

IICA  
PM-A4/BR-  
87-020

# IICA



Consultant Final Report  
IICA/EMBRAPA-PROCENSUL II  
Consultancy on EMBRAPA breeding program  
for resistance to wheat diseases

ESCRITÓRIO NO BRASIL

00001603

**Consultancy on EMBRAPA breeding program  
for resistance to wheat diseases**

BV 004261

1157

DM A41BR

87-020

**Série Publicações Miscelâneas Nº A4/BR-87-020**  
**ISSN-0534-0591**

**Consultancy on EMBRAPA breeding program  
for resistance to wheat diseases**

**Consultant Final Report  
IICA/EMBRAPA-PROCENSUL II**

**Manfred Heun**

**Brasília, abril de 1989**

**INSTITUTO INTERAMERICANO DE COOPERAÇÃO PARA A AGRICULTURA  
EMPRESA BRASILEIRA DE PESQUISA AGROPECUARIA**

Heun, Manfred

Consultancy on EMBRAPA breeding program for resistance to wheat diseases. Consultant final report IICA/EMBRAPA PROCENSUL II/por Manfred Heun.- Brasília : IICA/EMBRAPA, 1989.

15 p. (IICA. Série Publicações Miscelaneas, A4/BR 87-320)

ISSN 0534-0561

1. Variedade Resistente - Trigo. I. Título.  
II. Série.

AGFIS F30; H20  
CDU 632.938

## APRESENTAÇÃO

A reprodução e difusão dos Relatórios de Consultores, no âmbito restrito das Diretorias das Unidades do Sistema Nacional de Pesquisa Agropecuária, vinculado à EMBRAPA, tem como objetivo principal o de divulgar as atividades desenvolvidas pelos consultores e as opiniões e recomendações geradas sobre os problemas de interesse para a pesquisa agropecuária.

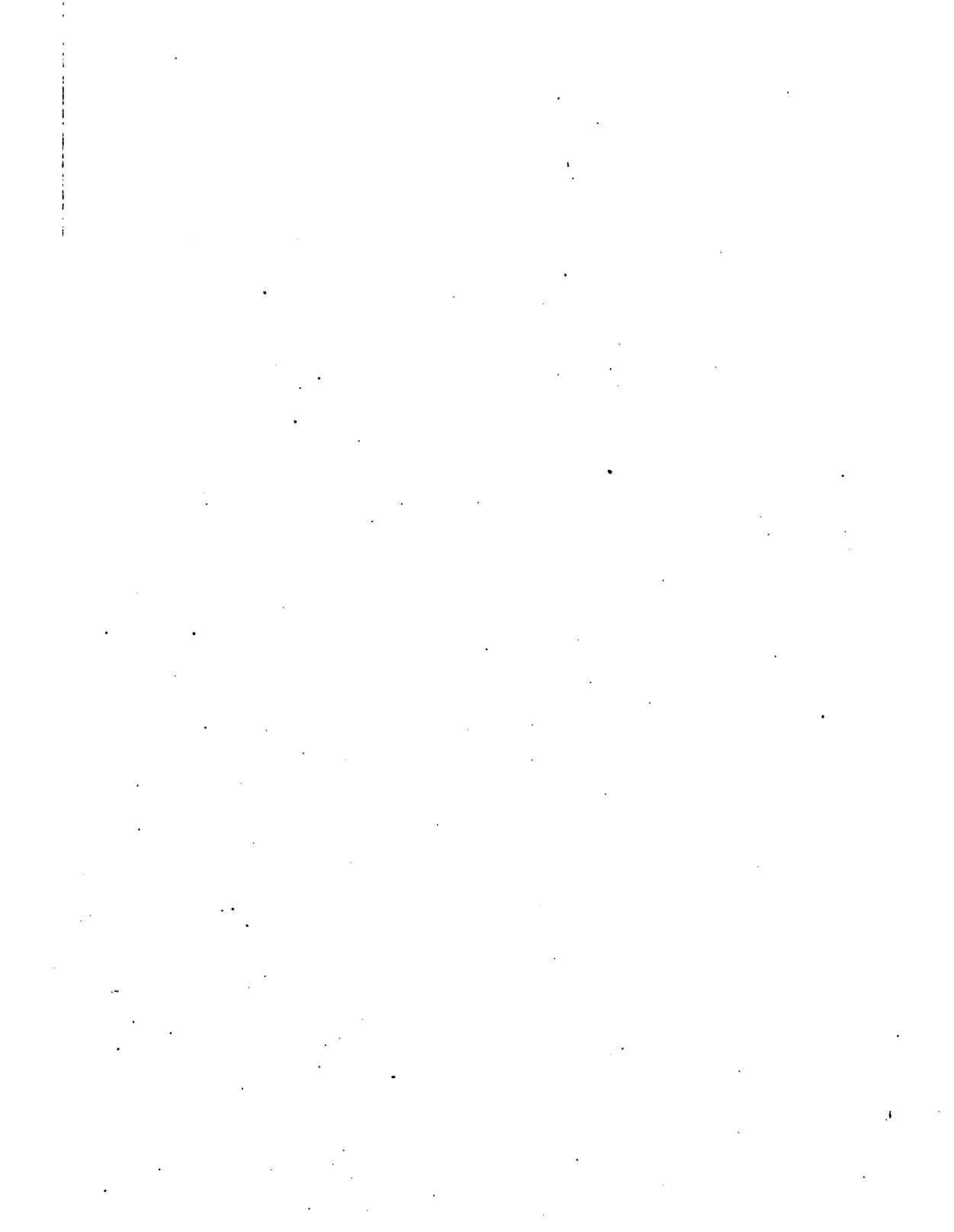
As atividades de consultoria são realizadas no âmbito do Projeto de Desenvolvimento da Pesquisa Agropecuária e Difusão de Tecnologia na Região Centro-Sul do Brasil - PROCENSUL II, financiado parcialmente pelo Banco Interamericano de Desenvolvimento - BID e a EMBRAPA conforme os contratos de Empréstimo 139/IC-BR e 760/SF-BR, assinados em 14 de março de 1985 entre o Governo Brasileiro e o BID.

