

PN-ANU-756

12-11-76

34

**SUMMARY OF
M S and Ph D DISSERTATIONS**

BANGLADESH RICE RESEARCH INSTITUTE

Mail address : GPO Box No. 911

Dhaka, Bangladesh

**USAID/Dhaka Staff
Reference Library**

DUPLICATE

FOREWORD

Our young scientists in course of their higher studies conducted appropriate research for the fulfilment of their respective academic requirements. Such research works are important contributions to technology development by individual scholars. These need to be documented for proper use.

By now BRRl has sent out 70 scientists to study at foreign universities for higher degrees. Thirty-eight of them have returned after successfully completing their degree courses. The present compilation is an extract of dissertations of these scientists. We have taken up this compilation to allow our scientists to read and learn developed ideas and thoughts in a single publication so that they can mutually benefit from and make best use of them.

The compilation includes 11 Ph D and 27 M S dissertations which have been done while at the Institute. One copy each of these dissertations have been kept in the BRRl Library for serious readers.

The objective to publish the summary dissertations will be worth if readers in agriculture, specially rice scientists, find it useful in their research work.

S M H Zaman
Director

CONTENTS

V FOREWORD

M S DISSERTATIONS

- 3 Effects of in vitro nutritional factors and host-passage on pathogenic variability of *Xanthomonas oryzae*
Mahammad Abu Bakr
- 4 Varietal variation and evaluation procedures for ratoonability in rice (*oryzae sativa* L)
Mohammad Mahiul Haque
- 6 Variation in cultural characteristics, physiology, and pathogenicity of field isolates of *Thanatephorus cucumeris* (Frank) Donk, the casual organism of rice sheath blight disease
Mohammad Aminul Haque
- 8 Resistance to the brown planthopper *Nilaparvata lugens* (Stal.) in rice varieties
A N M Rezaul Karim
- 11 Investigation into causes of sterility in Mala rice
Mohammad Rafiqul Islam
- 12 Studies on seepage and percolation in selected field conditions in Bangladesh
Mohammed Abdul Ghani
- 15 Socio-economic factors constraining yields of rice in selected sites in the Bangladesh Rice Research Institute pilot project area, Dhaka, Bangladesh, 1976-77
Mohammad Mukarram Hossain
- 20 A technique to identify constraints to high rice yields in farmers' fields
Kamal Rahim
- 24 Weeds in cropping systems as affected by hydrology and weeding regime with emphasis on dry-seeded rice
Nizam Uddin Ahmed
- 27 Component analysis for the integrated control of the rice whorl maggot, *hydrellia sasakii* yuasa and Isitani
Chowdhury Mohammad Nurrullah

- 30 Determining labour requirements for cultural operations in crops.
Debi Narayan Rudra Paul
- 34 An economic evaluation of the deep tubewell rehabilitation programme at Dhamrai, Dhaka, Bangladesh
Mohammad Nazrul Islam
- 39 Stability of selected Mungbean *vigna Radiata* (L) Wilczek cultivars evaluated under different growing conditions.
Mohammad Nazrul Islam Miah
- 42 An evaluation of the four-month Rice Production Specialist Training conducted by the Bangladesh Rice Research Institute
Farhad Jameel
- 45 An evaluation of the sorghum production pilot extension project in the province of Batangas, Philippines
Mohammad Tafiquddin Somobayee
- 59 Growth and development characteristics affecting the yield performance of nine varieties of soybeans planted immediately after rice in two climatic regions of the Philippines
Mohammad Nur-E-Elahi
- 65 Studies on host-parasite relationship of rice stem nematode, *Ditylenchus augustus* (Butler) Filipjev, 1936, on rice *oryza sativa* L.
Mohammad Loothfar Rahman
- 66 An economic analysis of the factors affecting the adoption of modern varieties of rice in some selected sites of Bangladesh
Bazul Ameen Ahmed Mustafi
- 69 Optimal cropping systems for some selected farms in Dhaka district, Bangladesh, July 1981
Mohammad Afzal Hussain
- 74 Testing evaluation, and modification of the IRR1 manual rice transplanter in Bangladesh
Mohammad Abdul Baqui
- 75 The influence of cinnabarmath *Tyria Jacoaeal* (Arctijidae Lepidoptera) on reproduction of ragwort, *Seneclo Jacobae* L (compositae)
Zahirul Islam
- 77 Effects of differently applied rice straw and neem cake on nitrogen transformation in flooded soil
Tafiqul Aziz and Dr I Watanabe

- 80 Evaluation of rat control techniques in experimental fields of the International Rice Research Institute
Mohammad Sayed Ahmed
- 83 Soil and plant tests for available sulphur in wetland rice soils
M Mujibul Islam
- 85 Effect of several growth regulators, shading and cultural management practices on rice ratooning
Mohammad Abdul Quddus
- 88 Agro-economic evaluation of double cropping in the Beqa's plain of Lebanon
Mohammad Jalaluddin
- 92 Rice processing in Bangladesh Rice Research Institute pilot project area, Joydebpur, Bangladesh
Mohammad Abdul Jabber
- Ph D DISSERTATIONS
- 99 The Influence of specific gravity and deterioration of rice seed on field performance under two plant population densities
A J M Azizul Islam
- 102 Etiology, epidemiology and control of diseases caused by sclerotial fungi in Louisiana rice
A K M Shahjahan
- 104 Resistance to biotype 3 of the brown planthopper, *Nilaparvata lugens* (Stal) in rice varieties
Muhammad Shamsul Alam
- 106 Selection for yield, protein, and kernel size in oat populations using a partitioning method
Nur Muhammad Miah
- 109 Photosynthesis and growth of rice (*Oryza sativa* L) as influenced by potassium nitrate and urea fertilization
Nilufer Hye Karim
- 111 Varietal resistance of rice to green leafhopper, *Nephotettix virescens* (Distant) : sources, mechanisms, and genetics of resistance
A N M Rezaul Karim
- 115 Inheritance of two mutant flower characters in Korean lespedeza
Muhammad Abdul Hamid

- 118 Chemical properties of lipids in developing and mature rice grain
Muhammad Nurul Hoque Choudhury
- 121 A study of nitrogen in soil plant system in relation to growth and yield of wetland rice as influenced by N supply and crop management
Nurul Islam Bhuiyan
- 126 Suppression of white-backed planthoppers, *Sogatella Furcifera* (Horvath), and rice leaf folder, *Cnaphalocrocis medinalis* (Guene) population by natural enemies
Nazira Quraishi Kamal
- 130 Microbial biomass and carbon metabolism in soils
Mustaqe Ahmed

M S DISSERTATIONS

Title : *Effects of in vitro nutritional factors and host-passage on pathogenic variability of Xanthanoma oryzae*

Author : Muhammad Abu Bakr

University attended : The Graduate Division of the University of Hawaii, USA

Year of completion : May 1972

SUMMARY

Successive passage of isolates of *X. oryzae* by artificial inoculations through resistant varieties of rice resulted in inconsistent increases in pathogenicity, while passage through susceptible varieties caused a consistent decrease in pathogenicity. The extent of alternations in pathogenicity, however, in resistant and susceptible varieties did not proceed beyond a certain level of resistance or susceptibility of the varieties. In passage through a moderately resistant variety some virulent isolates lost pathogenicity while others were relatively unaltered.

Serial transfer of the pathogen on basal agar media differing in carbon and nitrogen sources which supported good growth of the bacterium, decreased pathogenicity. The reduction in pathogenicity of *X. oryzae* was greater when cultured on sodium succinate and valine media where bacterial growth was slightly inhibited and less when cystine, casein hydrolysate or a combination of glutamate, cystine, aspartate and methionine media were used. In contrast, pathogenicity was not altered in serial transfers through potato semi-synthetic (PSA) medium.

The maintenance of the bacterium with monthly transfer on PSA slants in a deep-freeze over a period of four months did not affect pathogenicity.

Title : *Varietal variation and evaluation procedures for ratoonability in rice (Oryzae sativa L.)*

Author : Mohammad Mahiul Haque

University attended : The Faculty of the Graduate School, University of the Philippines at Los Banos, Laguna, Philippines

Year of completion : July 1975

SUMMARY

Varietal variation and the evaluation procedures for ratoonability in rice were studied. Ratoonability was found to be a variable character. Significant differences in ratoon yields and percent ratoon among the breeding lines were observed. Cutting the main crop 25 cm above the ground level and harvesting the main crop five days before optimum maturity were found to be optimum for the expression of maximum ratoonability. With nine different cutting height and time treatment combinations in a pair of varieties, one superior and the other an inferior ratooner, the same trend in ratoon yield and percent ratoon was observed. Thus, ratoonability was found to be a varietal character.

Significant positive correlation between the percent ratoon and the ratoon grain yield was observed. Significant correlation was also found between the main crop and the ratoon crop yields. Ratoon plant height increased with increased cutting height of the main crop, but length of regrowth and ratoon maturity period decreased with increased cutting height. In a particular cutting height, ratoon maturity period decreased with the later harvest of the main crop and vice versa.

By providing the optimum conditions for maximum ratoonability, thirty four IRRI breeding lines were evaluated for their varietal variability for this character. The comparison criterion was percent regrowth of ratoon tillers. IR2061-423-1, a sister line of IR29, was found to be the best ratooning line with ratoons from almost all the cut tillers. IR2145-13-3 and IR1924-30-2 performed

equal to the high ratooning check (IR2145-20-4). Seven IR lines viz : IR2071-11-4-31-3-2, IR1923-5-3-2, IR2797-86, IR2829-211, IR2071-527-6, IR2829-243 and IR2071-868-2-4 were also found to be superior in ratoonability performing significantly better than the low ratooning check (IR2681-16).

Title : *Variation in cultural characteristics, physiology, and pathogenicity of field isolates of *Thanatephorus cucumeris* (Frank) Donk, the casual organism of rice sheath blight disease*

Author : Mohammad Aminul Haque

University attended : The Faculty of the Graduate School, University of the Philippines at Los Banos, Laguna, Philippines

Year of completion : August 1975

SUMMARY

Sheath blight disease specimens were collected from rice fields at different places of the Philippines. Twenty five isolates out of 69 were selected for detailed study.

In cultural morphology of the isolates there were considerable variations. Size and number of sclerotical bodies were negatively correlated. Some isolates produced crust-like sclerotia, others normal sclerotial bodies scattered over the colony and petridish lid or in regular pattern on the colony. Others were like thick mats on the colony. Six different types of sclerotial formation pattern were noted.

In growth response to different temperatures, the isolates varied considerably but not widely except Rs 2 which was favoured by lower temperature. This isolate was collected from a cooler region Banaue, Ifugao. The fungus was found experimentally to be adaptable to higher temperatures after repeated culture of selected hyphal tips at higher temperature.

Different isolates were found to differ their CO₂ tolerance. Isolate RS 9 showed 49 % and Rs 11 showed 9 % growth inhibition due to CO₂ released by the respiration of 1 g green leaf of rice introduced into growth tube.

In pathogenicity tests on rice varieties in the greenhouse and in the field, all the test varieties and lines were infected showing

different degrees of resistance. The isolates also differed in their virulence. There was no distinct differential reaction to the isolates by the test varieties. Isolates growing vigorously in culture medium were found to be more virulent.

Incubation temperature showed effects on lesion development on artificially inoculated detached flag leaf of rice. Largest average was at 28 C. At 34 C, lesion development was not affected to the same extent as that at 20 C nor as the growth rate of the fungus on culture medium at 34 C.

Some of the sclerotia exposed to sun for nine hours failed to produce any infection and some produced smaller lesions compared to those of control and of 3 or 6 hour exposure. The test isolates varied slightly in this character.

Results on host range studies by two artificial inoculation methods showed that corn (sweet corn), sorghum (Cosor 3), peanut (CES 101), okra (smooth green), mung bean (Mg 50-10A), soybean (Hsih-Hsih) *Echinochloa crusgalli*, *E. colonum*, *Celosia argentea*, *Cyperus deformans* and *Monochoria vaginalis* were infected by all the test isolates.

Title : *Resistance to the brown planthopper, Nilaparvata lugens (Stal.) in rice varieties*

Author : A N M Rezaul Karim

University attended : University of the Philippines at Los Banos, Laguna, Philippines

Year of completion : October 1975

SUMMARY

A total of 2,323 rice varieties from the rice germplasm bank of the International Rice Research Institute (IRRI) was evaluated in the greenhouse for their resistance to the brown planthopper. Eleven varieties were finally selected. The damage suffered by these varieties was related to the number of insects present on them.

The nature of resistance to the brown planthopper in the selected rice varieties were identified as mainly of non-preference and antibiosis types. Tolerance was also identified as a factor for resistance. Nine of the eleven selected varieties possessed a high degree of non-preference and antibiosis, and two varieties, Kentjana and Bathurst, were found to possess considerable degree of tolerance. The varieties non-preferred by adults were also non-preferred by nymphs. Preference for feeding or shelter was found to be related with that for oviposition. The adult insects showed non-preference also for the plant extracts of the resistant varieties. The non-preference of the insects for the resistant varieties did not change with the growth stages of the plants. Gustatory stimulus (stimuli) appeared to govern the non-preference response of the insects. The resistant varieties consistently effected high mortality of the insects feeding on them and prolonged the rate of development of the nymphs. These suggested that resistant varieties probably lacked adequate nutrient(s) vital for the insect or contained toxins.

The longevity of the females was 5.7-13.4 days longer and of the males 12.5—17.4 days longer on the susceptible variety TN1 and the females laid 3.3 - 389.3 times more eggs on TN1 than on the

resistant varieties. A shorter longevity of the insects was due probably to ingestion of inadequate quantities of nutrients or to ingestion of toxins from the resistant varieties. These results confirmed the earlier records of high mortality of insects on resistant varieties. Resistant varieties caused distinct under-development of ovary which appeared to be the main factor for low fecundity of the females feeding on the resistant varieties.

High correlations were evident among the amount of feeding and honey-dew excretion, frequency of probing punctures, mortality of the insects, developmental rate of nymphs, longevity and fecundity of the adults, and ovarian development of the females. The resistant varieties, on which insects fed and excreted in a smaller amount and made more probing punctures, effected high mortality of the insects, prolonged the developmental period of the nymphs, shortened longevity and reduced fecundity of the adults, and caused under-development of the ovaries. These again indicated that the resistant varieties probably lacked adequate nutrients or contained toxins.

No consistent result on the survival of the insects feeding on plant extracts was obtained. Insects feeding on the extracts of the susceptible variety TN1 suffered as high mortality as those feeding on the extracts of the resistant varieties indicating that some important component(s) vital for insect survival were perhaps removed during the extraction processes.

The resistant varieties exerted persistently a cumulative effect in reducing or limiting the population buildup of the brown planthopper. Population increases on the susceptible variety TN1 were 90- and 240-fold after 30- and 55 days, respectively; whereas, on the resistant varieties, insect population declined or increased only slightly. The cumulative reduction of insect population on the resistant varieties was apparently brought about by a persistent high mortality of nymphs and adults, failure of the insects to feed adequately, under-development of ovaries of the females, low fecundity, and low hatching of the eggs.

The resistant varieties adversely affected the ovarian development of the females. Newly emerged females caged for 4 days on the resistant varieties had distinct under-developed ovaries

compared to fully developed normal ovaries of those confined on the susceptible variety TN1 for the same period. Ovarian under-development appeared to be the principal cause for low fecundity of females on the resistant varieties.

Adverse effect of the resistant varieties was recorded on the hatching of the eggs. Hatching of the eggs laid on the susceptible variety TN1 was 5 - 24% more than that on the resistant varieties. The cause of low hatching of the eggs on the resistant varieties was not clearly known. Chemical factors of the plant sap and immaturity of eggs caused by ovarian under-development may be related to low hatching.

The resistant varieties Kentjana and Bathurst were found to carry a low level of non-preference and antibiosis. Instead, they possessed a higher degree of tolerance. Infested with an insect population at which the susceptible variety TN1 suffered heavy damage, the resistant varieties Kentjana and Bathurst tolerated the infestation, grew significantly better and produced consistently more grain yield.

Title : *Investigation into causes of sterility in Mala rice*

Author : Mohammad Rafiqul Islam

University attended : Department of Genetics and Plant Breeding, Faculty of Agriculture, Bangladesh Agricultural University, Mymensingh

Year of completion : September 1977

SUMMARY

Mala (IR272-4-1-2) with its three sister lines were tested in a split-plot design with eight NPK combinations at ERRI, Joydebpur, in the 1975-76 consecutive Boro and Aus seasons. The object of the experiment was to find the causes of spikelet sterility in Mala. Detailed cytological studies revealed that the spikelet sterility in Mala was due to 2:1 ratio of normal and abnormal meiosis observed in the pollen mother cell (PMC) which may be due to genetical phenomenon of balanced lethal. This mechanism forces AA and aa to cause ovule abortion, and the heterozygote Aa to survive. Thus, due to this heterozygosis further selection on sterility will be least effective for selecting a fertile line. Further, abnormal meiosis was mainly due to reciprocal translocation. Distribution of spikelet sterility along the length of the panicle revealed that the top part showed the least degree of sterility followed by the middle and the bottom parts. This trend is definitely associated with the autogenic development of the spikelet. Presence of japonica germplasm in CP 231, a parent of Mala, might also be responsible for sterility. However, fertilizer treatments had no significant effect on chromosomal aberration and spikelet sterility.

Title : *Studies on seepage and percolation in selected field conditions in Bangladesh*

Author : Mohammed Abdul Ghani

Institute attended : The Asian Institute of Technology, Bangkok, Thailand

Year of completion : April 1978

SUMMARY AND CONCLUSIONS

This study was conducted to determine seepage and percolation rates for lowland rice in selected field conditions in Bangladesh. Field sites were located in the experimental farm of the Bangladesh Rice Research Institute and in the pilot project Area of the Institute. Experimental data were recorded for about three months, starting from the first week of March 1977. Soil types in all sites were clay loam.

Mean rates of seepage and percolation for the area were estimated from 1.3 to 2.0 mm/day with the use of the Inclined Metre Technique. Therefore, it can be concluded that seepage and percolation rate for clay loam type soil in Bangladesh is about 1.6 mm/day (the weighted mean rate for the four sites).

Seepage and percolation in this study has been computed by water balance accounting for which another important water balance component, evapotranspiration, was estimated. Evapotranspiration for the selected area was estimated as 4.2 mm/day, based on mean of the data recorded for three months. Thus, about 28% of the water used in the field is lost through seepage and percolation (not including surface drainage) ; this is 38% of evapotranspiration. It is a loss and, therefore, has a strong effect on the water requirement for rice cultivation.

Soil texture has an important impact on seepage and percolation, but since all four experimental areas had clay loam soils, the difference could not be shown in this study. However, the highest S and P rate was in the sites with greatest sand percentage.

RAINFALL AND STANDING WATER

Days of rainfall did not influence seepage and percolation. Standing water depths up to 6 cm did not show much influence on seepage and percolation rate, but if the depth is higher than that it will increase seepage and percolation. This is due to seepage through cracks near the tops of levees.

Seepage and percolation (S and P) has been estimated for this study by subsidence of water as measured by inclined metres. Inclined metres give satisfactory results; because the S and P rates computed by inclined metres are quite close to the water balance computed S and P rates. Moreover, data recording for this technique does not require great technical skill. A sincere observer is enough to record data.

