively with colleagues in other discipline areas - breeders, entomologists, plant pathologists, seed technologists, etc. The applicability of recommendations of a researcher will more often than not be dependent on other practices in the "pacote de praticas". The time to identify the inter-relationships is early in the research program. Doing this will help avoid repetition of research and will result in more useful, sound results.

2. Future Research: Operational Guidelines.

In actual handling of experimental plots, equipment similiar to that used by commercial soybean growers should be used to the extent possible. Lay-out of experimental plots so that they can be managed with tractor drawn implements will increase the researcher's ability to expand his program and/or reduce the time he will need to be involved in non-data recording aspects of

his work. Also, use of such an approach, especially with respect to planting will make results more comparable to those which might be obtained by a producer. To achieve the above, cone dividers which fit on row-crop planters should be obtained. The possibility of importing a plot-combine or modifying a small nationally manufactured combine for plot use should be explored. For most other operations, equipment manufactured for commercial production can easily be modified for use in research.

Because of the importance of wheat in the cropping system, experiments should be designed involving both crops. Because the effects of a preceeding crop on soil properties, moisture and nutrient availability and disease and insect populations can not be simulated artificially, both crops should actually be grown on the experimental area. Otherwise, the effects of such factors as date of planting will probably be underestimated.

Plot borders should always be removed from plots before yield is measured. Border plants in soybean plots compensate for the additional available space; there inclusion in the harvested material results in an overestimation of yield. While a group of cultivars of similar maturity may all compensate to the same extent, the yield result is not a realistic estimate of that a farmer might achieve.

3. Training

Staff at the National Soybean Research Center should organize and periodically offer soybean production shortcourses. Separate courses would probably be required for technical people (researchers, extensionists and commercial representatives) and commercial producers. Leadership might also be taken in providing short-term training for technical personnel from other Latin American countries.

The emphasis placed by EMBRAPA on training for its own staff is one of the positive things which has occurred. Hopefully this emphasis will persist

long enough for several of the ecology/cultural practice staff at the Center to earn their Ph.D. Stronger backgrounds in statistics and plant physiology would enhance the capabilities of researchers in this discipline area.

VI. ACKNOWLEDGEMENTS

Able leadership was provided by Dr. J. R. Jardim Freire during the early years of the Program. This leadership was shared by Dr. R. G. Hanson, who served as team leader. Their support and guidance throughout my time in Brazil is sincerely appreciated.

To my "students" and research colleagues I owe a special debt of gratitude. They were as capable and dedicated to their work as could be found anywhere; working with them guaranteed the success of our efforts. That my three years in Brazil were enjoyable and professionally rewarding, I attribute to them.

The support and encouragement provided by the International Agricultural Programs was also sincerely appreciated. I am especially thankful for the support provided after my return to the United States. This support permitted much progress towards analysis and intrepretation of research results obtained in Brazil.

Financial and material support for the conduct of our work from DNPEA, EMBRAPA, UFRGS, IPAGRO, FAPERGS, INSTISOJA, CRA, Trevo, IPB and the USDA is also gratefully acknowledged. Without assistance from so many, little could have been achieved.