As opiniões dos consultores são inteiramente pessoais e não refletem, necessariamente, o ponto de vista do IICA ou da EMBRAPA.

A coordenação dos Contratos IICA/EMBRAPA agradecerá receber comentários sobre estes relatórios.



Horacio H. Stagno  
Coordenador Contratos IICA/EMBRAPA





INTER-AMERICAN INSTITUTE FOR COOPERATION ON AGRICULTURE  
IICA/EMBRAPA CONTRACT

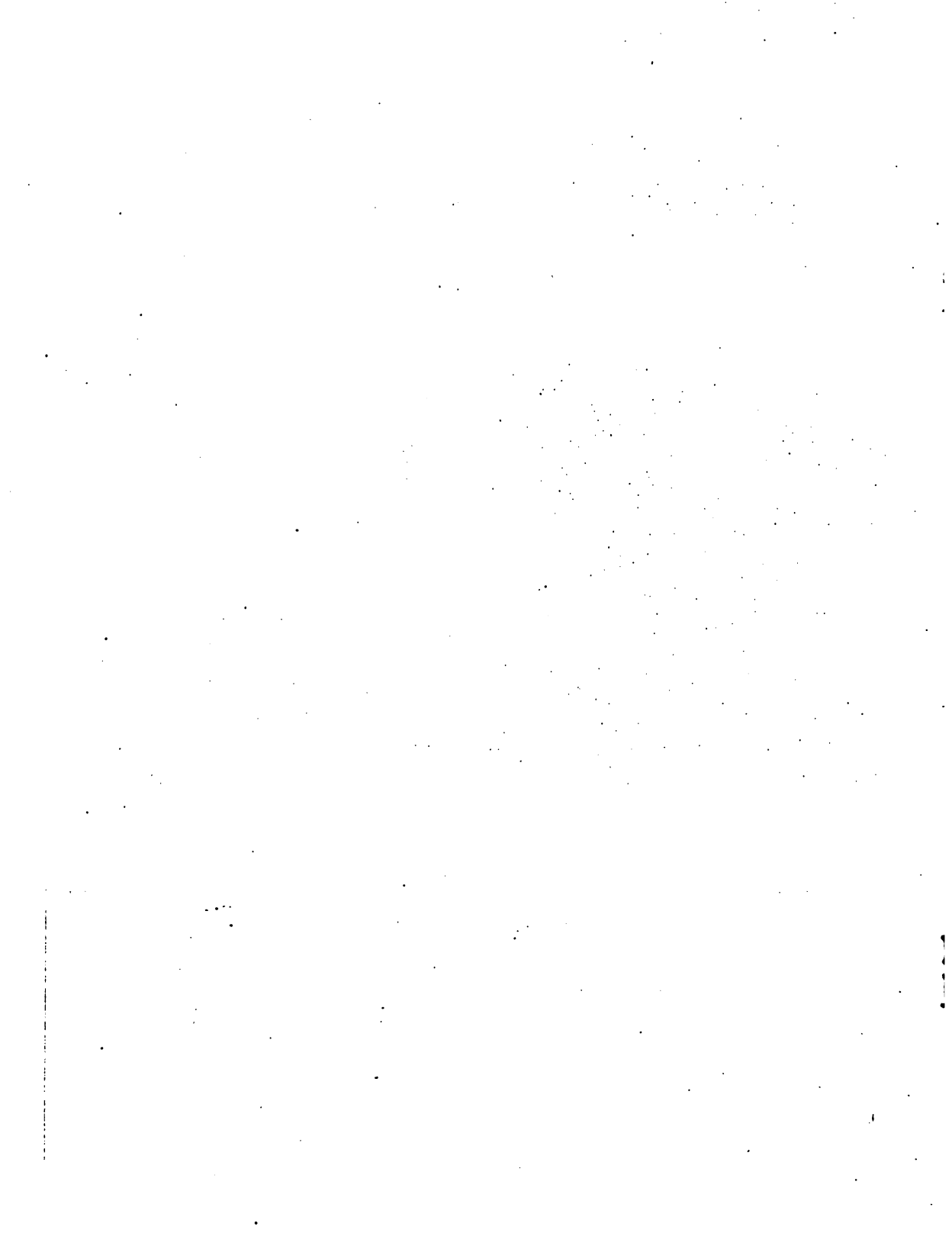
CONSULTANT FINAL REPORT

1. Consultant's full name: *Manfred Heun*
2. Specialist in: *Melhoramento para Resistência a Oídio em Trigo e Cevada*
3. Title of IICA Project: *2.SB.3*
4. EMBRAPA Program for which consultancy is provided:

PROGRAMA - *PROCENSUL II*  
SUE-PROGRAMA : *Pesquisa Vegetal*

IICA Project Activity Code: <i>2.SB.3.02</i>		Administrative Code: <i>R 4884 B1E 03101</i>	
Title of Activity of IICA Project corresponding to this consultancy	<i>Cooperation with EMBRAPA on research activities in the field of crop production</i>		
CONSULTANT CONTRACT PERIOD		DUTY LOCATION (Center)	
<i>August 1st. to 17th., 1988</i>		<i>EMPT/EMBRAPA, Passo Fundo</i>	
CONTRACT EXTENTION PERIOD (if any)		DUTY LOCATION (Center)	

5. Financial support: *PROCENSUL II*



**Final report of the consultancy (2.SB.3) of Dr. Manfred Heun  
concerning cooperation with EMBRAPA on research activities in  
the field of crop production**

**1. Acknowledgements**

First of all, I would like to thank Mr. A.G. Linhares for the good technical preparation of my stay at Passo Fundo. Dr. G.N. Arias and Mr. P.L. Scheeren helped a lot by translating from Portuguese/Spanish to English and enabled me to follow the presentations at the seminar and the excursion. Many thanks are due to them.