Manageability of the inclined metre is not an acute problem, but initial fixing of the metre needs care. The meter is fixed with a selected slope (5:1 in this study); so the accuracy of the data depends on the accuracy of the slope. Therefore, the angles and the level of the frame needs accurate fitting and should be checked frequently.

Inclined metre is a useful tool for estimating S and P and can be valuable in water management studies.

RECOMMENDATIONS

In this study S and P rates have been estimated for four selected field sites in Joydebpur, Bangladesh. It has been observed that a significant portion (28%) of the water requirements for rice cultivation is lost through S and P which averages about 1.6 mm/day. For reducing S and P the following recommendations are enlisted :

- ➊ Irrigated land in the middle of dry lands should not be selected ;
- ➋ Land should be levelled and if not possible to use completely levelled land then slope should be gentle;
- ➌ Strong levees should border the paddies ;
- ➍ Keeping depth of standing water on the paddies higher than 4-6 cm should not be practised because it encourages lateral flow through cracks in the levees;

- Greater difference in water depth between the adjacent paddies should be avoided;
- Alternate drying and flooding of irrigated land should not be encouraged;
- Thorough puddling should be practised ;
- Try to grow rice in soils low in sand content.

Studies of the effect of the listed recommendations on S and P rate and their influence on the water management may be taken up in the future.

Title : *Socio-economic factors constraining yields of rice in selected sites in the Bangladesh Rice Research Institute pilot project area, Dacca, Bangladesh, 1976-77*

Author : Mohammad Mukarram Hossain

University of attended : The Faculty of the Graduate School, University of the Philippines at Los Banos, Laguna, Philippines

Year completion : November 1978

SUMMARY

Agriculture is the mainstay of Bangladesh's economy. Rice alone occupies about 81% of the total cropped area. But, the productivity still remains at a low level of 1.8 t/ha. With the existing situation in Bangladesh, the only alternative left to increase rice production is the adoption of modern varieties with the new techniques of production. But, it is believed that the performance of modern varieties in farmers' field, is lower than their potential yield capacity. It is our interest to know the facts and if so, what are those biological (fertilizer, weed control and insect control, etc.) and socio-economic factors (profitability, availability of necessary inputs, knowledge, etc) which retard farmers' yield. This has been done in selected sites of the BRRl pilot project area following the general methodology of rice yield constraints developed in IRRI.

The scope of this study included three crop seasons, i.e. Boro 1976-77, Aus 1977 and transplant Aman 1977, comprising 11 villages. There are four rice-based cropping patterns existing in the study area. The most widespread cropping pattern is Aus followed by transplant Aman which is practised on the total farms studied. Most of the farmers under this pattern follow varietal sequence of modern/local. Three most important reasons identified by the farmers for using local varieties in any season of the year are :

- good taste ;
- fits easily in the cropping pattern ; and
- short maturity.

An average of 52% of the sample farmers mentioned insect infestation with comparatively more insect problems during the Transplant Aman than during other seasons. Insect infestation, however, was perceived as causing greater yield reductions during the Boro season.

Twenty percent of the farms under study fall under the owner-share system. In the Aus season, most of the tenants share the crop with their landlords on a 50:50 basis. However, the same farmer in the transplant Aman season gets only 33% while the rest 67% goes to the landlord, even if the landlord does not share in the cost of production.

Only 27% of the farmers under study borrowed from different sources. However, the amount received by farmers is not enough as reported by them. Seventy-two percent of the farmers said that they had income from other sources, averaging an annual income of Tk. 1500.

Comparisons between survey and experimental farms were made with respect to yield and input use by testing whether the groups are representative of the same population. The two groups did not differ significantly from each other except in two cases. These are weed control in the Aus season between experimental and survey farms within location I, and yield in the Boro season between experimental farms in location I and location II.

Among the experimental farmers who identified yield constraints, a large number perceived inadequate insect control as the primary yield constraint. A similar perception prevailed among survey farmers except in the Aus season when most of the farmers believed inadequate use of fertilizer was the primary constraint. The reason given by experimental farmers for inadequate insect control was the delay in taking insect control measures. Such delays are caused by the inability of farmers to recognize insect infestation well ahead of its occurrence. However, survey farmers mentioned non-availability of insecticides as the primary socio-economic constraint. The most important reason for inadequate use of fertilizer, cited by both experimental and survey farmers, was the lack of cash in their hands.

High yield gaps were estimated with modern varieties in the Aus and transplant Aman seasons (1.0 t/ha) in both cases. In the Boro

season, yield gaps were more or less equal for local and modern varieties averaging 0.8 t/ha. Management component experiments showed that yield increase up to M_5 level in the Boro season, and M_5 level yield was economically recoverable. In the Aus season, yield increased up to M_4 level with an economically recoverable yield at the same level. For transplant Aman, yield increased up to M_4 level with local varieties and level for modern varieties. In the both cases, M_3 level yield was economically recoverable. However, on the average economically recoverable yield gap was found to be a maximum of 1.0 t/ha in each season.

Since there are appreciable interaction effects among the test factors, both individual and joint contribution of test factors were computed for each season. However, economic analyses was made only on the joint contributions because in presence of interaction economic analyses of the individual contribution have a trival meaning.

Economic analyses of yield contributions on the average showed that (F+I) in the Boro, (N+P+K) in the Aus and (N+S) in the transplant Aman seasons provided highest net added returns (a).

In experimental farms (each having yield gap) for which yield contributions are computed, perceptions of those farmers are compared with experimental findings. It was found that most of these farmers were not aware that their yields could be profitably increased with a higher level of inputs. Economic analysis of the experimental data showed that farmers can achieve at least one ton increase in yield/ha by using the high level of inputs. Moreover, while experiments showed that joint contributions of test factors are most important, farmers mentioned single factor as important constraints. The interview of the survey farmers also gave similar results.

The economic analysis of the joint contributions in all seasons showed that fertilizer in combination with another factor was most often the major yield contributing factor, while most farmers perceived inadequate insect control as the primary yield constraint. The most important factors mentioned by farmers for the low use of fertilizer was the lack of cash in hand. Most of them also replied that non-availability of credit was the primary reason for not using

a F = Fertilizer, I = Insect control, N = Nitrogen, P = Phosphorous,
K = Potassium, S = Sulphur.

credit to buy fertilizer. But, during the study period, there appeared to be an adequate supply of fertilizer.

Two important reasons identified for inadequate insect control measures were : non-availability of insecticides and delay in taking insect control measures. The latter was traced to inadequate knowledge of insects and insect control measures.

However, the yield constraints identified through farmers' interviews vs. experiments can be summarized as follows :

● Farmers are not aware that their yield can profitably be increased with a high level of test inputs. Economic analyses of experimental data, however, showed that farmers profitably can increase their yield by 1.0 t/ha.

● Farmers' perceived single contribution of test factors are important while experiments show that joint contributions of test factors are more important.

● Farmers in the study area believe that they take adequate weed control measures. Experiments in the Boro and the transplant Aman seasons support the result that weed control measure as an individual factor have little contribution to yield. Weed control in combination with other test factor or factors, however, have high contribution to the yield.

● Farmers believe insect control more important than fertilizer while experiments show that fertilizer in combination with other factors is most important.

The statements above suggest that farmers' inadequate knowledge on input use is the most important constraint for high yield. The other socio-economic constraints identified through farm interviews are :

● Farmers cannot buy necessary fertilizer due to the lack of cash in hand. Credit facilities are still inadequate to fulfil the farmers' demand for cash. However, availability of fertilizer was not a problem over the study period.

● Poor insect control knowledge of the farmers prevent them from taking timely insect control measures.

● Non-availability of insecticides is also a very important reason for inadequate insect control measures taken.

LIMITATIONS AND RECOMMENDATIONS

Further experiments should be conducted in the farmers' fields in each season. Unlike the study years, the test factors used should be the same over time, so that the estimation of yield gap and the yield contributions of the factors by season can be made based on a larger number of observations over the years.

However, after several years of additional research and experience we may be able to more strongly recommend the following which are now only tentative :

● Farmers should be informed about the results of field experiments, for example, the highest yield found economically recoverable in their field and the quantity of inputs required for such yields.

● Farmers should be given field training on the application of fertilizer, and more specially on insect control measures such as identifying different insects and methods of applying insecticides.

● The institutional credit facilities should be improved. To provide incentives for the credit investing farmers, credit institutions should also be ready to share any losses from crop failure with the farmers.

Title : *A technique to identify constraints to high rice yields in farmers' fields*

Author : Kamal Rahim

University attended : The Faculty of the Graduate School,
University of the Philippines at Los Banos,
Laguna, Philippines

Year of completion : April 1978

SUMMARY

Despite the rapid adoption of new high yielding varieties and the corresponding production technology, yields in farmers' fields are far below the level usually obtained in the experiment stations. The difference between the experiment station yield and the actual farm yield is referred to as yield gap and the factors responsible for it as yield constraints.

A multidisciplinary experimental-survey approach to study yield constraints is being employed by rice research workers participated in the IRAEN project. In this approach the actual farm yield is not compared directly to the experiment-station yield but rather to the so called "potential farm yield" which represents the yield level obtained in the farmers' fields but with the use of improved technology. Hence, the yield gap used here refers to the difference between actual farm yield and potential farm yield. The experimental-survey approach attempts to identify and measure two types of yield constraints : biological and socioeconomic ; the first through experiments and the latter through surveys. The present work evaluates the experimental procedures used in conducting yield constraints experiments in farmers' fields.

Data collected from a series of experiments conducted in farmers' fields in the province of Laguna, Philippines from 1972 to 1977 were used to evaluate various experimental techniques for use in such yeild constraints study. The specific objectives were to:

- identify appropriate experimental designs and appropriate experimental plot techniques for use in on-farm yield constraints trials ;

- evolve effective analytical procedures for the analysis of data from such trials ; and
- identify and measure major biological constraints in the selected areas in the province of Laguna.

A yield constraints experiment attempts to obtain yield at farmers' level of practices, yield at improved level of some selected test factors, and yields at varying intermediate levels. Thus, as an essential part of a yield constraints experiment, the farmers' level of each test factors must be established and implemented in the experimental plots. We found that while there was no bias in the technique of simulation of farmer's level in the experimental plots regardless of whether it was done by the farmer himself or by the researchers (through the comparable paddy technique), the difference between the actual farmer's level and that simulated by the researchers could at times be very large. Hence, as much as possible the establishment in experimental plots of the farmer's level of as many test factors as feasible should be done by the farmer. Our work in Laguna farms indicate that insect control and weed control are two factors whose farmers' level could be done by the farmer himself in experimental plots. For fertilization, the researcher should perform the simulation but must employ an accurate determination of fertilizer rate (such as the marked-container technique).

Results indicate the presence of bias in results obtained from plots with farmer's insect control level placed adjacent to those with high level of insect control. An experimental layout that allows the separation of the two sets of pots, one with the farmer's level and another with the high level of insect control, should be employed.

Yields obtained from leveed and non-leveed plots could be different ; with leveed plots generally giving higher yields. Leveed plots could maintain water and chemicals applied better. These differences could be influenced by the specific locations of the plots in the paddy ; especially when the plots received high level of inputs. During the dry season when irrigation water is used throughout the season, a larger yield difference between leveed and non-leveed plots was observed when the plots were placed in the middle of the field (one side of the plot coincided with farmers'

levee) than when they were placed at the end of the field opposite to the entrance of irrigation water (two sides of the plots coincided with farmer's levee). When high levels of fertilizer and insecticide were applied to non-leveed plots, some chemical diffusion could be expected. The diffusion, however, was primarily confined to only about 1/2 m width outside the perimeter of the plot. No such distinct chemical diffusion was observed inside the perimeter of the plot.

As much as feasible non-leveed plots should be used in conducting yield constraints experiments in farmers' fields. Not only does it reduce costs in constructing and maintaining levees throughout the crop growth, it provides for more uniform operations of the farmers' level for such practices as land preparation, transplanting and water management; and, consequently, gives a better estimate of the various yield levels desired.

The use of 6 to 9 sq m harvest area per plot was found to be appropriate for use in yield constraints experiments in farmer's fields.

Variation among farms was the major component of variation in actual farm yield, in potential farm yield and in yield gap. However, for the measures of contributions of test factors, while the variation among farms was still relatively larger than the variation among replications within farms; it was not as dominant as in the case of yields and yield gap. Hence, yield constraints experiments should be conducted with emphasis on including a sufficiently large number of farms rather than on using a large number of replications per farm. Based on results from Laguna and without cost consideration, yield constraints experiments for the estimation of yield gap (supplemental trial, mini-factorial trial and/or complete factorial trial) should be conducted in at least 20 farms to achieve a degree of precision (indicated as coefficient of variation of mean expressed as a percentage of means) of about 9.5 to 10%. It was not necessary to have more than two replications per farm.

Interaction effects among the three factors tested (namely, insect control, fertilizer and weed control) were not consistently observed and generally small. Only the interactions between insect control and fertilizer were identified in a few farms in some years

but primarily in dry season crops. In areas where interactions among test factors are generally non-appreciable, such as in Laguna, the mini-factorial design could be effectively used. This would keep the size of the experiment small which would enable the researcher to conduct the experiments in a sufficiently large number of farms.

When interaction effects among test factors are non-appreciable, the choice of analytical procedures to be used was also shown to be not critical. The three alternative procedures evaluated did not show appreciable differences.

Average actual farm yield, potential farm yield and yield gap over four years was 4.5, 6.5, and 2.0 t/ha, respectively in the dry season and 3.5, 5.4 and 1.9 t/ha respectively in the wet season. Both actual farm yield and potential farm yield were about one t/ha higher in the dry season than in the wet season while the yield gap was the same. The size of yield gap did not seem to be dependent on the level of the actual farm yield ; i.e. yield gap was large even when the actual farm yield was high. In all seasons and years, improved insect control and fertilizer contributed consistently more than 80% of the total yield gap in Laguna farms ; with negligible contribution from improved weed control.

For actual farm yield, potential farm yield, yield gap and the contributions of the test factors, the coefficient of variation among years and seasons was much smaller than that among farms within year per season. That is yield-constraints results in Laguna were quite stable and consistent over seasons and years in the four years (1973-1976) that the experiments were conducted. Repeating experiments in the same localities over many years seem unwarranted in such case.

- Title** : *Weeds in cropping systems as affected by hydrology and weeding regime with emphasis on dry-seeded rice*
- Author** : Nizam Uddin Ahmed
- University attended** : The Faculty of Agriculture, University of the Philippines at Los Banos, Laguna, Philippines
- Year of completion** : January 1979

SUMMARY

Six field experiments were conducted from May 1977 to November 1978 at the International Rice Research Institute's farm, Laguna, Philippines.

In experiment I, different crop rotations were practised on four fields having different elevations and ponding potentials, to try to understand how many and what species of weeds appear under different soil moisture conditions and how these are affected by different cropping practices and weeding regimes.

The number of different weed species decreased with increase in ponding potential and cropping intensity. Grasses predominated in a well-drained upland whereas broadleaf weeds predominated in land with a high ponding potential. Dominance of weed species differed from field to field and from season to season. *Echinochloa colona* (L.) Link—a grass—and *Calopogonium mucunoides* Desv.—a broadleaf weed species—occurred in all fields growing in association with dry-seeded rice. *E. colona* was the only species which grew in all seasons and in all fields except the 1978 dry season in the well-drained upland. As the number of weedings increased, more weeds having less weed weight were removed in general from all the fields and in all seasons. Weed growth was high in land with a high ponding potential compared to the other fields when dry-seeded rice was planted in all the fields but when wet-seeded or transplanted rice was planted in land with a low or high ponding potential, weed incidence was much less compared to dry-seeded rice in well-drained upland.

The coefficient of similarity between the weed communities that grew in association with dry-seeded rice in land with a low ponding and a high ponding potential was 67.7% whereas that between a well-drained upland and with a high ponding potential was only 0.8%. The coefficient of similarity between the weed communities growing in association with wet-seeded and transplanted rice was 75.8% whereas that between a dry-seeded rice crop and a transplanted rice crop was only 8.0%.

The number of weeds occurring in the fourth or the fifth crop decreased in all the plots except in the unweeded plots of the well-drained upland due to the effect of weeding regimes applied to the previous three or four crops. Weed seed reserves in the soil also decreased except in the unweeded plots of the well-drained upland, land with a low and a high ponding potential where it increased as a result of the weeding regimes applied to the previous three or four crops.

No significant yield losses due to weeds were observed in wet-seeded and transplanted rice and upland crops but significant and almost complete yield loss was observed in dry-seeded rice.

The effect of different rates of basal application and topdressing of nitrogen on weed growth and yield of dry-seeded rice was studied in experiment 2. The amount of N applied to all plots during crop growth was constant.

The yield of dry-seeded rice was not affected by rate of basal application of N. Weed counts and weights 2 weeks after rice emergence (WAE) increased linearly with increase in the rate of basal N-application. Weed counts 5 WAE increased linearly with increase in the rate of nitrogen applied as a topdress.

In experiment 3, the effect of methods of seeding and time of weeding on the yield of dry-seeded rice was examined.

No significant difference was observed between dibbling and row seeding in terms of grain yield. Significantly higher grain yield was obtained by weeding the plots compared to no weeding for both seeding methods. No significant difference was observed between weeded and unweeded plots for either seeding method in terms of total weed counts but total weed weight was significantly lower in the weeded plots than the unweeded plots for both seeding methods.

Weeding requirements in dry-seeded rice were determined in experiment 4.

The highest grain yield was obtained by weeding three times 2, 5 and 8 WAE. The yield from the plots weeded once at 3 or 4 WAE was not significantly different from that obtained from the plots weeded two or three times or that maintained weed free. Time of weeding was more important rather than the number of weeding. As the number of weedings increased, the number and weight of grasses and broadleaf weeds decreased but the number of sedges remained constant.

Effect of method of seeding and number of weedings on the yield of dry-seeded rice was studied in experiment 5.

For all methods of seeding was superior to no weeding but there was no significant difference between the plots weeded twice or three times in terms of yield. There was no significant difference between broadcast seeding and seeding in rows 15, 20 or 25 cm apart with respect to grain yield. Significantly higher weed count and weight was obtained at harvest from the unweeded plots compared to the weeded plots. Seeding methods were not significantly different in terms of weed counts and weights at harvest.

Growth and yield of dry-seeded rice as affected by method of seeding and weed control practices was studied in experiment 6.

No significant difference was observed in grain yield between the plots that had a pre-emergence application of butachlor [*N*-(butoxy-methyl)-2-chloro-2', 6'-diethylacetanilide] followed by one hand weeding and those that were hand weeded three times. Yields from these plots were significantly higher than those from the unweeded check. The rice stand was not affected by butachlor application. There was no significant difference between broadcasting, sowing in rows spaced 15, 20 or 25 cm apart and cross sowing at 15 by 15, 20 by 20 or 25 by 25 cm with respect to grain yield, weed counts and weights at harvest.

Title : *Component analysis for the integrated control of the rice whorl maggot, *Hydrellia sasakii* Yuasa and Isitani*

Author : Chowdhury Mohammad Nurullah

University attended : The Faculty of the Graduate School,
: University of the Philippines at Los Banos,
Laguna, Philippines

Year of completion : 1979

SUMMARY

For sampling adults of the rice whorl maggot, the mylar cage trap was found to be more efficient than the floating sticky trap.