**2. Recall of functions**

My stay in Brazil was based upon two duties/responsibilities:

- I. a) To participate in the seminar on wheat breeding for resistance to diseases organized by IICA-PROCISUR/CNPT/EMBRAPA
- b) To deliver a lecture: "Cereal breeding for resistance to diseases (especially wheat) - the European experience"
- c) To participate in an excursion to Paraná and Mato Grosso do Sul
- II. a) To review the current breeding program for resistance to wheat diseases at CNPT/EMBRAPA
- b) To suggest changes aiming at improving its efficiency

**3. Results**

Within the first part of my stay in Brazil I mainly was in a passive function which means that the program of the seminar (2nd to 5th August 1988) and the excursion (6th to 11th August 1988) had been arranged, and I only had to participate, to listen, to ask and, if possible (only Dr. Wahl's

and my own presentation were given in English), to give comments.

ad I. a) Almost all of the 23 presentations held at the seminar from the six countries of the Southern Cone (one presentation from Argentina, one from Bolivia, 14 from Brazil, three from Chile, one from Paraguay and two from Uruguay) were well prepared, well presented and of high interest for the participants as active discussions showed. 12 presentations from the 14 from Brazil were given by EMBRAPA members; this allowed me to become known with EMBRAPA activities. Since all presentations will be published soon, it would be ineffective to go too much into detail here.

Unfortunately, the presentation of the CIMMYT activities within the spring bread wheat program (given by Dr. S. Rajaram) lacked actuality and reviewed only 'known' facts. Old-fashioned versions, e.g., about the polygenic nature of quantitative resistances were given and handled as absolute truth. Consequently, the possibilities, e.g. for handling quantitative resistances in breeding programs were neglected. I think that it must be a duty to recognize current publications.

In addition, I would like to propose that some (not much) research must be undertaken to verify the underlying assumptions for the respective breeding material. Only then, more realistic estimations about the chances of further efforts will exist. CIMMYT should provide such informations because of its intermediate position between science and applied breeding.

No doubt, the seminar was a success; the participants (all together 75) of the Southern Cone came together, discussed similarities and, also important, differences between the disease situations in their countries. Stimulated by Dr. M.M. Kohli (CIMMYT) an interesting summary was obtained:

- *Puccinia recondita*, *Puccinia graminis* and *Septoria tritici* are the three fungi which are most important for the whole Southern Cone.
- *Fusarium graminearum*, *Helminthosporium tritici-repentis*, *Erysiphe graminis* f. sp. *tritici*, *Septoria nodorum* are of intermediate importance.

- *Pyricularia oryzae*, *Puccinia striiformis* and *Fusarium culmorum*  
are only of local importance at the moment.

Then, coordinators were proposed to lead further efforts concerning the respective diseases. Everybody accepted this responsibility personally, although some mentioned that they are not in charge to give an official acceptance. Obviously, policy and administration have to be taken into account. I guess that 'PROCISUR' (the cooperative program for agricultural research in the Southern Cone) should try to overcome existing barriers.

I proposed to initiate a program for analysing the virulence situation of the leaf rust population (*Puccinia recondita* f. sp. *tritici*), realized by a Ph.D.-student who will be supervised by an independent group/person. A close connection between all responsible in the respective countries must be built up; the independence of the supervision is necessary to overcome local restrictions. I discussed this proposal with a couple of scientists, especially with Mr. M.C. Medeiros, Mrs. A.L. Barcellos and Mr. A.G. Linhares. It became evident that it must be the first step to identify the existing leaf rust resistance genes in the currently used cultivars, then followed by a virulence survey interpreted on the basis of field observations of test cultivars. The need of this over-regional analysis was accepted.

ad 1. b) My own presentation intended to cause a broad discussion, and it 'introduced' me to the other participants. Since my contribution will be published separately, it needs no further comments here.

ad 1. c) The excursion to Paraná and Mato Grosso do Sul was arranged by Mr. O. de Souza Rosa in a good way and allowed all participants to become close and to continue with discussions. No doubt, an essential aspect. The 6th and 7th August was filled with travelling and sight-seeing at Iguacu and Itaipu. On 8th August the experimental station of OCEPAR at Cascavel was visited. On 9th August we went to see two experimental fields of EMBRAPA-UEPAE at Dourados. In the afternoon we stayed at the farm Itamarati (45000 ha); the evening was filled with a final coming together, sponsored

by seed producers of Mato Grosso do Sul (APROSSUL). The 10th and half of the 11th August were used for travelling back to Passo Fundo. My minor criticism is that the relation between the travelling time and the time for field observations was not very effective. I sometimes missed an intensive discussion of the respective object; but it must be mentioned that I would not like to miss that excursion.

ad II. a+b) Starting in the afternoon of 11th August, I had three and a half day (11/12/15/17th August) for assessing the wheat breeding programs for resistance at CNPT/EMBRAPA. Furthermore, I used one day (16th August) for discussions with Dr. A.G. Arias and others about the barley breeding program:

I was highly impressed of the very good cooperation between the EMBRAPA barley breeding program and others financed by breweries and/or malting companies. The evaluation of the lines produced by these Brazilian barley breeders is done together, ensuring an objective judgement of the value of the lines. There has been a high improvement concerning the *Pyrenophora teres* resistance of the current lines compared with the old cultivars. The same is true for the aluminum tolerance and the malting and brewing quality.

All my comments now are focussed on wheat, only:

I had the possibility to have discussions with the following scientists:

department of phytopathology

a	Mrs. A.L. Barcellos	about	<i>Puccinia recondita</i>
b	Mr. J.F. Sartori	"	<i>Puccinia graminis</i> and <i>Fusarium culmorum</i>
c	Mrs. W.I. Linhares	"	<i>Erysiphe graminis</i>
-----			
d	Dr. E.M. Reis	"	<i>Fusarium graminearum</i> , <i>Helminthosporium sativum</i>
e	Dr. A.M. Prestes	"	<i>Septoria nodorum</i>
-----			

- |   |                      |       |  |
|---|----------------------|-------|--|
| f | Dr. J.M.C. Fernandes | about | crop rotation, <i>Septoria nodorum</i> |
| g | Mrs. M. Fernandez    | "     | crop rotation, zero tillage            |
| h | Mr. J.A. Diehl       | "     | <i>Gaeumannomyces graminis</i>         |

department of wheat breeding

- |   |                      |   |  |
|---|----------------------|---|--|
| i | Mr. C.N. A. de Sousa | " | aluminum tolerance, general wheat breeding |
| j | Mr. O. de Souza Rosa | " | backcross program                          |

department of cytogenetics

- |   |                                |   |  |
|---|--------------------------------|---|--|
| k | Dr. M.I.B. de Moraes Fernandes | " | synthetic wheat, <i>Agropyron</i> , anther culture |
|---|--------------------------------|---|--|

I would like to report about these discussion in three parts:

- |   |   |
|---|---|
| A | containing discussions with a,b,c,i,j and k |
| B | " " " d,e                                   |
| C | " " " f,g,h                                 |

ad A: Here we discussed about the three obligate fungi *P. recondita*, *P. graminis*, *Erysiphe graminis* which have the capacity to become virulent very easily to the resistance genes of the host.

Mr. O. de Souza Rosa created a backcrossing program for introducing existing rust (called Sr and Lr) and mildew (named Pm) resistance genes into adapted Brazilian cultivars. He observed that the backcrossing with only one parent is more effective (under the conditions of Mato Grosso do Sul) than the use of different parents. The disadvantage to use always the same parent is evident by the fact that only the yield level of that parent can be obtained but not, as usually wanted by plant breeders, a material out-yielding the current cultivars. We concluded that two goals must be separa-

ted: The introduction and the improvement work. To reach the first goal, quick backcrossing with the same parent should be done three or four times; then two or three backcrosses with other cultivars should follow for obtaining the second goal. As a by-product, the 'near-isogenic' lines with the new resistance genes (obtained after three or four backcrosses) could be used as a test sortiment for getting informations about the expression of these resistance genes under different field conditions. If non-adapted lines originating from different regions in the world would be used (sometimes no other material is available), differences in growth habitus etc. would cause disturbances influencing the proper disease assessment. Thus, even 'near-isogenic' lines not outyielding the current cultivars but adapted to Brazil are of high value.