The distribution pattern of the adults in a newly transplanted field as indicated by mylar cage sampling was found to be more random in the early morning than in the afternoon. There exists a significant positive correlation between afternoon sampling and tiller/unit area indicating that generally at high temperatures and windy condition in the afternoon the whorl maggot adult preferred dense areas for shelter. A significant negative correlation was observed between number of adults trapped and damaged leaves indicating a tendency of the whorl maggot to avoid damaged leaves for oviposition. Plant height and percent of damaged leaves had a significant positive correlation indicating whorl maggot damage significantly, reduces plant height. But there appeared to be no significant correlation between adult number and grain yield or percent damaged leaves and grain yield.

Both the field and screenhouse study indicated that rice whorl maggot damage significantly reduces plant height and delays flowering and maturity by 7-10 days. Whorl maggot damage has no adverse effect on tiller production, instead, it induced number of productive tillers per unit area above that of the protected plants. On the other hand, whorl maggot damages caused late panicle initiation in some tillers and, as a result, the panicles were still green at harvest. These immature panicles probably increased percent of unfilled grains in the unprotected plots, but the overall grain yield difference was not significant.

The peak whorl of maggot damage in terms of percent damaged leaves was observed from 3-4 weeks after transplanting (WT). In both the moderately resistant and susceptible varieties the peak of larval population was observed at 4 WT and declined sharply at 5 WT.

Modern high tillering varieties like IR40 and IR36 were found to recover very fast with time. By harvest there was no marked visual difference between damaged and undamaged plants, except for slight differences in plant height which was sometimes significant.

In the study where methods of insecticide applications were compared, carbofuran applied at the rate of 0.75-1.00 kg a.i./ha as a soil incorporation, prior to transplanting, was found to be more efficient in controlling whorl maggot than granular broadcast to paddy water, perlite-dapog root coat or a foliar spray. But in another study, on the timing of carbofuran application, late protected plants had more tillers than early protected plants. This again indicated that whorl maggot damage induce tiller development.

Differential seedling age at transplanting had no direct effect on whorl maggot damage but aged seedlings could pass the vulnerable tillering phase faster, compared to younger seedlings.

A varietal preference for oviposition was observed among varieties. As whorl maggots attack transplanted rice right after transplanting, weeds that come up several days later had no effect on adult maggot abundance or damage severity but other maggot species were found to be more abundant in weedy to that of weed-free field.

Plant spacing had no effect on damage intensity with a highly susceptible variety like TNI but with a moderately resistant variety like IR40, closer plant spacings had comparatively lesser damage.

Nitrogen had no effect on the ovipositional preference or damage severity of the rice whorl maggot but it had effect on the rate of plant recovery from whorl magot damage. To maximize the availability of nitrogen by the plants to recover from damage, split application was found better than basal application because of the chance for greater losses in the latter method.

Based on the present study it is evident that unlike the brown planthopper or stem borers, the rice whorl maggot infestation is quite randomly distributed throughout the field. This is assumed to

be because of the distribution pattern and behavior of the adults to avoid damaged plants in the field.

High infestations at 20 days after transplanting (DT) which caused 85% of the leaves to be damaged in IR36 (damage rating of 9) and 46% at 40 DT (rating of 7 as based on a 0-9 rating) ultimately affected plant height. But, even after such a severe damage pressure, the plants could recover the damage with time during the tillering phase. Although the damage caused reduction in plant height, on the contrary, damage induced new tiller development, and at harvest no significant yield difference was observed. In some instances some damaged plots gave higher yield (not significant).

The only observed adverse effect of rice whorl maggot damage on the yield components was the percent of unfilled grains. This could probably be overcome by reducing the proportion of nitrogen application as basal and increasing the number of split applications to induce faster rate of recovery. This, of course, needs further investigation.

Based on the present results and those of van Halteren (1977), it appears that rice entomologists should have some second thoughts concerning the whorl maggot. They should consider whether :

- it should really be considered as an economically important pest ;
- present efforts to identify 0-9 rating system should be modified ; and
- insecticides should be recommended where whorl maggot is the only pest problem at the early tillering phase.

To answer these questions and to make a well founded decision a time has come to start with very simple experiments consisting of treatments with and without protection at different problem areas to establish whether whorl maggot damage causes any economic damage.

As it is often difficult in the field to exclude the interaction of the other pests, parallel experiments should therefore be conducted inside a screenhouse where possible by introducing field collected adults. Also, the cumulative effect of the whorl maggot plus other insects and the relationship between whorl maggot and disease susceptibility should be studied.

Title : *Determining labour requirements for cultural operations in crops*

Author : Debi Narayan Rudra Paul

University attended : The Faculty of the Graduate School, University of the Philippines at Los Banos, Laguna, Philippines

Year of completion : June 1980

SUMMARY

Labour data on several crop-operations ; namely, ploughing, harrowing, planting, fertilization, insecticide application and harvesting were analysed in order to :

- estimate the labour requirement for these crop-operations and
- identify the factors responsible for the variation in the labour requirement data.

The study was based on the "secondary data" collected by the staff of IRRI Agricultural Economics Department in the Cropping Systems Programme through Farm Record Keeping (FRK) method. Encoded data on computer magnetic tapes were the input data used in the analyses. Results of preliminary investigation on the daily labour usage indicated an extremely high degree of variability in the labour data.

An internal consistency check of the data file was, therefore, undertaken to evaluate the quality of the data to be employed. The check was performed manually and included :

- proof reading (i. e., comparison of data in the tape-file with those on the original FRK form) ; and
- identification of inconsistencies in the records and possible remedies.

As a result of this check, 5% of the observations were identified being erroneous. Most of the errors occurred at the data recording stage. Eighty-nine percent of these detected errors were finally corrected, while the rest were treated as missing data.

Specific validation rules that could be used in a computer validation programme which would be able to detect most, if not all, of these errors were proposed.

In order to study the nature of variability in the labour data and to check for extreme observations, if any, the frequency distribution of labour usage for each selected crop operation was examined. The labour data used were the total (accumulated) labour usage on different "order" of operation (such as first ploughing; second ploughing, etc.) defined on the basis of reported treated area and the actual area of the plot. Range, variance and CV values were also computed to measure the extent of variability in the labour data. Skewness and kurtosis of each frequency distribution were computed to test the normality of the distribution. In addition, Shapiro-Wilk W-statistics and Kolmogorov-Smirnov D-statistics were also used as a supplemental test of normality.

As a result of the above investigations, the presence of extreme values in the labour data was observed. The extreme values were located at the "high" side of the frequency distributions.

A high degree of variability in labour usage, in all cases, was also observed. The range varied from 24 to 100 manhour/ha for second ploughing in dry seeded wetland rice to 1 to 141 manhour/ha for planting of mungbean. The distribution of labour data was found to be non-normal and positively skewed.

A hypothesis that there are known and measurable factors affecting labour usage was then set up in order to make proper adjustment in the estimate. The factors which were hypothesized to affect labour usage of one or more of the operations were plot size, rate of material applied (such as seed rate, fertilizer rate, insecticide rate) and crop-yield.

On plot size, the objective was to determine the plot size under which estimates of labour to requirement might not be "reliable". For this purpose, the data on labour usage was plotted against the plot size for each selected crop operation. Large fluctuations in labour usage on small plot sizes were observed. At the beginning of further investigation, all the outliers identified in the labour data were removed. The rule used was to identify an extreme point or a group of points as outlier if the total range of labour data including the extreme

point or group of points was greater than twice the range after excluding the point or group of points. In out of 26 crop-operations, outliers were identified. After excluding the outliers from the data, a simple correlation between plot size and labour use estimate was computed for each of the 26 crop operations. In 15 out of these 26 cases, labour usage was found to be associated with the plot size indicating large labour usage on small plots. However, due to possible confounding of the effect of plot size with the number of days needed to complete an operation, no lower limit on plot size as originally planned was determined.

An acceptable range of labour data for each of the selected crop operations was determined in order to reduce the large fluctuation in the data and thereby improving its quality. The distribution of labour data falling within the acceptable range tended to be normal.

In the succeeding analyses, all labour data falling outside the acceptable range were not included.

The effect of some continuous factors, namely, seed rate for planting (i.e., sowing), fertilizer rate for fertilization, insecticide rate for insecticide application and crop yield for harvesting on the corresponding labour usage were examined. The procedure was to plot the total labour usage per area against the corresponding rate of material or yield level to see whether there exists any relationship between the labour usage and the factor considered. Correlation coefficient (r) was used as a measure of dependency of labour usage on the factor examined. For a significant " r " (which explains at least 50% or nearly so of the labour usage in terms of the levels of factors examined) the functional relationship between the labour usage and the level of the factor considered was established.

The result shows that, except for planting, first insecticide application and harvesting of mungbean and fertilization and second insecticide application in transplanted rice, there was no dependency of such factors in all crop operations, implying that labour requirement for such crop operations could be estimated independently of the levels of these factors. For operations which showed dependency of labour usage on the level of

factors examined, labour requirement should be estimated as a case to case basis (i.e., separately for each level of the factor).

Finally, estimates of labour requirement except for planting, first insecticide application and harvesting of mungbean ; and fertilization and second insecticide application in transplanted rice were obtained as simple averages of labour usage within the acceptable range. For planting, first insecticide application and harvesting of mungbean and fertilization in transplanted rice estimates were obtained as simple average at three different levels of the factor under consideration. The estimate of labour requirement for the second insecticide application was obtained at the average insecticide rate of 783 cc/ha with an additional labour requirement of 2 manhour/ha for every 1,000 cc/ha increase of the insecticide used.

Title : *An economic evaluation of the deep tubewell rehabilitation programme at Dhamrai, Dacca, Bangladesh*

Author : Mohammad Nazrul Islam

University attended : The Faculty of the Graduate School, University of the Philippines at Los Banos, Laguna, Philippines

Year of completion : July 1980

SUMMARY

The study evaluates a deep tubewell rehabilitation project known as Deep Tubewell Irrigation and Credit Programme (DICP) at Dhamrai, Dacca, Bangladesh. The study was conducted during September 1979 to January 1980. Two main sources of information were used in this study :

- ① a sample survey of 168 farmers from both the rehabilitated and nearby non-rehabilitated tubewell service areas ; and
- ② secondary data collected from the rehabilitation project and other official records.

MAJOR OBJECTIVES

The major objectives of the study were :

- to examine the main factors behind the differences in performance of the DICP project wells and non-project wells ;
- to analyze and compare cropping intensity, labour employed, costs and returns, and inputs use patterns in crop production under the conditions of 'with' and 'without' the DICP project ; and
- to evaluate the private and social benefits of the DICP project.

The examination of socio-economic factors which cause the differences in performance between rehabilitated and non-rehabilitated deep tubewells (DTW's) was presented in Chapter V. The results of the enterprise budgets, benefit-cost analyses and the profitability of the DICP project in terms of private and social benefits were discussed in Chapter VI.

MAJOR FINDINGS

The major findings of this study were :

DTW performance

④ In irrigated areas, the proportion of a higher size of a land area for rent has decreased. This indicates that farmers having access to irrigation water prefer to cultivate their land rather than rent it out ;

④ Losses of fuels and spares were frequent in non-project tubewells ;

④ Rehabilitated tubewells were found to be better supervised and have more organizational activities compared with non-project tubewells ;

④ Maintenance of canals and payment system of water fees have improved in rehabilitated tubewells.

Agricultural productivity

④ In irrigation conditions yield, level of fertilizer use, and labour inputs per hectare were not significantly higher in project wells compared to non-project wells ;

④ The cropping intensity was lower in irrigated area than in rainfed area for both categories of tubewells. This is because of topographical constraint, i. e. the tubewells are mostly located in low seasonal deep flooding areas. The farmers prefer and find it more profitable to grow one transplant Boro crop during the dry season in irrigated condition than growing other crops during the year ;

④ Considering the command area of a tubewell as a whole, a shift from non-irrigated crops to modern rice varieties has occurred due to expanded irrigation service ; this has resulted in higher comes higher employment opportunities and higher inputs use per tubewell.

Project benefits

From the private and social viewpoints, the results of benefit-cost analysis and net present worth indicated a high profit potential of

the DICP project. The benefit-cost ratio for the project implies that each Taka expenditure of public money earns Taka 1.61 to Taka 4.77 for the private sector and the benefit-cost ratio from the overall viewpoint ranged between 1.25 and 2.26 depending on assumptions made in relation to the shadow price of labour and imported inputs.

The study revealed that the benefit due to the DICP project is derived from the additional expanded area, not from either a higher cropping intensity or a higher per hectare productivity. This implies that a tubewell can produce still greater benefits particularly if cropping intensity in the study area is, however, influenced by its generally low topography which causes seasonal deep flooding and leaves limited scope to increase cropping intensity by use of irrigation water.

Based the above findings, the following recommendations are made :

● a tubewell should be located to command an area topographically suitable for more than one crop in a year so that full potential benefits from the development can be achieved ; and

● the DICP type of programme should be undertaken to rehabilitate tubewells all over the country, but priority should be given to those which are in topographically favourable locations and have higher return potentials.

The experience from this study strongly suggests the need for a better and more effective delineation of responsibility among the agencies concerned with deep tubewell irrigation development in the country. At the present time, the Bangladesh Agricultural Development Corporation (BADC) irresponsibility is to establish DTW's for farmer-societies and render mechanical services if and when requested from the tubewell management committee. Surprisingly, the operational responsibilities of such highly capital intensive irrigation facilities are completely vested on the farmers' societies which are often not properly organized to fully utilize the water resources and where :

● no expert services are available to help proper alignment, construction and maintenance of the water conveyance system, i. e. the main and field channels ;

- no agency has direct responsibility to see that the tubewell's water resource is utilized properly for maximum benefit to the society members ;

- no agency is responsible to have periodic monitoring of the discharge from the tubewells and determine water and fuel losses due to various factors such as bad maintenance of channels, high seepage and percolation rates in lighter-textured soils, and inefficient scheduling and distribution of water from the source ;

- farmers get inadequate extension counselling from the responsible agency because of which benefits from optimum input use are not properly understood by farmers ;

- there is insufficient interest and initiative by the appropriate agencies to study the agronomic, soil, economic and socio-institutional problems faced by farmers in their efforts to grow multiple irrigated crops ; and

- tubewell pump sets are not maintained by routine mechanical services to prevent frequent breakdown of engines and obtain more efficient longer service from them.

It is, therefore, recommended that the agencies involved in deep tubewell irrigation development embark on a well-coordinated and integrated action programme to deal with the practical problems faced by farmers. The most efficient use of tubewell water should be a major goal of such a programme.

LIMITATIONS

The approach adopted in this study suffer from some important limitations such as :

- The design of the study demanded survey of all crops grown by a farmer in the selected sample plots in a given crop year and a single interview technique was used for collecting the information. Reliance was put on farmers' memory and ability to recall where farmers are mostly illiterate and are not in the habit of keeping farm records. Also, due to time limitation, it was not possible to visit farmers frequently to gather information on cultivation practices for each of the crops.

- In a setting where a large proportion of the productive inputs are supplied by the farm households and where major bulk of the out-

puts was consumed at home, it was difficult to obtain information on some basic quantities such as inputs, outputs and the values thereof. Additionally, the market condition was highly volatile, segmented and localized ; therefore, it was difficult to find a price for a particular input or output. Sometimes indirect pricing was used in such a situation and values of some items were imputed through value judgement.

- The benefit-cost ratio was measured based on one year's information. A project such as the tubewell rehabilitation programme needs time before the full benefits from the project are gained by farmers and the performance of system management can be fairly assessed ; thus, the estimation of benefit-cost ratio might be under or over-estimated. In this study, estimates were made considering 5 years as the project life and only the direct benefits, but some benefits, direct or indirect, from the project would still be generated after 5 years. The findings, therefore, suffer from the limitation of under estimation in that respect.

Title : *Stability of selected mungbean [Vigna Radiata (L) Wilczek] cultivars evaluated under different growing conditions*

Author : Mohammad Nazrul Islam Miah

University attended : The Faculty of the Graduate School, University of the Philippines at Los Banos, Laguna, Philippines

Year of completion : May 1980

SUMMARY

Ten mungbean cultivars were evaluated under eight growing conditions, namely :

- ① dryland monocrop, dry season (partially irrigated) ;
- ② dryland intercropped, dry season (partially irrigated) ;
- ③ dryland monocrop, wet season ;
- ④ dryland intercropped, wet season ;
- ⑤ dryland monocrop, following rice (rainfed) ;
- ⑥ wetland (fallow) monocrop, dry season (partially irrigated);
- ⑦ wetland monocrop, before rice (rainfed) ; and
- ⑧ wetland monocrop, following rice (rainfed, zero tillage)

The evaluation was made to identify the stable genotypes that could be grown over a wide range of environmental conditions with little risks under environmental stress ; and maximum grain yield under most favourable growing conditions to ;

- evaluate the cultivars under monoculture and intercropping systems as well as when grown before and after wetland rice ;

- determine the relationship between yield and yield contributing characters as well as the environmental responses for yield performance of the cultivars under different growing conditions.

Based on the environmental parameters, three growing conditions viz ; wetland (fallow) monocrop, dry season (partially irrigated) ; wetland monocrop, before rice (rainfed) and wetland monocrop, following rice (rainfed zero tillage) were considered as favourable environments. All other growing conditions could

be considered as relatively poor because of poor soil condition and high precipitation in association with low solar radiation prevailed during these experimentation. Favourable environments were manifested by high environmental average yield and positive environmental indices.

The results indicated that the major sources of variation in characters, especially seed yield was due to the main effects of cultivars, growing conditions and the interaction effect between cultivar and growing condition.

Cultivar CES-ID-21 produced the highest seed yield, followed by EG-MG-174-3, CES-IF-5 and M-350. Cultivars S-8 (Green) and CES-14 produced the lowest yields. Among the growing conditions, the highest seed yield was obtained under the wetland (fallow) monocrop, dry season (partially irrigated) condition whereas lowest seed yield was obtained under the dryland intercropped, dry season, (partially irrigated) condition. Either moisture excess or stress, shading or limited light under intercropping; more disease prevalence, poor plant density and the day length appeared to be the significant factors for poor growth and low yield of mungbean.

Based on the three stability parameters viz, phenotypic index ($P > 0$), stability coefficients ($b \approx 1.0$) and least deviation from regression mean squares (Se^2); cultivars EG-MG-174-3 and CES-55 were considered to be generally adapted to all growing conditions, i.e., consistently better under both favourable and unfavourable environments (average stability). M-350, CES-IF-5 and CES-ID-21 were specifically adapted to favourable environments, i.e. superior in high yielding environments. MG-50-10A(Y) and CES-14 were specifically adapted to unfavourable environments, i.e., superior in low yielding environments (above average stability). Moreover, under specific set of growing conditions, some cultivars were found more stable compared to other cultivars tested. M-350 and CES-55 were stable under monoculture, EG-MG-174-3 under dryland site, CES-ID-21 under wetland site and CES-55 under low solar radiation and dry season conditions. However, no cultivar was found stable under wet season growing conditions.