Mrs. A.L. Barcellos and Mr. J.F. Sartori (earlier Mrs. E.T. Coelho) are involved in that backcrossing program by making isolates of *P. recondita tritici* and *P. graminis* available. These isolates were obtained out of the field in different years. The greenhouse conditions for maintaining and testing these isolates are adequate.

Two aspects were discussed intensively:

1. In future, rust resistance genes must be identified to get a better knowledge about the pressure on the pathogen population and to predict changes. For identifying the currently used resistance genes, pure isolates must be selected, allowing to differentiate between resistance genes. Several good isolates are available at the moment, others have to be selected. Then, by taking into account pedigree relationships, the identification of the resistance genes in the different cultivars should be started. With these informations in mind, a virulence survey and field observations of test sortiments can be used to clarify the whole picture about the host-pathogen systems. This should not be limited to Brazil, but should take into account the whole Southern Cone, since interactions among the disease developments in the different countries can be expected. This work is applied science and allows better predictions concerning, e.g., the use of new resistances. Thus, these results would enable the involved plant breeders to focus their activities. All these aspects were discussed intensively.



2. We also started to change the map of frequencies of *Puccinia graminis* races into a map of virulence frequencies. This is possible since the virulences of the respective races are known. But it is only correct to do so, if these virulences were determined for describing the races at that time when the races were sampled, tested and classified. Thus, this can not be done retrospectively, e.g. by determining the virulence against a new gene and by assuming that all G1 isolates sampled in 1955 would react like the used G1 races obtained in 1988. I guess that a virulence map would simplify to detect changes in the pathogen population, especially if knowledge about the underlying resistance genes would be available.

Informations about the use of cultivars (obtained via Mr. A.G. Linhares, Mr. C.N.A. de Sousa, Mr. P.L. Scheeren and OCEPAR) are good and would be helpful, too: From the 1717500 ha sown with wheat in Paraná in 1987, 84.1% were covered with six cultivars: 'Anahuac' (43.9%), 'Tapejara' (14.4%), 'Maringá' (12.7%), 'PAT 7392' (4.8%), 'Cocoragne' (4.2%) and 'Batuíra' (4.1%). For Rio Grande do Sul the same was true: the six cultivars 'Tapes' (30.5%), BR 14 (22.0%), CEP 11 (12.1%), CNT 8 (8.8%), 'Minuano' (8.7%) and BR 15 (7.7%) are covering 89.8% of the total wheat area (981331 ha). Paraná and Rio Grande do Sul have 78.5% of the wheat area sown in Brazil in 1987. Obviously, it should be possible to analyse this little number of cultivars with respect to their major resistance genes against *Puccinia recondita*, *Puccinia graminis* and *Erysiphe graminis*. Even if some other cultivars or ancestors have to be considered, it is still realistic to do so. These resistance gene data have to be combined for each year to allow an analysis of the use of specific resistance genes in different years. These data combined with virulence data and field observations will give a clear pattern of the host-pathogen situation.

The work for mildew performed by Mrs. W.J. Linhares in the last years used mixtures of powdery mildew obtained from the field each year and used in the subsequent greenhouse period: By doing so, the resistances of cultivars and lines were described. In future, the building up of defined isolates would be helpful for improving the efficiency of that program. All things described above can also be done here. But the limiting factor here are the present greenhouse conditions: powdery mildew needs temperatures

< 20°C. The conditions for maintaining powdery mildew isolates and for doing separate inoculations with specific isolates must be improved. This is a pre-assumption for further efforts in the direction of identifying powdery mildew resistance genes and for doing virulence analyses. All technical details were discussed; I guess the most technical problems can be overcome by investing about 3000 US\$.

All aspects discussed till now are linked; the diseases are different, but the underlying mechanisms of the host-pathogen systems are very similar. The backcrossing program depends on the use of well defined isolates. The work of Mr. C.N.A. de Sousa, aiming at describing all used Brazilian cultivars, their pedigrees and their multiplication areas, can be used directly as described above for all three diseases. Combining all efforts will reduce the efforts for the single scientist. Some genetic studies, e.g., about the dominance change of the Pm8 resistance (reported by Mr. C.N.A. de Sousa) could be verified by using specific mildew isolates. Genetic studies (some should be done, but not too much) can be used for knowing the breeding material better. On a long term scale, quantitative differences can also be taken into account, but the work with the major resistance genes should be done within the next future.

The work of Dr. M.J.B. de Moraes Fernandes is a very important part of that group. The incorporation of new resistances from *Aegilops squarrosa* by producing synthetic wheats or from *Agropyron* is necessary for broadening the genetic basis. Since her work is very expensive and since it must be seen on a long term scale, the very proper analysis of the original parents (the *Aegilops squarrosa* and *Agropyron* lines) is essential. The production of doubled haploids should be continued and incorporated into breeding programs, e.g., aiming at the transfer of quantitative resistances from wheat ancestors into adapted wheat cultivars. Unfortunately, the greenhouse conditions are poor. Dr. E. Picard mentioned that before (Final report: Biotechnology and Plant Breeding, 1987), stressing the fact that the quality of the donor plants is essential for the success of the anther culture method (see also: Olsen, F.L. 1987: Induction of microspore embryogenesis in cultured anthers of *Hordeum vulgare*. The effects of ammonium nitrate,

glutamine and asparagine as nitrogen sources. Carlsberg Res. Commun. 52, 393-404). Again, 3000 US\$ would be a big help for the beginning. The incorporation of more sophisticated methods like the microspore culture or transformation systems are not necessary at the moment.

ad B: I was highly impressed by the work of Dr. A.M. Prestes working on *Septoria nodorum* and of Dr. E.M. Reis presenting his work about *Fusarium graminearum* and *Helminthosporium sativum*. These diseases are different from those mentioned earlier because of the pathogens' non-obligate life cycle; the adaption to the host genes is not that specific. Consequently, resistances, if they occur, are only expressed quantitatively. Very sophisticated methods for observing quantitative differences are necessary. Different traits (for *Septoria*: the latent period, spore production, colonization of nodes, infection of the ear etc.) have to be assessed. On the other hand, these methods for determining the resistance level must be simple to become applicable to breeding programs, and it is not simple to find that compromise. Working with these diseases needs phytopathologists interested in plant breeding whereas the earlier mentioned obligate pathogens need plant breeders interested in phytopathology.

Consequently, the work of Dr. A.M. Prestes and Dr. E.M. Reis is more related to phytopathology. They can show that these diseases can be controlled by a better rotation having wheat only every second year and by the use of non-contaminated seeds (important for *Septoria nodorum* and *Helminthosporium sativum*). The existing quantitative differences among cultivars are considered as an additional source for controlling the disease. Well defined conditions for inoculating field plots are being developed.

Linkage with the above-mentioned backcrossing program exists.

ad C: Within this group, rotation and zero tillage are the most important scientific goals. A big program financed by the Canadian government is involved. These programs are not directly linked with resistance breeding and consequently, I do not want to mention these efforts. Since I did not have the chance to discuss with Dr. W.C. da Luz and Mrs. L.A. Selli, their

work can not be mentioned here, too.

#### 4. Summary

- Almost all parts of the breeding projects of wheat are very well performed.
- The fact that many EMBRAPA people were also educated in different countries (like USA, West-Germany) increased the 'variability' of ideas.
- I proposed some changes, hoping that they will help to increase the efficiency.
- A short review of my activities is given by this final report.
- I offered that some work like the identification of powdery mildew resistance genes, the analysis of the dominance change of Pm8, the description of synthetic wheats etc. could be done in our laboratory, if wanted.
- The greenhouse conditions should be improved; facilities for maintaining powdery mildew should be created; the library needs to be improved since a lot of periodicals are being missed.
- I would also like to keep in contact with EMBRAPA, especially for observing the initiated work about the identification of resistance genes and their use at EMBRAPA.
- Seminars and visits of consultants are essential and helpful. I hope that my consultancy will be helpful, too.