Apparently, the cultivar produced best yield under one growing condition need not be the best under another condition. Some of the cultivars such as EG-MG-174-3, CES-ID-21, CES-IF-5 and M-350 were relatively high yielders for most of the growing conditions. But the cultivars CES-14 and S-8 (Green) were low yielders for such growing conditions. Positive and significant associations between monocrop and intercropped yields and rank orders indicated the possibility of selection of cultivars under monoculture only, but the significant seasonal and varietal influences rather complicated the selection procedure. Seed size (1000-seed weight), pods per plant, seed weight per plant and pod length were the most important yield contributing characters in mungbean.

The present study further reveals that cultivar EG-MG-174-3 has wider adaptability and is suitable for general cultivation over a wide range of growing conditions. It is, therefore, suggested that this cultivar should be used in hybridization programmes as it can be expected to transmit high mean yield and increased phenotypic stability to its progeny.

Title : *An evaluation of the four-month Rice Production Specialist Training Conducted by Bangladesh Rice Research Institute*

Author : Farhad Jameel

University attended : The Faculty of the Graduate School
University of the Philippines at Los Banos,
Laguna, Philippines

Year of completion : June 1980

SUMMARY

The evaluation study was conducted on the basis of the general objectives of the training programme, which was aimed at developing the participants as trainers, production specialists, extension agents, and applied researchers in rice. The objectives of the study were to explore the participants' appraisal of the programme, determine the level of improvement in their knowledge and skills, assess the extent of training utilization, and identify the constraints in utilizing the training.

Data were gathered from office records and through a questionnaire mailed to the former trainees. Some information were also obtained from the training staff over discussion.

The participants of this in-service training were selected by the authorities of their respective organizations. Seniority in the service was the main criterion for the selection of 43.83% participants. Nature of job and training need were instrumental in selecting 26.03%.

All the participants were male and most of them were married. Their age ranged from 24 — 38 years, the majority being comparatively younger. Participants' job experience varied from a few months to 11 years and most of them had a Bachelor or Master degree in Agriculture.

The overall pre-training orientation of the participants was good. A majority of them knew the objectives of the programme before hand, became happy on being selected and prepared mentally

for the training. Most of them considered the training appropriate for their pre-training jobs and felt a need for increasing their knowledge and skills in rice production.

The knowledge and skill level of the participants was raised from 36.30 — 76.14% showing an overall improvement of 39.84% during training. On the basis of their performance in the examinations, 57% of the participants were qualified to be Rice Production Specialists ; 21% of them received "distinction" and 36%, "satisfactorily completed" certificates. The remaining 43% received "participation" certificate.

Most of the participants were satisfied with the overall training programme. However, a majority (57.53%) expressed that they were somewhat satisfied and 35.62% were very satisfied. Only 6.85% indicated not satisfied. In relation to their previous background and experience, 86.30% of the participants considered the training to be at proper level.

It was observed that the training could not make much difference in the ability of the participants to solve rice production problems of the farmers due to the socio-economic condition of the country. However, it was considered very adequate and somewhat adequate by 35.62% and 60.27% of the participants, respectively as regards the objectives of the programme.

The participants faced many problems during training. The more frequently mentioned problems were inefficient resource persons, unsatisfactory accommodation (3 to 4 person in one room) and food in the dormitory, lack of instructional materials, less emphasis on the practical aspects and short duration of the course.

The utilization of the training was found meager. Only 23.29% of the participants were making full utilization of the training. Some utilization and little or no utilization were indicated by 60.27% and 16.44%, respectively. As regards the primary objective of the programme, it was observed that only 16.28% of the participants were conducting rice production training. Moreover, the second generation trainees had little opportunity to learn by doing and gain a total experience in rice production. A majority of the participants (43.03%) were utilizing the training in general extension work and only 12.79% had the job responsibility for conducting applied

research in rice. As high as 16.28% of the participants were engaged in other crops and 11.63% were conducting basic research in rice; though these job assignments were out of the way of the stated objectives of the training programme.

It may be concluded that the training programme itself had several shortcomings and the stated general objectives could not be fully achieved by any of the recipient organizations. The setback in the utilization of training is attributable to the fact that the organizational functions and the job assignments of the participants were not in full conformity with the general objectives of the training. The only exception was the training and visit system of extension adopted in one of the four divisions of the country by the Directorate of Agriculture (Extension and Management). If this organization, which is the chief clientele of the training, expands the same system all over the country, then the training might find the proper setting for a maximum utilization.

Most of the participants had the opportunity to utilize the training in any, if not all, of the stated objectives. But this was handicapped by a lack of facilities like finance, transport, supplies and services; freedom and decision making; incentives for work; and efficient programme, support and supervision. Unless these are provided to the participants, it would be difficult for them to utilize the training.

Title : *An evaluation of the sorghum production pilot extension project in the province of Batangas, Philippines*

Author : Muhammed Tafiquddin Somobye

University attended : The Faculty of the Graduate School, University of the Philippines at Los Banos, Laguna, Philippines

Year of completion : July 1980

SUMMARY

The success of agricultural technology in agricultural development greatly depends on the process of making this package suitable for farmers under their own condition by conducting applied research trials. In addition, the best-suited ones should be introduced on the basis of the results of applied research through the integrated agricultural production programme such as the Sorghum Production Pilot Extension Project Programme (SP-PEP). This was characterized by the concerted efforts of different agencies. This study, therefore, was conducted to assess the effectiveness of the SP-PEP programme in terms of the following :

- farmers' awareness of the SP-PEP programme and means of awareness;
- farmers' knowledge obtained from their exposure to the SP-PEP programme ;
- farmers' evaluation of sorghum production from both agronomic and economic points of view;
- farmers' attitude towards SP-PEP programme and sorghum ; and
- adoption of sorghum as a crop by the cooperators and the possible relationship between certain demographic factors and adoption of sorghum.

The data were collected through personal interviews with 45 farmers who participated in the programme and referred to as co-operators in this study and 171 farmers who did not participate in

the SP-PEP in four towns of Batangas namely : Sto. Tomas, Tanauan, Lipa City and San Jose, Philippines. An interview schedule was prepared and administered for this purpose in 1977. The data were analyzed and interpreted through the use of frequency counts, percentages, means, medians, t-tests, chi-square tests, and multiple regression.

RESULTS OF THE HYPOTHESES TESTED

Hypothesis I. "Farmers' conversation with their friends, relatives, and neighbours, is not an important communication contacts for enhancing awareness as that of seeding", was rejected. The farmers, generally, became aware of the new technology, sorghum production, through their conversation with relatives, friends and neighbours. Relatives and friends played vital roles in diffusing the new technology among farmers during the awareness stage compared to technicians or extension workers.

Hypothesis II. This was rejected. The knowledge, evaluation and attitude of cooperator-farmers were significantly higher than that of the non-cooperators, i.e. SP-PEP resulted in the increase of knowledge of the cooperators about sorghum; their evaluation of sorghum from both the agronomic and economic aspects and their attitude towards the same had been changed.

Hypothesis III. This was accepted. The farmers' awareness of the SP-PEP programme was not dependent on the farmers' age, gross annual income, tenure status, educational attainment, frequency by which the technicians visited the farmers and attendance in farmers' meetings, field days, etc.

Hypothesis IV. This was accepted only as regards the finding that the change in the farmers' knowledge was influenced by their gross annual income and their attendance to the farmers' meetings. The gross annual income, however, had a negative influence on the farmers' knowledge in sorghum production, while the latter had a positive influence.

Hypothesis V. This was partially rejected and accepted. The co-operator-farmers' change in attitude toward the SP-PEP and sorghum was influenced by their :

- gross annual income ;
- evaluation of the presence of constraints in sorghum production ; and
- attendance in the farmers' meetings.

Out of these three, only attendance in farmers' meeting had a positive influence on attitude.

Hypothesis VI. This was partially rejected. The gross annual income, farmers' knowledge in sorghum production, attitude towards sorghum and SP-PEP programme were not strong enough to influence their evaluation of sorghum production from the agronomic and economic points of view. Only educational attainment had shown significant influence on their evaluation of SP-PEP programme and sorghum.

Hypothesis VII. This was partially rejected. Farmers' demographic factors, farmers' evaluation of sorghum production from both agronomic and economic points of view and their knowledge about sorghum was not strong enough to influence their adoption of sorghum as a crop. But farmers' attitude towards the SP-PEP and sorghum and tenure status had significant influence on adoption.

MAJOR FINDINGS

Stated briefly, the summary of the major findings are as follows :

Awareness of the SP-PEP programme and sorghum

The non-cooperators were aware of the SP-PEP programme and sorghum. The great majority of the respondents became aware about it through hearing. The farmers indicated their friends and relatives as their most important sources of information about this new technology rather than the extension agents or extension activities. The neighbours' farms also played a significant role in this respect. A majority of the non-cooperators heard more about the advantages than disadvantages of sorghum viz, "sorghum is non-lodging, good, drought resistant, etc." Most of the cooperators mentioned three main reasons for joining the SP-PEP programme such as :

- 'to earn money',

- 'to improve their living condition', and
- 'sorghum is better than corn'.

The results of this study showed the importance of integrated agricultural production programme like the SP-PEP to create awareness among farmers about a new technology.

FARMERS' KNOWLEDGE ON THE SP-PEP PROGRAMME AND SORGHUM

With the exception of one item, namely, the comparison between ratooned and regular crops, the technical knowledge score of cooperators was significantly different from that of non-cooperators. However, the general knowledge score of cooperators was not significantly different from that of non-cooperators except two items, viz :

- suitability of soil type for sorghum ; and
- suitability of farmers' soil for sorgum.

The farmers' knowledge on sorgum production was influenced by their awareness of the SP-PEP programme and sorghum.

FARMERS' EVALUATION

Almost all cooperators and non-cooperators recognized the profitability of growing sorghum. More cooperators than non-cooperators gave advantageous evaluations of sorghum than disadvantageous ones specially from the agronomic point of view viz, "sorghum is drought resistant", "can be ratooned" and "can be grown under coconut trees". More cooperators than non-cooperators evaluated the economic constraints of sorghum production such as : "lack of established market" and "low price during harvest". Most of the farmers mentioned "inadequate time and helpers" as one of the most important disadvantages of sorghum.

FARMERS' ATTITUDE

With the exception of only one item namely, "I would like to become a cooperator again if there is an opportunity", "all the items related

to the SP-PEP programme and sorghum were highly favoured by a majority (51%) almost all (96%) of the cooperators "Government should spend money to conduct applied research in the barrio", "sorghum is easy to plant", and "research should be conducted before recommending any crop/innovation", apparently were the ones most favourably reacted to.

The least favoured items were : "I would like to become a co-operator if there is an opportunity", and "sorghum is better than corn". Of the nine items related to the SP-PEP programme and sorghum, the most highly favoured was that "government should spend money to conduct applied research in the barrio", while the least favoured was "I would like to become a cooperator if there is an opportunity".

ADOPTION OF SORGHUM

The adoption of sorghum as a crop by nearly 75% of the cooperators was below the 50% of the total area. The adoption level of sorghum by cooperators was low.

Of the 13 demographic and behavioral dimension variables treated for their relationships with the adoption of sorghum as a crop by the cooperators, only five variables and sorghum were found to have statistically significant relationships with the adoption level of sorghum such as :

- types of occupation ;
- tenure status ;
- evaluation of profitability of growing sorghum ;
- presence of constraint to sorghum production ; and
- farmers' attitude toward the SP-PEP programme.

On the other hand, the farmers' age, educational attainment, number of dependents, gross annual income size of farm, agronomic advantages/disadvantages of sorghum, knowledge of sorghum production and credit availability had no relationship with the adoption of sorghum.

FARMERS' PARTICIPATION

There were more cooperators than non-cooperators who attended the extension activities of the SP-PEP programme. Of the 43%

non-cooperators who were aware of extension activities of SP-PEP programme, 70% of them attended field days. Almost all of the cooperators (98%) also attended the field days. More than 90% of the cooperators attended to farmers' meetings and other extension activities in addition to field days. However, the percentage attendance of the non-cooperators was below 30% in all items.

PERSONAL CONTACTS

More cooperators than non-cooperators had more personal contacts with the technicians and with other farmers. The former discussed more with other farmers the different aspects of sorghum than the latter. The discussions were generally based on the following : "Sorghum is a good and profitable crop" and "It is drought resistant and has low fertilizer requirement. More than one-fourth of the cooperators and almost one-third of the non-cooperators discussed solutions to their crop production problems with the barrio captain, friends and other farmers than with technicians.

CREDIT AVAILABILITY

More than 80% of the cooperators did not have any problem in obtaining credit in 1976, because there was an arrangement with the lending institutions to provide them direct loans for sorghum production.

POTENTIALS OF AGRICULTURAL PRODUCTION

The integrated agricultural production programmes such as the SP-PEP have great potential in accelerating the diffusion of modern agricultural technology.

Requirements

More suitable technology and extension activities are not sufficient to change the farmers' ways of thinking and acting in favour of an

appropriate recommended technology. In addition, the integrated agricultural programme like the SP-PEP should provide the farmers with marketing outlets, and a fair price for their produce using the technology. Likewise, comprehensive explanations of the nature and functions of technology to increase their productivity and income and provision of sufficient time for farmers to learn the use of such correctly and an understanding of way they should do so are necessary in order for farmers to adopt or change their old ways.

IMPLICATIONS OF THE STUDY

Technology. Technology influences and is influenced by the environment. The feasibility of production techniques such as sorghum production introduced through an agricultural production programme is not conditioned only by the ecological and climatical conditions of an area in which the technology will be used widely, but also by the socio-economic and physical aspects of the area and the socio-psychoeconomic conditions of the farmers. The existing knowledge and skills of the farmers regarding the technology introduced, the economic aspects such as marketing outlet and a fair price for the products obtained by using that technology and social aspects such as people's belief and eating habit of the product should be prime considerations. If many of the essentials are lacking in agricultural development, then programmes should not be implemented in a hurry and in a large-scale. The programme implementation should be based on the abundance of market outlets and the price of the product and its utilities, especially for a new crop such as sorghum. The farmers' 'readiness to use it with minimum guidance must also be considered in implementing the programme. Ignoring the above-mentioned factors in the implementation of the programme and basing the programme only on the need for increasing crop production through utilization of idle lands during the dry season by growing alternative suitable crop to follow rice, might bring complete failure of a minimal of success on such client-oriented programmes.

The recommended technology should fit into the existing cultural milieu and resources of the farmer clientele. For example,

if an adequate supply of threshers is not possible or unavailable, then there must be some other techniques which can be used by farmers.

Marketing outlet, price incentive. A new technology may be adopted by farmers for varied reasons : some obvious, others less so. The major reasons are usually economic. However, the non-economic ones such as the socio-psychological factors may also be important. Direct income improvement would logically seem a primary goal for those who apply new technology and the procedures generally respond positively to price incentives. Generally, farmers' behavioral changes are economically motivated.

New technology also could be adopted for indirect economic reason such as to take advantage of (or because of) existing resource patterns. For example, the land which remains idle during the dry season can be used to produce another crop which need less water and less management care, and which can provide crop insurance in case of crop failure because of a changed rainfall pattern and other factors. Growers may not realize the specific reasons but marketing outlets exist for the products and the price for these will help them sense the need to make changes. Therefore, any integrated agricultural programme such as SP-PEP should not be implemented solely basing on the suitability of the technology to the climatic and ecological conditions, but also should consider other factors. Otherwise, such a programme will be a failure.

Extension activities. The extension activities should be conducted before as well as during the implementation of an integrated agricultural programme such as the SP-PEP. The necessity of the extension activities before the programme implementation is to create awareness among both the farmers and the people who are doing business associated with agricultural production such as poultry farm-owners, foodgrain industry, etc. and other sectors (administrators and policymakers, planners, political leaders, technologists, and scientists). These could be done through :

- training selected farmer leaders,
- method and result demonstration,
- farmers' meetings and seminars, etc.

These types of activities will equip farmers and non-farmers associated with farm business, with the necessary information, knowledge and skills to understand and to use the technology properly.

Extension activities during the programme implementation should be focussed on :

- correcting possible mistakes in farmer's use of the technology ;
- encouraging the farmer to utilize the product in their local way as much as possible. For example, the use of sorghum in native food preparations or some other forms of utilizing sorghum may be tried out ;
- improving the farmer's knowledge and skills in the advocated technology ;
- forming positive attitudes toward the advocated technology ;
- enabling the farmer to understand the profitability of the technology ; and
- building the farmers' sense of responsibility for continuance of the programme.

Training agricultural technicians themselves is necessary before programme implementation, especially before they are involved in the project, to equip them with the necessary knowledge and skills in :

- the subject matter related to the technology to be introduced to farmers ;
- building their competence in identifying and solving anticipated and unanticipated problems related to the use of technology ;
- effective teaching and communication method in order to enable them to persuade and guide farmers effectively and correctly.

Short-term training is not sufficient for these people, especially in case of a new technology such as sorghum which need more time to learn and understand problems related to it.

Therefore, in planning a training programme, subject matter concerning the technology must be given first consideration. Generally, the assumptions are taken during the short-term training that :

- the agricultural technicians had basic knowledge and skills in related technology, so, there is wastage of time and energy to repeat the same fundamental matters such as teaching methods ; and

- the trainees are expected to master the knowledge and skills obtained from the training in their respective assigned areas.

These assumptions sometimes endanger the results of the training. It is also true that these technicians have heavy assignments and do not have the same background. Some of them have had special training in teaching methodology while others did not have and some of them are new college graduates. So, on account of the time limitation of the technicians to increase their knowledge and skills in their assigned areas, there is therefore a need, at least as a refresher course, to provide them with all the knowledge and skills needed to assure the correct use of the technology and to identify and to solve some problems related to crops and diseases faced by farmers.

Different types of extension activities, especially farmers' meetings and seminars should be conducted several times at different places before the implementation of the programme. So far, if possible, each and every aspect of the technology should be discussed in one or more meetings, depending on the level of understanding of the farmers. Because discussion of many aspects in one setting may create confusion among the farmers about the technology which, in turn, may be ineffective in terms of knowledge and skills gained by them, demonstration on the correct use of procedures of the recommended practice would be very useful in assuring the farmers the correct utilization of the technology.

Therefore, the purpose of the extension activities during the programme implementation is to :

- strengthen,
- correct, and
- intensify extension activities done before the implementation of the programme.

These activities could be undertaken through :

- farmers' meetings or seminars,
- personal contacts with technicians as well as well trained selected farmer leaders,

- method and result demonstration ; and
- field days.

Credit availability. Many authors have given emphasis on the importance and availability of credit in projects like sorghum production. But this study did not support this view. This study showed that although credit was available, farmers did not avail of it because of their perceived inability to repay on time.

The need for strong coordination and leadership. An integrated programme or project, like the SP-PEP is composed of many sectors, viz ; extension, research and farmers. It rests on the participation of a great number of people from different organizations. It should aim, therefore, to involve as many as possible in the planning and decision-making stages. But the spark that leads to action generally comes from leaders. It is they who guide and decide the direction in which the project will move and at what speed.

Needless to say, the programme as a whole requires a special type of leader. They should be men whom the rank and file can rely on to coordinate and to mobilize the cooperation of the members in the project activities.

An integrated agricultural project like the SP-PEP is composed of three types of people, viz :

- researchers those who have thorough knowledge about the technology and who test the same at both the research station and in farmers' fields ;

- extension workers—those who have the technical know-how who work with the farmers in diffusing the recommended technology and will guide them in the adoption of such technology ; and

- farmers—the real end-users of the technology.

All of these groups are led by separate leaders in their respective fields. Hence, there is a strong need for coordination and cooperation among the three groups to implement the project for its success. Likewise, leaders at all levels, barrio-municipal-provincial-national, should also understand the nature and function of the technology in increasing crop production. They should be able to mobilize the existing resources and to make those available on time. They should be able to distribute responsibility and to check

operations. In addition, they should encourage every institution involved in the programme to share the responsibility for the success of the programme.

CONCLUSIONS

Results of this study showed that the SP-PEP was able to create awareness among the farmers about sorghum. Moreover, the results also showed that the SP-PEP influenced the farmers' knowledge, attitude and their evaluation of sorghum from both in agronomic and economic aspects relatively within a short period of time.

Therefore, integrated agricultural production programmes have a great potential in developing the farmers' mental and emotional readiness through increasing their knowledge and skills and providing them a more positive attitude which helps in accelerating the diffusion and adoption of the new technology.

However, the knowledge and attitude changes as influenced by the SP-PEP programme were not strong enough to encourage farmers to continue growing sorghum as a crop. There were several reasons for this. The major reason were economic, i.e. lack of established markets and price incentives. Generally, farmers adopt a new technology because of economic reasons. It appeared that the improved knowledge and skill developed by SP-PEP were not enough to convince the farmers to continue the growing of sorghum.

The results of this study showed that although the farmers were highly convinced of the advantage of sorghum over corn, sorghum has no established market and sometimes they cannot sell it on time. Therefore, this study substantiates the known fact that market for the product and price incentives for the farmers are the prime essential factors that encourage farmers to adopt a new technology. It sums, therefore, that before starting any project on any technology, market feasibility and price for the product must be given important consideration.

The extension activities of the integrated programme should also be given primary consideration, so that farmers can become aware of the technology properly and be ready mentally and emotionally to adopt the new technology correctly.

Moreover, the technology should be tailored to the existing resources available in the area. Mobilization of resources (e.g., thresher, sprayer, machines, etc.) is beyond the farmers' control. When this expectation is not met, the effectiveness of the technology is reduced, and farmers lose confidence in the technology as well as in the programme and the extension people. Therefore, the main aim of the programme cannot be achieved.

Generally, there is a great need for the integrated agricultural production like SP-PEP which comes through different applied research trials to diffuse the new technology among the end-users and to get them to adopt the technology.

Suggestions

Since the study was conducted dealing with only sorghum production in only a few barrios of the four towns of one province of the Philippines, the findings may not be representative of the entire country. It is suggested, therefore, that similar studies be conducted over a wider area covering both sorghum and rice farmers to ;

- get the effect of the integrated agricultural production programme like SP-PEP on farmers' awareness, knowledge, evaluation, attitude towards, and adoption of new technology ; and

- determine variations that may exist in farmers' behavioral dimension toward the two crops.

While the study attempted to determine farmers' awareness, knowledge, evaluation, attitude toward SP-PEP programme and sorghum it never ascertained the possible reasons underlying whatever belief and attitude the respondents held toward its cultural practices and its other aspects. Therefore, a follow-through study may be conducted to determine not only means by which the farmers' awareness, knowledge, evaluation, attitude toward the new technology but also their actual skills on the cultural practices and other aspects of and sorghum like method of plantation and disease control. A follow-through study will enable the researchers to determine farmers' skills, i.e. whether or not farmers are able to apply the recommended practices correctly, by observing how they actually do them.

Moreover, because this study included only a few socio-economic variables associated with the adoption of sorghum as a crop by farmers and almost all of them are internal variables, a study may also be conducted to include variables external to them such as groups, norms and values, influence of farmer leaders or other influentials on their decision to adopt or not to adopt a new technology.

Likewise, communication patterns and effects of communications message content to the technical knowledge of farmers should also be studied. It seems that it is the message content of extension activities which causes change on the farmers' behavioral dimension, but not the extension activities which are only means of achieving such a change.

Title : *Growth and development characteristics affecting the yield performance of nine varieties of soybeans planted immediately after rice in two climatic regions of the Philippines*

Author : Mohammad Nur-E-Elahi

University attended : The Faculty of the Graduate School, University of the Philippines at Los Banos, Laguna, Philippines

Year of completion : August 1980

SUMMARY

A field study was conducted to identify the morphological and phenological characteristics that are strongly related to yield performance of nine soybean varieties in two climatic regions of the Philippines. In the study, three field experiments were conducted, one in Laguna (Los Banos) and two in Pangasinan (Managoa). For each of the three experiments, factor analysis was used to identify and quantify the morphological and phenological factors of the nine soybean cultivars.

To aid in factor interpretation, the initial factor solutions were rotated orthogonally using varimax criteria, and then obliquely using the promax criteria. Eighteen variables were examined in the first factor analysis. Following interpretation and inspection, 4 of the 18 variables were deleted and a second factor analysis was performed on the 14 variables. In the first factor analysis, five factors that explained 83% of the total variance were extracted from the Laguna (Los Banos) data. Factor 1 was interpreted as an expression of vegetative growth. Factor 2 was regarded as expressing fruiting site potential per plant. Factor 3 reflected the degree of indeterminacy in the varieties. Factors 4 and 5 appeared to express degree of nodulation or nitrogen nutrition at R_1 and R_5 , respectively.

Five factors that explained 79% of the total variance were extracted from the first Pangasinan planting data. Factor 1

was regarded as fruiting site potential per plant. Factor 2 expressed degree of nodulation at R_4 or grain filling duration. Factor 3 expressed degree of nodulation at R_5 . Factor 4 was interpreted as a crop biomass factor and a pre-pod filling growth duration interpretation was given to Factor 5.

From the second Pangasinan planting data, six factors that explained 85% of the total variance were extracted. Factor 1 and Factor 2 expressed fruiting site potential per plant and reproductive growth duration pattern, respectively. Factor 3 was interpreted as a crop biomass factor. Factors 4 and 5 were interpreted as late nitrogen nutrition or late degree of nodulation, and nitrogen nutrition or degree of nodulation at flowering, respectively. Factor 6 expressed the degree of indeterminacy. It was found that deletion of data from two varieties that were not common to both experiments ORBA and JUPITER in the first and second experiments respectively did not alter factor interpretations appreciably.

In the second factor analysis, four factors that explained 83% of the total variation were extracted from the Los Banos data. Factor 1 expressed fruiting site potential per plant, Factor 2 expressed pod-filling potential, and Factor 3 was interpreted as a vegetative growth factor. Factor 4 was interpreted as an expression of the pattern of reproductive growth phase duration.

From the first Pangasinan planting data, five factors that explained 82% of the total variance were extracted. Factors 1 and 2 expressed as fruiting site potential per plant and pod-filling potential, respectively. Factor 3 was interpreted as a pre-pod-filling growth phase duration factor. Factor 4 was regarded as a late nitrogen nutrition or late nodulation factor and factor 5 was regarded as a vegetative growth potential factor.

Four factors that explained 75% of the total variance were extracted from the second Pangasinan planting data. Factors 1 and 2 were regarded as expressing fruiting site potential and podfilling potential factor, respectively. Factors 3 and 4 were interpreted as expressing nitrogen nutrition during the pre-pod-filling growth and the degree of indeterminacy, respectively.

To determine the contributions of factors on yield, regression analysis was used. Factor scores from the three experiments were

used as independent variables in a step-wise regression procedure. Because stand was very uneven in both Pangasinan experiments, plant density was introduced as an independent variable in the analysis of these data. The analysis showed that two factors; namely, vegetative growth expression (Factor 3); and reproductive of growth phase duration (Factor 4), were the dominant explainers soybean yield differences in the Los Banos experiment. Because the regression coefficient of factor 3 was negative, varieties in the test group with heavy vegetative growth and a long vegetative growth period had low yields. The regression coefficient for factor 4 was positive, indicating that varieties with short flowering periods and long pod-set periods gave comparatively high grain yields. Factor 1 (fruiting site potential) had comparatively minor influence on yield but it formed an important interaction with factor 4, suggesting that as the pod-set period lengthened and the flowering period shortened, the number of fruiting site becomes important. In both Pangasinan experiments, pod-filling potential was found to be the dominant crop characteristic explaining soybean yield differences. The pod-filling duration factor was positively associated with yield. In both Pangasinan experiments, fruiting site potential was a secondary factor explaining yield differences. In Pangasinan, final plant population was an important variable explaining yield differences, and it formed a significant interaction with pod-filling potential.

The factors found to be associated with yield differences in the Los Banos data were clearly different from those found in the Pangasinan data. Although the same varieties were compared in the Los Banos and in the first Pangasinan experiment, environmental factors apparently caused differential expressions of crop characteristics, and these differences explained the yield behavior between the two locations.

To obtain detailed information on crop developmental characteristics, dry matter partitioning among plant fractions, leaf area index and root distribution of four contrasting cultivars were studied in the three experiments. In both the Los Banos and the first Pangasinan planting, the pattern of dry matter partitioning into different plant fractions of UPLS-2, TK-5 and SL-6 were roughly similar within

experiments but more assimilate was available in Los Banos than in Pangasinan. The pattern of dry matter accumulation in L114 was distinctly different from the other three varieties. Total dry matter accumulation was highest in both the Los Banos and the first Pangasinan experiment. Differences in the dry matter partitioning were apparently a result of differences in genetic factors controlling partitioning and the photosynthetic efficiencies among the varieties tested in this study. At Los Banos, SL-6 accumulated most dry matter in the green and empty pods, UPLSY-2 was intermediate, and TK-5 was the least. In the first Pangasinan experiment, UPLSY-2 partitioned slightly more dry matter into seed by RS stage than the other three varieties. L114 was comparatively inferior in partitioning dry matter into seed in both the Los Banos and the first Pangasinan experiments.

In the second Pangasinan experiment, dry matter partitioning in UPLSY-2 and TK-5 were roughly similar. Compared to UPLSY-2 and TK-5, dry matter accumulation in the reproductive organs was comparatively lower at R_5 . An undiminished rate of total dry matter accumulation in Jupiter and L114 suggests that these two varieties can continue to grow well under some apparent soil moisture stress. At R_5 , total dry matter accumulation was highest in Jupiter and least in UPLSY-2. Between R_1 and R_5 UPLSY-2 and TK-5 accumulated the largest amount of dry matter in the reproductive organs whereas Jupiter accumulated the least; L114 was intermediate.

The leaf area index development pattern under Los Banos conditions were comparatively similar among TK-5, SL-6 and UPLSY-2. LAI either declined or was arrested between R_1 and R_3 for these three varieties whereas it increased in L114. A sharp increase in LAI occurred in L114 between R_3 and R_5 . For four varieties, the maximum LAI for the first and second Pangasinan experiment occurred at pod formation (R_3) and at flowering (R_1), respectively. For Jupiter, however, maximum LAI occurred at pod formation (R_3). Much higher LAI's were obtained in the Los Banos experiment compared to either Pangasinan experiment because water was not limiting at Los Banos.

In a root study, it was found that only minor variations were found in the root densities of selected varieties within each

experiment but variations were pronounced between locations. The similar distribution within an experiment as compared to the large differences between experiment suggests that environmental factors play a major role in root proliferation.

The relative mean root densities of TK-5 and UPLSY-2 in the 0-20 cm soil layer at V₃ of the first and second Pangasinan experiments and the Los Banos experiment were 74, 75 and 77% respectively, suggesting that there was little differences in relative densities regardless of conditions. At R₁, the relative percentage means root length densities for the 0-20, 20-40 and 40-60 cm soil layers were 50, 28, and 22 for Los Banos, and 63, 22 and 16 for the first Pangasinan experiment and 64, 19 and 17 for the second Pangasinan planting experiment, showing that a greater relative fraction of the roots were concentrated in the 20-60 cm increment in Los Banos. At R₃, comparatively greater root densities in the 20-60 cm increment were obtained. Despite differences in absolute root length densities between the two Pangasinan experiments, the relative root density distribution changed in parallel over the sampling stages.

These experiments indicate that some soybean varieties like UPLSY-2, SL-6 and Clark 63 may perform satisfactorily under very different post-rice season climatic conditions. However, to increase yield potentials for each climatic situation, the analysis suggests that varieties with certain characteristics would be desirable. For climatic conditions like found in Los Banos where moisture is not severely limiting, researchers should identify soybean varieties that do not exhibit excessive vegetative growth but exhibit comparatively long pod-set durations. For climatic conditions like found in Pangasinan where moisture is likely to be limiting, researchers should identify that must have comparatively long pod-dilling durations and a higher number of fruiting sites. In Pangasinan, production practices that increase plant populations should be used. Because of the limitations inherent in this study, these suggestions require verification for more years and for more locations.

Furthermore, because of seed limitations, only a small number of varieties could be tested. To increase the range in morphological and phenological characteristics being examined, a greater number

of cultivars with a wider range of characteristics should be used in experiments. A wider range of cultivar characteristics would reduce the possibility of unrelated variables being identified in the same factor by chance covariance. Factor analysis would be an even more effective method of data reduction than it was in these experiments if more varieties are used in the experiments. With a greater number of cultivars, replication could be reduced to keep the experimental units to a manageable level.

Title : *Studies on host-parasite relationship of rice stem nematode, Ditylenchus angustus (Butler) Filipjev, 1936, on rice oryza sativa, L.*

Author : Mohammad Loothfar Rahman

University attended : Imperial College of Science and Technology, University of London, UK

Year of completion : September 1980

SUMMARY

Some aspects of the host parasite relationship of the rice stem nematode, *Ditylenchus angustus* (Butler) Filipjev 1936 were investigated under greenhouse conditions. After resuming activity different stages of nematodes can enter the host within one hour. Invasion from outer leaf sheath to innermost leaf sheath took only 4 days in 12-day-old seedlings. Entry and consequently degree of infestation was variable with different plant age. The older the plant age, the lower was the degree of infestation. Under high humidity (80+5%) successful transmission was observed through water, stem and leaf contact. But water dispersal was the most effective mode of transmission.

During the vegetative phase of the plant, the severity of the above symptoms increased with increase in inoculum density. Variation also occurred in the degree of infestation correlating with the inoculum densities. Reproduction rate was high at low inoculum density and low at high inoculum density. Reduction in grain yield was also significant.

Different rice varieties showed different attractiveness to nematodes correlated with their different categories of susceptibility. None of the rice varieties included in the experiment seemed to be resistant against *D. Angustus*.

Placement of infected plant tissues at the base of seedlings proved to be the easiest way of inoculation in comparison with either soil or sheath inoculation method.

The vegetative growth of the plant, e.g. plant height was affected due to nematode infestation but leaf number was unaffected.

- Title** : *An economic analysis of the factors affecting the adoption of modern varieties of rice in some selected sites of Bangladesh*
- Author** : Bazlul Ameen Ahmad Mustafi
- University attended** : Faculty of the Graduate School, University of the Philippines at Los Banos, Philippines
- Year of completion** : March 1981

SUMMARY

There is a growing recognition of the crucial role which agriculture can play in accelerating the rate of growth of a developing country. This is reflected in the national planning of developing countries. In Bangladesh, the first Five—Year Plan (1973-78) accorded the topmost priority to agriculture.

Rice is the most important crop in Bangladesh. However, the per acre yield of rice in Bangladesh is one of the lowest in the world and the country suffers from a chronic shortage of food. On the basis of the seasonal classification three types of paddy are grown in Bangladesh, namely, Aus, Aman and Boro. Aman paddy accounts for 55% the total acreage of the country. Transplanted Aman paddy locally known as "shail" is the major Aman paddy which occupies 46% of the total rice acreage in the country. Thus an increased acreage of Aman paddy will affect the total rice production in the country. But transplanted Aman paddy is generally grown rainfed following the traditional practice. In recent years, however, modern varieties of transplanted Aman paddy have been introduced. The present study was designed to collect information relating to the cost and benefits of growing modern and local varieties of Aman paddy. It also dealt with the factors influencing the adoption of modern rices and the productivity of different resources used.

One thana, namely, Narsingdi, under Dacca district was selected for the study. Farmers in this area grow traditionally a large acreage of transplanted Aman. A stratified random sample of 168 farmers

were selected for the study. For budgeting, the dominant cropping pattern was chosen for analysis. T. Aman-Boro cropping pattern was the most important pattern which was grown by 49% of the total farmers surveyed. The yields of modern varieties in T. Aman of the T. Aman-Boro cropping pattern were 3.2 t/ha and 3.4 t/ha under irrigated and rainfed conditions while the local rice fielded 1.8 and 2.2 t/ha, respectively. In the case of Boro, the average yield of modern rices was 3.7 t/ha. Aus and T. Aman cropping pattern was the second most important cropping pattern observed which occupied 22% of the total farms surveyed. In the case of Aus, the yield of a local variety was 1.9 t/ha. While T. Aman of the Aus T. Aman cropping pattern, the yield per hectare of modern and local rices were 3.1 t/ha and 2.6 t/ha respectively.

As also found from other studies, modern rice was found to be superior in terms of both yield and net return when compared to local rices for owner-operators. Total labour requirement for modern rice and local varieties did not differ. However, the proportion of hired labour to total labour requirement was significantly higher in modern rice production. Thus, hired labour has been substituted for family labour in producing modern varieties. Increase in labour requirement for producing modern varieties coupled with hired labour substitution for family labour has resulted higher share of labour in modern varieties compared to local varieties.

The cost of production of modern varieties and local varieties of rice indicate that more inputs were used for modern varieties and so it incurred a higher cost compared to local varieties. Specifically, labour, fertilizer, irrigation, and insecticides used were comparatively higher in case of modern in both the dominant cropping patterns. In both modern variety and local rice varieties, human labour is the single item of cost production in all the dominant cropping patterns.

Production function were worked out for the poul rice production system of rice culture. The production function was linear. The variables included were yield, fertilizer, weeding, labour, plant protection and manure. Production function analysis concludes that irrigation significantly increases the productivity of modern varieties than the local varieties.

Discriminant analysis was done to find out the characteristic differences of adopter and non-adopter of modern rices. Factors found to have significantly influenced the farmer's adoption of modern varieties were irrigation water facilities and extension contact.

Factors share analysis was done to show the distribution of benefits of growing modern and local rices among the four rice production systems of culture. Landowner of both modern varieties and local rice cultivation earned the highest percentage of earnings but the landowner of modern rice cultivation earned the highest percentage than local rice cultivation. Current inputs in modern rice earned a highershare to output than local varieties.

CONCLUSIONS

- Modern variety of rice in both the dominant cropping patterns has shown significantly higher yield than the local variety of rice. ;
- Adoption of the modern varieties in the T. Aman season might be facilitated by improving the availability situation of the important factors like irrigation and extension services ;
- Increases in productivity of modern variety of rice compared to local variety of rice might be obtainable by enhancing the rate of adoption of modern rice varieties together with the good management and packages of modern inputs.
- Increases in income of the farmer from modern variety of rice enables substitution of hired labour for family labour.
- Additional output might be obtained by increasing the uses of available inputs.
- Income distribution originating from modern variety rice cultivation is found to be marginally less egalitarian than local variety rice cultivation.