(Dr. Manfred Heun)

24. August 1988



## Programa II. Geração e Transferência de Tecnologia

O Programa de Geração e Transferência de Tecnologia é a resposta do IICA a dois aspectos fundamentais: (i) o reconhecimento, por parte dos países e da comunidade técnico-financeira internacional, da importância da tecnologia para o desenvolvimento produtivo do setor agropecuário; (ii) a convicção generalizada de que, para aproveitar plenamente o potencial da ciência e da tecnologia, é necessário que existam infra-estruturas institucionais capazes de desenvolver as respostas tecnológicas adequadas às condições específicas de cada país, bem como um lineamento de políticas que promova e possibilite que tais infra-estruturas sejam incorporadas aos processos produtivos.

Nesse contexto, o Programa II visa a promover e apoiar as ações dos Estados membros destinadas a aprimorar a configuração de suas políticas tecnológicas, fortalecer a organização e administração de seus sistemas de geração e transferência de tecnologia e facilitar a transferência tecnológica internacional. Desse modo será possível fazer melhor aproveitamento de todos os recursos disponíveis e uma contribuição mais eficiente e efetiva para a solução dos problemas tecnológicos da produção agropecuária, num âmbito de igualdade na distribuição dos benefícios e de conservação dos recursos naturais.

## INSTITUTO INTERAMERICANO DE COOPERAÇÃO PARA A AGRICULTURA

O Instituto Interamericano de Cooperação para a Agricultura (IICA) é o organismo especializado em agricultura do Sistema Interamericano. Suas origens datam de 7 outubro de 1942, quando o Conselho Diretor da União Pan-Americana aprovou a criação do Instituto Interamericano de Ciências Agrícolas.

Fundado como uma instituição de pesquisa agronômica e de ensino, de pós-graduação para os trópicos, o IICA, respondendo às mudanças e novas necessidades do Hemisfério, converteu-se progressivamente em um organismo de cooperação técnica e fortalecimento institucional no campo da agropecuária. Essas transformações foram reconhecidas oficialmente com a ratificação, em 8 de dezembro de 1980, de uma nova convenção, que estabeleceu como fins do IICA estimular, promover e apoiar os laços de cooperação entre seus 31 Estados membros para a obtenção do desenvolvimento agrícola e do bem-estar rural.

Com um mandato amplo e flexível e com uma estrutura que permite a participação direta dos Estados membros na Junta Interamericana de Agricultura e em seu Comitê Executivo, o IICA conta com ampla presença geográfica em todos os países membros para responder a suas necessidades de cooperação técnica.

As contribuições dos Estados membros e as relações que o IICA mantém com 12 Países Observadores, e com vários organismos internacionais, lhe permitem canalizar importantes recursos humanos e financeiros em prol do desenvolvimento agrícola do Hemisfério.

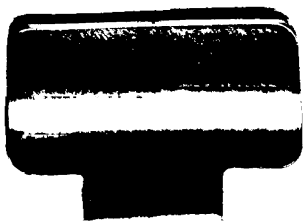
O Plano de Médio Prazo 1987-1991, documento normativo que assinala as prioridades do Instituto, enfatiza ações voltadas para a reativação do setor agropecuário como elemento central do crescimento econômico. Em vista disso, o Instituto atribui especial importância ao apoio e promoção de ações tendentes à modernização tecnológica do campo e ao fortalecimento dos processos de integração regional e sub-regional.

Para alcançar tais objetivos o IICA concentra suas atividades em cinco áreas fundamentais, a saber: Análise e Planejamento da Política Agrária; Geração e Transferência de Tecnologia; Organização e Administração para o Desenvolvimento Rural; Comercialização e Agroindústria, e Saúde Animal e Sanidade Vegetal.

Essas áreas de ação expressam, simultaneamente, as necessidades e prioridades determinadas pelos próprios Estados membros e o âmbito de trabalho em que o IICA concentra seus esforços e sua capacidade técnica, tanto sob o ponto de vista de seus recursos humanos e financeiros, como de sua relação com outros organismos internacionais.







INSTITUTO INTERAMERICANO DE COOPERAÇÃO PARA A AGRICULTURA  
SHIS QI 5, Conj. 9, Bl. D, Comercial Local, Caixa Postal 09-1070, Brasília, D.F., Brasil  
Tel. [061] 248-5477 - Telex 611959 INAG-BR - Correio Eletrônico 1536 - Fac-Símile: [061] 248-5807