Title : *Optimal cropping systems for some selected farms in Dhaka district, Bangladesh, July 1981*

Author : Mohammad Afzal Hussain

University attended : University of the Philippines, at Los Banos, Laguna, Philippines

Year of completion : July 1981

SUMMARY

This study aims to identify the cropping patterns that will increase farmers' income subject to availability of land, labour and other constraints :

- evaluate the existing crop combination ; and
- identify the problems of the farmers in their production process.

A linear programming (LP) model was employed to find out the optimal solutions under basic representative farm situations : own rainfed land, irrigated land, family labour, and home consumption requirements at a minimum level. All the farms were taken as averaged and tried to maximize the cash surplus, net return over variable costs except seedlings, and for maximization of total production with their existing available resources. Land was considered in two situations : rainfed and irrigated. As there are three cropping seasons, namely, Aus from April to June, transplanted Aman, from July to November, and Boro, December to March, the land was used as rainfed during earlier two seasons and as irrigated only in the Boro season.

The level of constraints was considered as average of the whole sample farms. Available rainfed land was considered 1.003 ha of which 0.39 ha could be irrigated in the winter or the Boro season. Average size of the family members was eight and available family hours per farm were taken to be 210. This was calculated by taking 2 workers working 5 days in a week, 3 hours a day. Minimum home consumption was taken 144 kg/period per farm making yearly consumption of about 1,152 kg.

Thus, when we run the model for the objective of maximum cash surplus and net return, the solution came with crop combinations of transplanted Aman high yielding variety like Pajam with the experimental field conditions, and modern Boro crop taking as BR3 or Pajam, also considered the experimental conditions. In both cases the inputs requirements were more or less similar but the value of the objective function in maximization of cash surplus (MXCS) was Tk 1407.49/period and maximization of net returns (MXNRTN) was Tk 14,177.52/year. In both cases the utilization of family labour got more emphasized than hiring of labour. In case of maximization of total production (MXTP) the solution was 5,667.93 kg/period, which can be grown within their existing available resources.

In identifying the MXTP constraints, farmers were interviewed. Majority of the farmers gave positive reply about the high price of fertilizers and trends of increasing irrigation cost which increased the cost of production of the Boro rice crop. Although the farms of that area were the combination of large and small farms, the farmers were not thinking about the size. Rather they emphasized the current institutional problems which hampered the production activities. In case of MXTP the situation included one more activity in the Aus season but the same with experimental conditions and taking high yielding variety like Chandina. The solution also emphasized for utilization of more Aus land than transplanted Aman.

CONCLUSIONS

- The experimental cropping patterns which are tested in the area can be introduced on average farms.
- Farmers at Salna can increase their total production by practicing triple cropping with one local and, if all are moderns, turnaround time should be reduced.
- In the maximization of cash surplus and net returns the family labour should be utilized fully whatever they have, because of the increasing cost of hired labour of that area at the time of peak period.

In rainfed conditions income uncertainty consequent upon yield varieties inhibits farmers from maximizing income from available

resources. Owing to the inefficiency of price stabilizations, and other costs of stabilizing increases directly, attention must be focussed on finding means to raise yields and reduce yield variability under conditions of uncertain rainfall.

POLICY MEASURES

For the development of rural areas in Bangladesh, it is of great importance to solve the technical production problems and socio-economic difficulties of the small-scale farmers living there. Priority should be given for rural development as it is vital for national development.

- A prerequisite for integration of rural population into the national and economic system is that both the quality and quantity of production be raised. The basis for such progress must be created through the expansion of agricultural research and extension sources to the actual farmers' fields. Only then will it be possible to utilize local production potential to the full.

- Research and extension services should be run simultaneously to the farmers' field as they are the base of production activities. Cropping system research (micro project) follows both the sides at a time. Although this kind of research is multidisciplinary yet it focusses in regional basis. As different regions have different climates, rainfall, soil, topography and socio-economic conditions, the cropping patterns and their practices should be developed on that criteria.

- The intensification of land use should be vertical for the limitation of the area as well as horizontal if fallow land is available, in each region. Cropping intensity should be increased by adding new crops in a year through the adoption of new technology developed by the cropping systems researchers. For this reason the irrigation system should be well-furnished and the cost should be minimized to give incentive to farmers for growing more rice. As fuel costs are increasing day by day the government should give subsidy in this regard. Inputs like fertilizers and insecticides' cost are also increasing which hamper the farmers' production process. These items should be supplied directly to the farmers so that they

can purchase easily from local market at low costs. Credit facilities should be available at the lowest interest rate and the official system of giving loan should be made easy so that they can get money from the bank and spend at proper time of transplanting, weeding and other activities.

- The cropping system research should be on regional or site basis for the period of maximum three years and it would be run as a mobile project from site to site on the basis of needs and potentiality of the area.

- To overcome the food deficit situation in Bangladesh, transformation of practicing local variety rice to modern is urgently needed. Farmers can get double or even triple production by adoption of modern varieties of rice like BR3, in the Boro, BR4 Pajam in the transplanted Aman and Chandina in the Aus seasons.

- Production brigade team should be formed in each region by taking the researchers and extension workers of the different agricultural organisations who collaborate with the BIRRI cropping systems research so that they can go directly to farmers' fields and can realize their problems and help to solve them in different respects of the farming activities.

- Finally, in regards to policy measures vide paras 2, 4 and 5 BIRRI should play an important role for the national systems so that the country can utilize her available resources by applying new technology in agricultural sectors to become self-sufficient in food production within a short period of time.

LIMITATIONS

The present study provides some insights into the way by which choice of rice crop combinations in the sense of varieties interact with the resource base of the farmer because of their different growing seasons. Researchers can identify suitable cropping patterns by using modelling process to farmers' practical situations. However, good basic data is needed to elicit the real judgement of the farmers concerned. The study still suffers from certain deficiencies such as the following which should be considered in future studies.

Firstly, land suitable for rice crop are the two types considered

In the model, irrigated and rainfed, But for individual farmers, additional constraints are sometimes added because particular fields had been found unsuitable for a certain variety of rice crop due to the different maturity days and uncertainly of rainfall.

Secondly, a constant average wage rate over the year has been assumed. But variation of demand for labour in peak period and off-season causes the fluctuation of wage rates which has been ignored in the study. Also, the availability of off-or non-farm work for the farmers would need to be further studied.

Thirdly, linear programming approach implies linearity of the objective function. In addition it considers the same technical requirements for farms with different levels of farm sizes and conditions. But it may vary with small, large and medium farms.

Fourthly, livestock enterprises are not considered in the study and this generally comprises the farm household activities. The interrelation between crops and livestock in mixed farming should be given attention.

Fifthly, in the model home consumption rice is taken as fixed for each period. But in practice small farmers probably substitute one food given the other depending on relative prices.

Finally, the assumptions of the LP model itself account for the limitations in the study. Other types of mathematical programming as well as extension and modifications of the basic LP technique would be helpful to depict a more realistic farming situation.

Title : *Testing, evaluation, and modification of the IRRI manual rice transplanter in Bangladesh*

Author : Mohammad Abdul Baqui

University attended : The Institute of Agricultural Engineering and Technology, University of the Philippines at Los Banos, College Laguna, Philippines

Year of completion : July 1981

ABSTRACT

The IRRI manual rice transplanter (model TRI) was tested for adaptability in Bangladesh. The average working efficiency of the machine was satisfactory (69-75%) with an average effective field capacity of 0.14 ha/day. Based on 100 effective working days prevailing in Bangladesh conditions, the transplanter can cover 14 ha/year with this capacity. The total manhours needed for transplanting a hectare of land was 336 and 122 for hand and machine transplanting, respectively.

The maximum energy expenditure were 3.79 and 3.09 kcal/min in machine and hand transplanting, respectively. However, the energy expenditure per plant was much lower in machine (0.019 kcal) than in hand transplanting (0.069 kcal).

At the present wage level (US\$0.5/day) the machine transplanting has a break-over of 26 ha which is too far above the annual capacity of the transplanter. This makes use of the machine uneconomical in Bangladesh. However, raising of seedlings in bamboo frames makes the machine transplanting economical with a cropped area of over 11 ha/year.

Title : *The influence of cinnabar moth Tyria Jacobaeae L. (Arctiidae Lepidoptera) on reproduction of ragwort, Senecio Jacobaea L. (Compositae)*

Author : Zahirul Islam

University attended : Imperial College of Science and Technology,
University of London, U. K.

Year of completion : August 1981

SUMMARY

● The emergence time of Cinnabar moth in Silwood Park was found to vary substantially between two sites. The adult population on Pond Field was $0.36/m^2$,

● Fecundity in the laboratory and in the field was 200 and 218 per female respectively but potential fecundity was 405. Fecundity correlated strongly with the female body weight.

● The mean egg batch size was 52 egg/batch. The number of eggs per batch is independent of plant size. Egg distribution is related to the plant size. There is a curvilinear relation between plant density and number of plant received eggs.

● Egg mortality is low (4.5%) and larval mortality is around 50% and independent of density.

● Mean instar duration of the first four instars is 4-5 days and 11 days for the fifth instar at 25° C and 70% RH with 16 hours photoperiod. Feeding period is approximately half of the duration of each stadium.

● Survival of larvae is high up to 3rd or 4th instar at all tested densities. Survival on original food plant drops suddenly during 4th and/or 5th instar due to dispersal following to defoliation.

● Invasion of uninfested plants by dispersing larvae is related to plant size.

● The probability of an uninfested plant being attacked by dispersing larvae within one metre of a primary infested plant is high (75%) and decreases over distance.

● Functional response to food availability of first four instars are Type II, while fifth instar's responses is more like to Type I.

● The increase of body weight of all five larval instars is strongly linearly correlated to the amount of food (dry weight eaten).

● The effect of all tested egg densities on small plants is defoliation with no flowers at all being produced. The number of undamaged flowerheads produced by large plants is a function of egg density and timing of attack.

● The effect of emigrant larvae on an invaded plant depends on the developmental stage of the plant and its size at the time of infestation.

● The effect of pre-flowering attack on large plants by dispersing larvae is more severe than post-flowering attack.

● Mature ragwort plants react to defoliation by producing from leaf axils. Production of regrowth is related regrowth to plant size and the extent of defoliation.

Title : *Effects of differently applied rice straw and neem cake on nitrogen transformation in flooded soil*

Authors : Taufiqul Aziz and Dr. I. Watanabe

University attended : The Faculty of the Graduate School, University of the Philippines at Los Banos

Year of completion : September 1981

SUMMARY AND CONCLUSIONS

Greenhouse and field experiments were conducted at IRRRI, Los Banos, Philippines, to study the effects of rice straw and neem cake—an agricultural by-product, on nitrogen fixation and the population of nitrogen fixers and nitrifiers in a flooded soil.

Greenhouse experiment conducted in small concrete tanks showed that application of rice straw on the surface without incorporating it into the soil increased the total and blue-green algal population. Maximum growth was observed between the 8th and the 10th week when algal population was five times higher in surface applied than in the incorporated rice straw treatment. On the other hand, the population of heterotrophic aerobic and anaerobic nitrogen fixing bacteria showed a different picture. Incorporating the rice straw into the soil increased their population. Thus, these results indicate that surface application of straw gives a better condition for the growth of blue-green algae, while incorporation gives a suitable condition for the growth of heterotrophic nitrogen fixing bacteria. Photodependent acetylene reduction activity was also increased in straw surface applied after an initial depression. Maximum acetylene reduction activity and the growth of blue-green algae coincided about the same time.

From the diurnal change of dissolved oxygen, it was shown that the respiratory activity was maximum specially in the initial periods in straw surface applied, but the photosynthetic activity also showed an increase after an initial depression and remained high compared to the other two treatments.

Surface application of rice straw thus promoted the growth of total and blue-green algae, increased acetylene reduction activity and showed higher photosynthesis of the overlying water. It seems probable that the surface application of rice straw in field makes an environment favourable for the growth of blue-green algae and may explain the reason why its growth is more in paddy field ecosystem. Surface application of rice straw may be beneficial to rice specially in terms of algal nitrogen.

A very simple method was adopted to study the decomposition of rice straw in the flooded soil. Results of the experiment indicated that the decomposition of rice straw in flooded soil was quite rapid particularly up to 40 days. Loss of organic matter was 44, 60, 66 and 75 % of the original content after 20, 40, 60 and 80 days respectively. Decomposition of straw was also accompanied by a remarkable decrease in dry weight and an increase in total N% of the remaining residue. Ash content remained the same through out the period.

Experiments conducted in beakers showed that neem cake (the crushed and deoiled seed kernels of neem or *Azadirachta indica*) stimulated the growth of blue-green algae by depressing the activity of predators which eat the algae biomass. Similar results were obtained in the field. Application of neem cake produced six times more algal biomass in field than the control. Neem cake lessened the depressing effect of ammonium on algal growth. *Gloeocapsa*, *Gloeotrichia*, and *Anabaena* were the main blue-green algae in neem cake-treated plots. Photodependent acetylene reduction activity was also enhanced in neem cake treatments mainly because of increased growth of blue-green algae. In the field, neem cake produced 163 and 145% increase in acetylene reduction activity than the control at 12th and 15th weeks respectively, while in nitrogen treatment the activity was less than the control.

Neem cake was found to reduce the population of nitrifiers for 3-4 weeks. Greenhouse experiment showed the effectiveness of neem cake at the 1st and the 3rd weeks for *Nitrosomonas* and the 2nd and the 3rd weeks for *Nitrobacter*. In the field, neem cake reduced the population of *Nitrosomonas* at the 2nd and the 3rd weeks, and *Nitrobacter* at the 1st week only in the oxidized layer of the soil.

Neem cake as a split application along with nitrogen gave higher grain and straw yields than nitrogen alone.

It seems from the result that neem cake when applied to soil promotes the growth of blue-green algae, increases nitrogen fixation and reduces the nitrogen loss from soil by reducing the population of nitrifiers. It may thus be beneficial for rice in the flooded soil.

Title : *Evaluation of rat control techniques in experimental fields of the International Rice Research Institute.*

Name of author : Mohammau Sayed Ahmed

University attended : Faculty of the Graduate School, University of Philippines at Los Banos, Laguna, Philippines

Year of completion : October 1981

SUMMARY

Four rat control techniques, on an experimental farm area, were evaluated during the wet season, 1980 and dry season, 1981. The control techniques compared were Sustained Baiting (SB) with a multiple dose anticoagulant rodenticides (caumachlor), Pulse Baiting (PB) with a single dose antiacoagulant rodenticide (brodifacoum), a Lethal Electric Rat Barrier (LERB), and a Nonlethal Electric Rat Barrier (NLERB). No Experimental Rat Control (NERC) plots were used for comparing the control techniques. Tiller damage and rat activity were the parametrs used to evaluate the effectiveness.

Tillea damage was found only in the flowering (8-9 WAT) and maturity (13-14 WAT) stages of rice in both seasons. Higher bait consumption, rat activity, and the absence of tiller damage in the early stages (about 4 WAT) indicated that the rat do not prefer the young rice plant over bait material. Rat activity generally increased as the rice crop matured and rats preferred to cut tillers. Presence of higher rat activity and damage and absence of bait consumption at the maturity stage of rice suggested that rat prefers to cut tillers and eat grain heads rather than eat the bait.

Similar rat activity from tillering (4 WAT) to maturity (13-14 WAT) in the baited plots (SB and PB) revealed that baiting with anticoagulant bait was effective in reducing rat populations and the resulting damage.

Low or no rat activity inside and high rat activity outside the LERB plots at maturity indicated that LERB effectively protected experimental plots from immigrant rats. Similar activity inside and outside the NLERB plots at maturity suggested that NLERB did not prevent the immigration of rats. This was due to the presence of rat burrows under the fence through the dike.

Tiller damage assessment at the maturity stage showed that LERB gave better protection to experimental plots from rat damage followed by SB, PB, and NLERB. However, total cost/ha per season for the LERB (about peso 10,000.00) was much higher than the other techniques (about 50 times greater than SB and PB). The high cost of LERB was due to the much higher manpower needed to remove the electrocuted rats from the fence.

Results of a survey indicated that most of the researchers felt that the rat problem on the IRRI farm was moderate. Rat damage occurred in almost all of the experimental plots and caused a complete loss of data in 6.3% of the experiments and partial loss of data in 59.5% of the experiments. Season had no effect on the occurrence of rat damage. Electric barrier used in the IRRI farm did not provide any increased protection in experimental plots from rat damage in 1980.

CONCLUSIONS

- There was no difference of tiller damage within baiting methods. Sustained and pulse baiting were the cheapest rat control techniques tested. These were easier to maintain and give adequate protection from rat damage to experimental plots. Large scale pulse or sustained baiting throughout the IRRI farm would highly increase their efficiency.

- At the maturity stage of rice, rats do not prefer bait.

- The lethal electric rat barrier with rodenticides effectively protected the small experimental plot from rat damage but it is highly expensive, difficult to maintain and hazardous to non-target species. Modification of the electrical system for preventing

necessity of labourers for night patrol (night crew) to remove the electrocuted rats would highly reduce the cost.

- The nonlethal electric rat barrier is not effective and needs modification of the fence design to prevent burrowing of rats under the fence through the dike ;

- Rat damage in the IRRI farm causes loss of experiment data ;

- Locations made little differences except block A-E where a very high percentage of data was completely lost. Block F-T had lowest loss of data. However, loss of data depends on the type of experiments. Those that require data at harvest would differ from those that only require data up to 8 WAT ;

- Seasons had no effect on the occurrence of rat damage and experimental data loss ;

- Barriers used in the IRRI farm afforded no better protection of experimental data from rat damage than no barrier at all ;

- Majority of the researchers feel that the rats have been a moderate problem and has become more serious during the last three years.

Title : *Soil and plant tests for available sulphur in wetland rice soils*

Author : M. Mujibul Islam

University attended : The Faculty of the Graduate School, University of the Philippines at Los Banos, Laguna, Philippines

Year of completion : November 1981

SUMMARY AND CONCLUSIONS

Greenhouse experiments were conducted at IRRI during the 1981 dry season with 30 soils representing large rice growing areas of the Philippines. The main objective was to study the availability of sulphur to wetland rice by soil and plant tests.

Soil available sulphur was determined by four extraction methods and correlated with soil total sulphur, grain yield and sulphur status of the rice plant. Calcium phosphate and ammonium acetate extractable sulphur were highly correlated with the grain yield ($r=0.655^{**}$ and $r=0.629^{**}$ respectively), total sulphur content of the straw ($r=0.667^{**}$ and $r=0.606^{**}$ respectively) and grain total sulphur ($r=0.512^{**}$ and $r=0.571^{**}$ respectively), indicating the suitability of these extractants for determining available sulphur in wetland rice soils.

Critical levels of the soil and plant sulphur were determined using the Cate-Nelson graphical method. For wetland rice the critical limit of soil available sulphur by calcium phosphate, lithium chloride, ammonium acetate and hydrochloric acid extraction methods were 9, 25, 30 and 5 mg/kg, respectively.

The critical level of total sulphur, N:S ratio and sulphate sulphur varied with the growth stages of the rice plant. Critical sulphur content in the shoot and straw for optimum dry matter weight was 0.11% in the shoot at the maximum tillering stage (8 WAT), and 0.055% in the straw at maturity. The critical limit in the grain was 0.065%. The critical N : S ratio for optimum dry weight was 15 in the shoot at

the maximum tillering stage (8 WAT), 14 in the straw at maturity and 26 in the grain. The critical level of sulphate sulphur was 150ppm in the shoot at the maximum tillering stage and 100ppm in the straw at maturity. The critical limit of SO_4^{-2} /total sulphur percentage ratio in the rice plant was not affected by the age of the plant. The critical SO_4^{-2} /total sulphur percentage ratio was 15 in both the shoot at the maximum tillering stage (8 WAT) and straw at maturity.

Visual symptoms of sulphur deficiency were observed in six of the twelve soils containing 2 — 8 mg/kg available sulphur by calcium phosphate method. Plant height, number of tillers and panicles, as well as straw and grain yield were lower in these soils compared to soils containing >8 mg/kg available sulphur. Addition of sulphur markedly increased the plant height, tiller and panicle numbers, and grain and straw yields.

Submergence increased the pH values of acid soils and decreased those of calcareous soils and caused them to converge at 6.6 to 6.8 at 8 weeks after submergence. Redox potential (Eh) decreased with duration of submergence. The concentrations of NH_4^+ , H_2PO_4^- , K^+ , Fe^{+2} , Mn^{+2} and Zn^{+2} in the soil solution markedly increased, while the concentration of sulphate decreased rapidly with submergence. In all soils increase in concentration of ions in the soil solution reached a maximum value after 3-4 weeks of submergence, then declined with time.

Title : *Effect of several growth regulators, shading and cultural management practices on rice ratooning*

Author : Mohammad Abdul Quddus

University attended : University of the Philippines at Los Banos, Laguna, Philippines

Year of completion : November 1981

SUMMARY AND CONCLUSIONS

To study the effect of some growth regulators and cultural management practices on the performance of ratoon rice, three field and two screenhouse experiments were conducted at IRR1, Los Banos, Laguna, during the period from February 1980 to January 1981.

Because of high ratoonability reported in former IRR1 trials, IR13471-57-3, IR50 and IR9784-52-2-3-2 were cultivars used for the experiments. Grain yield and other plant characters of both main and ratoon crops were studied.

Indoleacetic acid (IAA) at 100 ppm concentration applied at the milk stage and GA3 at 100 ppm concentration applied at the flowering stage produced significantly a higher number of panicles per hill in field trials of both main and ratoon crops than in control plots. But in a screenhouse experiment no such effects were observed. Other plant characters were not significantly influenced by the growth regulators.

Artificial shading of plants always reduced grain yields of the main crop. Among different shading treatment shading at the late milk stage (LMS) of the main crop produced a higher ratoon yield than shading at the flowering stage. Except the paraquat treatment which killed all plant parts, shading and additional 30 kg N/ha over normal N rate did not show significant effect on yield components of a ratoon crop.

The time of nitrogen application at different plant growth stages of the main crop did not significantly affect the yield or the plant characteristics of the main or the ratoon crop.

Yields were not influenced by cutting height, but a cutting a height of 5 cm produced significantly a higher percentage of missing hills than the cuts at 15cm or ani-ani which were statistically identical.

By cutting at 5 cm, the number of tillers per square metre and the number of panicles per hill were significantly reduced compared with cutting height of 15 cm and ani-ani. The number of tillers per square metre in the ratoon crop was higher than in the main crop. Closer observations showed that the higher number of ratoon tillers at a higher cut was due to the higher capacity of stubble to produce tillers both from the basal and ancillary buds.

Lower cuts on the main crop increased the field duration of the ratoon crop. The field duration of the ratoon crop was increased by 9 and 4 days by reducing cutting from 15 to 5 cm and from 15 cm to ani-ani, respectively.

A screenhouse experiment shows that increased nitrogen levels increased the grain yield. This was associated with the increased number of panicles, filled grains and ratoon vigour. A higher rate of nitrogen applied at 8-10 cm depth reduced the grain-straw ratio.

Placement of 100 kg N/ha at 8-10 cm depth markedly increased the grain yield of ratoon rice compared with the amount of nitrogen fertilizer broadcast on the surface.

The original hypothesis was that ratooning ability is associated with percent carbohydrate of the rice plant at harvest. So, if the senescence of the leaf of the main crop can be delayed by the application of growth regulators, more carbohydrate might be accumulated through the process of photosynthesis which in turn might help ratoon tiller inducement. Our hypothesis did not work as both the field and screenhouse experiments indicate that the application of growth regulators on the main crop had little or no beneficial effects on ratoon rice.

The effectiveness of growth regulators in rice seems to be highly contradictory and debatable. Moreover, basic information on the physiology of rice ratooning and the factors influencing higher yields of ratoon rice remain inadequate. Against this background, it will be unwise to draw conclusive remarks based on the application of growth regulators only at the post-flowering stage. Within the same variety performance may differ across different stages of plant growth and agroclimatic conditions.

Among the major factors that determine the success of a rice ratoon crop are genetic ratoonability of a variety ; resistance to pests and disease ; plant population, time of harvest and cutting height in the main crop ; rates, time and placement methods of nitrogen fertilizer and water management of the ratoon crop.

The use of growth regulators seems less important in rice ratooning until a more basic understanding of their physiological role and the what, where, how and how much questions are investigated more fully.

The many growth regulator variables compared in these trials generally gave non-significant results.

Title : *Agro-economic evaluation of double cropping in the Beqa'a plain of Lebanon*

Author : Mohammad Jalaluddin

University attended : American University of Beirut, Lebanon

Year of completion : February 1982

SUMMARY

Field experiments were conducted at the Agricultural Research and Education Centre (AREC) of the American University of Beirut, in the Beqa'a plain of Lebanon, in 1979-80 and 1980-81 cropping seasons, to study the agro-economic suitability of double-cropping.

In the first year, broadbean variety, Lebanese local, was planted in mid-November, on a large plot which was divided into halves, one for green and the other for dry harvest. The dry *bean* (seeds) were harvested about 3 weeks after the harvest of green *beans*. After harvest of green and dry beans, each of the plots were again divided into halves for growing sweet corn in one and potatoes in the other. Two hybrids of sweet corn, Bantam Golden Cross and Target A in one experiment, and two varieties of potato, Arranbanner and Spunta in the other experiment, and two varieties of potato, Arranbanner and Spunta in the other experiment, were planted at four N rates, in a split-plot design with four replications, hybrids/varieties in main plots and N rates in sub-plots.

In the second year, fine varieties of broadbeans, namely, New Mammoth, Raina Blanka, Syrian Local, Seville Giant and Lebanese Local were grown with and without applying Captan at the rate of 10 g/kg seed, as seed treatment fungicide, in a split-plot design with three replications seed-treatments in main plots and varieties in sub-plots.

Data on green-pod yield and dry-seed yield of broadbeans were collected from the first year's crop. From the second year experiment, data were taken on percentage of plants killed by root-rot/wilt,

percentage of plants showing yellow Mosaic, and seed yield. From sweet corn, data were collected on plant height, total tillers per plant, number of marketable ears per plant, fresh weight per marketable ear and silage yield. From potatoes, tuber yields were recorded.

Broadbeans grown in winter, either for green vegetables or for seeds, followed by sweet corn or potatoes in summer, were agronomically suitable and economically profitable. Broadbeans-sweet corn was economically more profitable than broadbeans potatoes cropping pattern. Again, sweet corn/potatoes after green beans were more profitable than those after dry beans.

The yield of broadbeans, Lebanese Local, in the first year, was affected by frost injury and root-rot/wilt diseases. The variety, Syrian Local, was the most tolerant to root-rot/wilt and virus diseases, and produced the highest seed yield, among the five varieties tested in the second year. The seed yield of the broadbeans varieties were highly dependent on their tolerance to these diseases. Seed treatment with Captain significantly increase root-rot/wilt damage and reduced yield in all varieties.

Sweet corn hybrid, Bantam, was specifically suitable for early planting, but target A had wider adaptability with respect to planting dates. The optimum N rate for Bantam was 200 kg/ha and for target A was 300 kg/ha, when they were planted after green beans. But, when planted after dry beans, 100kg N was optimum for target A whereas no N was needed for Bantam.

The potato variety, Arranbanner, was suitable for early planting and Spunta was suitable for late planting. Nitrogen application did not increase potato yields at any planting dates. The net return and benefit-cost ratios of potatoes declined with the increase in N rates from 0 to 300 kg/ha.

CONCLUSIONS

The results of the present study led to the following conclusions :

- The utilization of land and inputs can be maximized by choosing proper combinations of crop varieties in multiple cropping.

● Field duration of the winter crops and maturity duration of the summer crops are very important factors to be considered in choosing crop varieties for double-cropping.

● Long field-duration of the winter crop shortens the growing season for the following summer crop, and thus affects the production and net return.

● Cost of production for the summer crop can be minimized by reducing the N need if a legume crop is successfully grown in the preceding winter.

● Broadbean are profitable legume crops when grown in a double-cropping system in the Beqa'a plain of Lebanon.

● Green broadbeans are more suitable in double-cropping than dry broadbeans.

● Variability in disease-resistance and yield potential exists in broadbean varieties, and Syrian Local is a much better variety than Lebanese Local, with respect to disease resistance.

● Broadbean yield and net return can be increased by using varieties which are resistant to root-rot/wilt and virus diseases, and frost, and if black aphids are controlled at early stage of plant growth.

● Sweet corn has considerable prospects as summer crop in Lebanon, in view its high benefit-cost ratio.

● Potatoes as summer crops, can be grown with minimum N application if legumes are grown in the preceding winter. However no N should be applied if potatoes are planted in July, after legumes.

● Broadbeans—sweet corn and broadbeans-potatoes are profitable cropping patterns in the Beqa'a plain of Lebanon.

● Sweet corn hybrid, Bantam Golden Cross, grown after the broadbean variety, Syrian Local (as a green crop), would be the best practice.

RECOMMENDATIONS

Based on the result of this study, the following recommendations can be made :

- More number of early-maturing varieties of broadbeans which are tolerant to frost, root-rot/wilt and virus diseases, should be identified.

- On-farm trials should be conducted to evaluate the performance of Syrian Local in comparison with that of Lebanese Local, variety of broadbeans.

- Dry broadbeans can be grown in Lebanon, but on a limited scale, to meet the local demand for seeds only.

- Green beans should be followed by Bantam with 200 kg/ha N, and dry beans should be followed by target A with 100 kg/ha N.

- Nitrogen rates beyond 100 kg/ha should not be applied to potatoes grown after broadbeans.

- Available hybrids of sweet corn should be tested under different N rates, planting dates and plant populations, when grown after broadbean, so that a package of management practices can be determined for each hybrid to be grown in a double-cropping pattern.

- Broadbeans—sweet corn and broadbeans-potatoes cropping patterns can be practiced in Lebanon at considerably high economic production level.

Title : *Rice processing in Bangladesh Rice Research Institute pilot project area, Joydebpur Bangladesh*

Author : Mohammad Abdul Jabber

University attended : The Faculty of the Graduate School, University of the Philippines at Los Banos, Laguna, Philippines

Year of completion : September 1982

SUMMARY

The study evaluates various rice processing systems in the BRR Pilot Project area of Joydebpur, Bangladesh. The study was conducted during June to September 1981. Two main sources of information were used in this study; a sample survey of rice millers; and secondary data collected from official records.

The major objectives of the study were to :

- evaluate the performance of rice milling facilities in terms of milling recovery ;
- examine the employment potential of the three kinds of rice milling systems over different seasons ; and
- find out the comparative cost and returns of the different rice processing units.

The major findings of this study were :

Condition of the millers/mills

- Among the different milling systems, the majority of the millers in the study area are millers-cum-farmers ;
- Modern millers have significantly higher educational level than those of the traditional system :
- In the acquisition of the machinery, 77 and 80 percent of the small and large rice mills respectively were bought new ;
- In the study area, 37 and 40 percent of the small and large millers respectively had their establishment by selling lands while only

30 and 27 percent of the small and large millers purchased their mills from farm income ;

- During the peak season, the prevailing good weather helps facilitate drying of the newly harvested Aman paddy. As a result, the milling activity goes up ;

- During the normal season, the paddy supply falls below that harvested during the peak season. Because of excessive rainfall, the drying is severely affected. Consequently, mill activity is lowered. The millers reported that the rainy season creates problems in the drying of rice ;

- During the slack season, paddy is not at all available to the millers. Due to this reason, milling activity is least at this time.

- The movement of paddy from the farmer to consumers is as follows :

- from the village to the primary market or declared hat ;
- from the hats (or farm) to the warehouses ;
- from the warehouse (or farm) to the processing place ;
- from the processor to the wholesaler and the retailer ;
- from the retailer to the consumer.

Performance of rice milling facilities

- The amount of head rice in the parboiled rice is always higher than that in the unparboiled rice ;

- The parboiling system in the large mills is more developed than in the other mills ;

- Parboiling improves the milling quality as well as the total recovery by reducing the proportion of broken grains ;

- The simple small - scale method of parboiling is inferior to that used by the larger mills because there is less control of temperature and the grains do not get the uniform treatment which leads better parboiling ;

- The large milling system is technically more developed than the small and traditional system.

Employment

- Traditional system provides greater family labour employment opportunity than the other systems ;
- The small and large mills offer better employment opportunities for landless labourers ;
- The modern mills are replacing the traditional ones. The traditional systems require arduous physical labour and are operating on a noncommercial basis ;
- A large number of labourers are employed during the peak season in all milling systems, because of the newly harvested Aman paddy, which contributes about 60% of the total production ;
- Among the three milling systems, the large mills provide the highest of hired labour ;
- Labour-capital intensity of parboiling and drying operations under the modern milling systems used less capital but more labour compared to other operations ;
- The labour-capital intensity of the traditional system for parboiling and drying stages differs from other types of milling operations. It requires more capital relative to labour as compared to the other 2 milling systems.

Cost and returns

- The large mill had the highest investment for building among the three categories of milling operation.
- Labour payment was the highest expense for all types of mills studied. The small and large mills had higher fixed labour expense as compared to the traditional system. This may be explained by the fact that the small and large mills usually employed more hired workers than that in the traditional system.
- The average annual milling cost of the traditional, small and large mills were Tk 914, Tk 95,193, and Tk 1,33,087 respectively. On per metric ton basis, the milling cost in the study area was Tk 431 for traditional system, Tk. 162 for small mill, and Tk 170 for large mill.

● The primary sources of income from the different milling systems (traditional, small and large) computed per metric ton is Tk 385, 220 and 248 respectively.

● Other sources such as broken rice, bran and husks of the different milling systems (traditional, small and large) the income is Tk 27, 27 and 41 per metric ton.

● Among the different types of mill, the large mill received greatest income from milling. This is due to the fact that large rice mill, as mentioned earlier, do have higher milling recovery such that they were more preferable than traditional and small milling systems.

● Limited range of data available for the estimation cost function ;

● Extrapolation is not possible with the estimated cost function, unless, the production function is linearly homogenous.

● From the R^2 more than 95 percent of the variability in total cost in all the milling systems can be explained by the variability in output. Among the coefficients of output (the volume of paddy) in all the milling systems, the traditional system had a higher value than that of the other systems. The fixed cost both in small and large milling systems is much higher than that for the traditional system.

● As the volume of paddy increases, the average total cost per unit decrease in all the milling system.

● The cost elasticity (traditional, small and large mills) measured mean values were. 0.88, 0.95 and 0.94 respectively, implying that in one percent increase in output, the total cost will increase by less than one percent.

● The break-even point of the traditional system was 3.60 metric tons. At that time, the fixed cost was Tk 102, and the total cost was Tk 1,552. The break-even point for both small and large mills was 60 metric tons. The fixed cost was Tk 4,629 and Tk 7,908, and the total cost was Tk 9,720 and Tk. 10,200 for the small and large mills, respectively.

● The traditional system husked yearly 2 metric tons volume of paddy and the small and large mills, 586 and 782 metric tons respectively.

● Large mills registered the highest profit of Tk 119 per metric ton followed by small mills with Tk 85 per metric ton. The loss incurred by the traditional system is Tk 19 per metric ton.

RECOMMENDATIONS

● Comparatively the large mill are more efficient in terms of terms of milling recovery. They provide for more employment. More attention can therefore be directed to the improvement and expansion of large mills in potential market places.

● Findings were : Most of the rice mill owners were only able to establish their mills either by selling lands or from their own resources ; there were small mills already and they need improved parboiling systems. It is therefore recommended that institutional support be given for expansion of the small mills and improvement of the parboiling system. This incidentally will provide for more employment in the rural areas.

● During the slack season there is a shortage of paddy causing mills to stop operating. It is recommended that the appropriate agency of the Ministry supply the required paddy so that the normal milling operation during the slack season is maintained.

● Although the traditional system is not economically profitable, but considering the employment of family labour it will continue to survive in the near future. Until other avenues for family labour employment are created these people will depend on the little earning for their family through this system. Considering the hardwork put into the traditional system, little innovation may ease this problem. So, some innovative measures should be undertaken to improve the traditional system.

Ph D DISSERTATIONS

Title : *The influence of specific gravity and deterioration of rice seed on field performance under two plant population densities*

Author : A J M Azizul Islam

University attended : The Faculty of Mississippi State University, Mississippi State, Mississippi, USA

Year of completion : August 1976

SUMMARY

Combine-run starbonnet rice seed were separated into five specific gravity classes :

- I control,
- II 1.00-1.05,
- III 1.05-1.13,
- IV 1.13-1.20, and
- V 1.20-1.22.

A portion of the seed of each specific gravity class was deteriorated by accelerated aging for four days at 42°C and 100% relative humidity.

Ten treatment combinations obtained from all combinations of the five seed specific gravity classes and the two levels of deterioration, aged and non-aged seed, were evaluated in the laboratory by the standard germination test, measurement of root and shoot growth of seedlings and a soil emergence test in the greenhouse. The germination percentages, soil emergence percentages, and the rate of root and shoot growth of seedlings increased as the specific gravity of the seed increased. Accelerated aging significantly reduced standard germination and root and shoot growth but it did not differ from non-aging in its effect on soil emergence percentages of the seed. The effects of interaction between seed specific gravity and aging on the responses of the laboratory tests were not significant.

The ten treatment combinations evaluated in the laboratory were sown in the field with two spacings :

- 25 - x 25-cm, and
- 15 - x 15-cm.

The effects of seed specific gravity, aging and spacing on most of the plant parameters measured were independent of one another. In some cases, specific gravity interacted with spacing.

Plant heights and the number of tillers per hill measured at weekly intervals after planting were increased with an increase in specific gravity of the seed. But, as the growing season advanced, the differences in plant heights and tillers among specific gravity classes other than class II, disappeared. The final plant height and tillers per hill produced by seed class II, only, were significantly lower than those from other classes. Accelerated-aged seed caused a significant reduction in plant height and tillers per plant in the early stages of plant growth ; but, at maturity, there was no difference in these parameters between aged and non-aged seed. The 25 - x - 25 cm spacing consistently produced more tillers per plant throughout the growing season than the 15 - x - 15 cm spacing.

Panicle exertion, anthesis, days to grain maturity and moisture content of the grain at maturity were progressively increased as the specific gravity of the seed decreased. The 25 - x 25-cm spacing significantly delayed panicle exertion, anthesis, maturity of grains, and increased moisture content of the grain at maturity. Aging treatments had no effect on any of these plant characters except that moisture content of grain at maturity was greater from the aged-seed than non-aged. Although panicle exertion and time to reach anthesis were influenced by the treatments, grain filling period was not influenced.

The number of filled grains per panicle and weight of 1000 grains were similar among the specific gravity classes and between aging levels. Panicle length was significantly reduced in seed class II, but it did not differ between aging levels. Grain yield per plot obtained by the seed class II was significantly the lowest. Compared with the control the different specific gravity classes yielded as follows :

- II 86% ;
- III 98% ;
- IV 100% and
- V 104%.

Accelerated-aged seed produced 7% less yield than non-aged seed. No significant difference existed in grain yield between spacings. Apparently there was a compensating effect among the various components of yield.

Isolated plants grown from seed class II, III and V with aging and non-aging treatments exhibited similar plant performance as described above. The individual plant performances were improved greatly. At the same time, panicle exertion, anthesis and grain maturity were much delayed. Grain yield per plant from seed class II was also much reduced.

The specific conclusions drawn are :

- Seed with a specific gravity of 1.13 or higher always performed better in terms of plant growth, development and grain yield than lighter seeds ;
- the lightest seed was most vulnerable to deterioration by accelerated aging ;
- the effect of seed deterioration was manifested by a reduction of early plant growth, and then again as reduced yield ;
- seed specific gravity, deterioration and spacing were independent of one another in plant performances ;
- closer spacing (15 - x 15-cm) significantly increased plant height, reduced the number of tillers per plant and caused early flowering and maturity with no difference in grain yield compared to wider spacings (25 - x 25-cm) ; and
- the detrimental effect of low seed quality was not overcome by increasing plant population densities.

Title : *Etiology, epidemiology and control of diseases caused by sclerotial fungi in Louisiana rice*

Author : A K M Shahjahan

University attended : Louisiana State University, Louisiana 70803 USA

Year of completion : September 1977

SUMMARY

Surveys conducted during the 1974 and 1976 growing seasons showed that stem rot caused by *Magnaporthe Salvinii* (*Sclerotium oryzae*) and *S. oryzae* var. *irregulare* and sheath blight caused by *Thanatephorus cucumeris* (*Rhizoctonia solani*) were present in all the south-west Louisiana parishes surveyed. Of the varieties surveyed, it was found that Lebonnet, Nato, Salum, Starbonnet and Vista had a higher percentage of tillers infected with stem rot than Bluebelle, Barros, Laballe and Nova-66. On the other hand, Bluebelle, Brazos, Laballe and Lebonnet had a higher percentage of tillers infected with sheath blight than Nato, Nova-66, Saturn, Starbonnet and Vista. Two additional sclerotial fungi, *S. hydrophyllum* and *S. rolfsii* were found associated with stem and sheath rotting of rice. They were pathogenic to rice in pathogenicity tests.

Scanning electron microscope studies of newly formed lesions on sheaths and stems of rice showed that conidia of *S. oryzae* and *S. oryzae* var. *irregulare*, produced by sclerotia can cause secondary infection under field conditions.

Sclerotia of *S. oryzae* and *S. oryzae* var. *irregulare* were found in soils of all the southeast Louisiana parishes surveyed. Most of the sclerotia were found in the top 2.54-7.62 cm of the soil. Sclerotial numbers and viability decreased with increasing soil depth. The sclerotia were relatively uniform in their distribution in each field sampled.

Isolates of *S. oryzae* collected from different fields in southwest Louisiana could be separated into two mating types previously

reported from California. No new mating types were found. The perfect stage of *S. oryzae* var. *irregulare* was not obtained by crossing isolates. The isolates of *S. oryzae* var. *irregulare* found in Louisiana varied in virulence. In addition, the relative virulence of isolates of *S. oryzae* was higher than that of *S. oryzae* var. *irregulare* isolates in field and greenhouse tests.

In field tests stem rot and sheath blight significantly lowered yield, caused lodging, reduced the percent green leaf area, and lowered the percent whole, milled rice. There was a high negative correlation between yield and percent infection (PI) or disease index (DI) for most varieties infected with stem rot or sheath blight. A system for predicting yield loss to stem rot or sheath blight, based on multiple regression of PI and DI, was derived.

There was a high correlation between the PI with stem rot at tillering and the PI at maturity. The correlation between PI at tillering or maturity and total viable sclerotia TVS/g soil was also high and significant, suggesting that stem rot severity at maturity could be predicted from the PI at tillering or from the TVS/g soil at planting. Prediction equations for yield loss due to stem rot involving TVS/g soil of *S. oryzae* and/or *S. oryzae* var. *irregulare* were also derived.

In-vivo and *in-vitro* studies on the interaction of sclerotial fungi attacking rice stems and sheaths showed that *R. oryzae* interferes with the normal growth of the other fungi, especially *R. solani*. *R. oryzae* reduced damage or yield losses to rice due to *R. solani* in field tests.

The possibility of using fungicides to control diseases caused by sclerotial fungi was studied. In agar-incorporation tests, the fungicides Baydam, Benlate, Duter, Topsin-M, and sodium azide were fungitoxic to one or more of the test fungi *R. oryzae*, *R. solani*, *S. Oryzae*, or *S. oryzae* var. *irregulare* at concentration of 1 to 10 ug/ml. However, control of stem rot *in-vivo* using these fungicides could not be obtained by a single application at the tillering stage.

Title : *Resistance to biotype 3 of the brown planthopper, Nilaparvata lugens (Stal) in rice varieties*

Author : Mohammad Shamsuf Alam

University attended : Cornell University, USA

Year of completion : January 1978

SUMMARY

A total of 4,324 rice cultivars representing 50 countries obtained from IRRI germplasm bank were screened for resistance to biotype 3 of the brown planthopper inside a screenhouse from March to August, 1976.

Seeds were sown 5 cm apart in 20 cm rows in 60-x 10-cm seed boxes filled 5 - 7 cm deep with soil. Two susceptible varieties, ASD 7 and TN1, and a resistant check variety Mudgo were sown in random rows in seed boxes and were transferred to a galvanized tray placed inside a screenhouse. The tray was kept filled with water (5-10 cm deep) to maintain an optimum humid environment adequate for brown planthopper. Infestation was made a week after sowing with first and second instar nymphs as uniformly as possible so that each seedling received 5 - 7 nymphs, an optimum number for differentiating resistant varieties from susceptible ones.

Damage ratings for each variety were made when all the seedlings of the susceptible check varieties were dead. This rating was based on a visual grading of the 0-9 scale :

- 0, no visible damage (highly resistant) ;
- 1 and 3, partial yellowing of the first and second leaves (resistant) ;
- ⊕ 5, pronounced yellowing and some stunting (moderately resistant) ;
- 7, wilting and severe stunting (susceptible), and
- ☉ 9, all test plants dead (highly susceptible).

Seventy-eight cultivars having a grade of 5 or less were selected from mass-screening for retesting. This led to the identification of

20 cultivars, Rex/2 BBT 50, Surdurvi 306, Murunga 308, Murunga 137, Sudurvi 305, Murunga 307, PI 220408, RDR7, RDR2, MTU 15, Murunga 307, HR8, MTU 20, HR 106, HR 98, HR 100, HR 105, HR 109, IR1561-288-3-3 and IR910-12-3-1-1 as resistant or moderately resistant. All were indica types and most were natives of India and Sri Lanka except Rex/2 x BBT 50 from USA and IR1561-288-3-1-1 from IRRI.

The nature of resistance in these varieties was studied and observed to be mainly insect non-preference and antibiosis except in HR 100 which also possessed a low level of tolerance. Relative degrees of non-preference and antibiosis were not uniform among the resistant varieties. The varieties which were non-preferred by nymphs were also non-preferred by adults for food and shelter but with no preference for oviposition or for olfactory stimuli.

Nymphal mortality was high on resistant varieties and the developmental period was prolonged and irregular which suggested the presence of an antibiosis factor. Insects made more feeding punctures, stylet sheaths reached the vascular bundles but fed less, insects excreted less honey dew and gained less body weight on resistant varieties and also were smaller in size.

Longevity of females on the susceptible ASD 7 variety was 4-7 times longer :

- the preovipositional period was 2-3 times shorter ;
- fecundity was 2-30 times higher ; and
- percentage of egg hatching was higher.

Reduction in population buildup was dramatic at 60 days after infestation between resistant and susceptible varieties. Population increase on the susceptible varieties was 9—132 times greater than on the resistant varieties.

In general, the nitrogen fertilizer level had no effect on insect survival on resistant varieties. Nymphal survival was greatly affected by different temperatures. Nymphal mortality increased with increase in temperature from 25⁰ to 30⁰C. At 20⁰C, survival of nymphs was higher than at other temperatures on resistant varieties. Mortality of nymphs was higher on resistant varieties at 35 days after seeding than on 10-75-day-old plants. It appears that the cause of resistance to biotype 3 in rice varieties is mainly biochemical.

Title : *Selection for yield, protein, and kernel size in OAT populations using a partitioning method*

Author : Nur Muhammed Miah

University attended : The University of Arkansas, USA

Year of completion : 1978

SUMMARY

Eight oat populations, of which six were heterozygous and two homozygous were grown at the Rice Branch Experiment Station, Stuttgart, Arkansas, in 1974-75. The objectives were to :

- utilize Powers' partitioning method to simultaneously select for kernel protein, plant yield, and kernel weight;
- extend the partitioning method from bivariate to trivariate analysis; and
- determine the degree of association among characters and sources of covariance control.

Kernel protein means of the populations ranged 17.6-22.1% with Ark. 99-66 having the highest level. The range in plant yield was 9.4-11.4 g/plant with Ark 99.266 being the highest yielding. Kernel weight means varied from 2.5-3.3 g for 100 kernels with Ark 99-66 being the heaviest. The variances for kernel protein, plant yield, and kernel weight of the *heterozygous* populations were significantly greater than that of the homozygous populations, except for Chicota x Diana for plant yield and Ark. 99—66 for kernel weight.

The frequency distributions for kernel protein, plant yield, and kernel weight were partitioned into inferior and superior sections by beginning with a single variable, then combining variables two at a time into bivariate distributions, and ultimately combining the three into a trivariate distribution.

The results of the univariate frequency distributions indicated that selection could be most effective in the heterozygous populations for kernel protein followed by plant yield and kernel weight.

The population Nora x Jaycee had the highest number of identifiable genetic deviates for kernel protein and plant yield ; whereas, the population Nora x Pettis had the highest number of identifiable genetic deviates for kernel weight. The Borad sense heritability ratios of individual populations for kernel potein, plant yield, and kernel weight ranges from 0.30—0.67, 0.05—0.053, and 0.14—0.63, respectively. The population Nora x Jaycee showed the highest heritability ratios for all the three characters.

Results from the bivariate frequency distributions indicated that simultaneous selection for kernel protein and plant yield would be most efficient in these populations followed by selection for kernel protein and kernel weight, and least effective for plant yield and kernel weight. The population Nora x Jaycee consistently exhibited a higher number of identifiable genetic deviates for all the three bivariate combinations.

Simultaneous selection for all three characters based on trivariate analyses appeared to be possible only in Nora x PI320839 and Nora x Jaycee populations due to the lack of genetic variability for one of the characters in the other heterozygous populations. Selection probably would have been more effective if the population size had been increased.

Results of the correlation studies indicated that kernel protein was negatively associated with plant yield and kernels per panicle. Plant yield was positively correlated with kernel weight, panicle number, kernels per panicle, and plant height. Plant height was positively associated with kernels per panicle and panicle number and negatively correlated with kernel weight.

In most of the cases the genotypic and phenotypic correlation coefficients were of the same magnitude. In the relationship of kernel protein with kernel weight environmental effects were opposite to the genetic effects. Multiple correlation analyses indicated that variation in kernels per panicle had the greatest influence on variation in kernel protein followed by plant yield, panicle number, kernel weight, and plant height. Panicle number was the trait most closely associated with plant yield followed by kernels per panicle and kernel weight. Kernels per panicle was the most correlated trait with kernel weight,

with kernel protein, plant height, and panicle number having minor effects. Simultaneous improvement for yield and protein is possible but there was a negative relationship between these traits. Selection based on kernel weight alone in these populations may not have much effect in improving yield or protein content.

In general, the partitioning method was most effective in separating the superior genotypes using one character at a time followed by two characters together and least effective for three characters together. The efficiency of selection could have been improved in these populations with less selection intensity and/or increased sample size in each population.

Title : *Photosynthesis and growth of rice (Oryza sativa L.) as influenced by potassium nitrate and urea fertilization*

Author : Nilufer Hye Karim

University attended : University of Florida, Gainesville, Florida, USA.

Year of completion : March 1978

SUMMARY

In young rice, *Oryza sativa* L. CV. Nato, seedlings urea enhanced growth and affected carbon/nitrogen metabolism more than nitrate or control (minus N) treatments under both low and high radiation. Efficiency of urea was due to its rapid hydrolysis in shoots and roots, providing reduced nitrogen for amino acid and protein synthesis and additional CO₂ for fixation.

Photosynthesis was highest in 20-day-old seedlings topdressed with nitrogen. With foliar spray chlorophyll, total carbohydrate, fresh and dry weights of 20-day-old shoots were highest when subjected to high radiation (1700-1900/m²/s). Except for chlorophyll, values for other growth parameters increased total nitrogen content by the 20th day compared to foliar spray, but on the 30th day there was a decrease in total nitrogen content. By the 30th day, protein content of roots from topdressed plants had increased, while that of sprayed plants decreased.

Shoots under high radiation showed the highest carbohydrate content in 10-day-old plants when no fertilizer was applied; total nitrogen, protein, and carbohydrate decreased with time in both shoots and roots. Plants subjected to high light and topdressing showed a decrease in photosynthesis, chlorophyll, and protein contents of shoots at 20 and 30 days, with corresponding increases in fresh and dry weights of both shoots and roots. There was an overall decrease in growth from the 20th to the 30th day, probably due to depletion of nitrogen.

A comparison of the two light levels showed that shoots and roots had the highest growth rates under high light with either

topdressing or spray application of nitrogen. Rice plants utilized fertilizer more effectively when topdressed at young stages of growth.

Nitrate reductase activity was highest in shoots subjected to high light and foliar spray. Nitrate-treated shoots always gave higher activities for nitrate reductase. Application of urea also elevated nitrate reductase activity, probably due to an improved nitrogen status in the plant. Nitrate reductase activity was only present in roots of plants under high radiation and was lower in intact tissue of 10-day-old shoots. Low activity in intact tissue assay may reflect, a rate-limiting step in transport of substrate (product) to (from) the site of activity.

Urease activity was highest in shoots and roots of 10-day-old plants, suggesting that the enzyme is important in early development stages. Urea gave a higher response in urease activity than nitrate topdressing giving the highest activity. Urease activity in roots at the 20th day was appreciable, being higher with topdressing. Low light caused no drastic reduction of urease activity in shoots or roots. This was because urease is not light dependent. Urease activity of 10-day-old intact tissues was lower than that of *in vitro* assay. Activity on the enzyme was linear over 20-h and highest in tissues of urea-treated plants. Urease activity was low in roots. At the 30th day, urease activity of both shoots and roots was low, probably due to poor plant growth and depletion of nitrogen.

A definite carbon/nitrogen relationship existed in the rice seedlings. Nitrogen fertilization increased protein and carbohydrate content. Photosynthetic activity also increased with higher leaf nitrogen content. Higher levels of carbohydrate resulted in higher fresh and dry weight of roots and a higher shoot-root ratio. Low light intensity decreased growth by decreasing carbohydrate supply to roots.

These studies suggest that N-serve, a soil nitrogen stabilizer, had no adverse effect on physiological responses of the plant.

Title : *Varietal resistance of rice to green leafhopper, Nephotettix virescens (Distant) : sources, mechanisms, and genetics of resistance*

Author : A N M Rezaul Karim

University attended : University of the Philippines at Los Banos, Philippines

Year of completion : October 1978

SUMMARY

The life history pattern of the green leafhopper, *Nephotettix virescens*, in Bangladesh was similar to that observed in other countries. Nymphs, hatching out from eggs in about a week, passed five instars in about 2 weeks. Average duration of each instar was about 2-3 days except that of the fifth instar which lasted about 4 days. There were not much differences in life stage durations of male and female except in adult longevity. Adult females outlived the males by about 1 week. Average longevity of the female was about 2 weeks. The preoviposition period was about 6 days and females laid eggs in the air cavities of the leaf sheath wings in rows. On the average, about 200 eggs were laid by a female in her life.

A total of 2,361 varieties/lines, including 99 accessions of *Oryza glaberrima*, was screened for resistance to *N. virescens* under greenhouse conditions. Forty-four varieties/lines were selected as resistant or moderately resistant after retesting. All the accessions of *O. glaberrima* were susceptible. The selected resistant varieties were all of indica type having origin in Bangladesh, India, Sri Lanka, Indonesia, China, Laos, and the Philippines.

Tests of differential varieties obtained from IRRI showed that *N. virescens* in Bangladesh is a biotype different from that of the Philippines. Results of inheritance of resistance in Ptb 18 confirmed the finding.

N. virescens is a major vector of rice tungro virus. Results showed that some varieties were resistant to both vector and the virus, while others were highly resistant to the vector but susceptible

to the virus. On the other hand, a variety susceptible to the vector was resistant to the virus. No correlation was obtained between resistance to the vector and the virus ($r = 0.149ns$).

The mechanism of resistance to the green leafhopper, *N. virescens*, was mainly of nonpreference and antibiosis type which however varied among the test varieties according to the degree of their resistance.

Resistant varieties were nonpreferred by both nymphs and adults for food, shelter and oviposition. Nonpreference for food and shelter appeared to be strongly linked with tactile stimuli due to pubescence and partly with olfactory stimuli due to odour of some varieties. Gustatory stimuli, however, may have some influence. Ovipositional nonpreference in the resistant varieties was found to be governed by tactile stimuli due to sheath pubescence and narrowness of air cavities in the sheaths.

The resistant varieties exerted various antibiotic effects on the insect such as high insect mortality, slow nymphal development, under development of ovary and low egg production, long preovipositional period, low egg deposition, and low hatching. Except hatching the above effects were mainly caused due to inadequate food ingestion and low utilization of the food taken from the resistant varieties. The insect made more probing punctures on the resistant varieties but fed and excreted little. The stylet of the insect reached the feeding site in the resistant varieties but much less frequently than it did in the susceptible variety. The inability of the insect to push its stylet in the feeding site was correlated with leaf pubescence. This appeared to be a cause of low feeding on the resistant varieties. However, low food ingestion may also be caused due to the lack of feeding stimulants or presence of antifeedant(s) in the resistant varieties. Low hatching on the resistant varieties, on the other hand, appeared to be created by certain biochemical(s) in the plant system that was harmful for embryonic development and egg eclosion.

The adverse effects of the resistant varieties on the insects seriously curtailed their multiplication capacity. The insects failed or produced a very low population on the resistant varieties as compared to a high buildup on the susceptible variety.

Information on genetics of resistance in the test varieties revealed that resistance to *N. virescens* is under monogenic control.

The resistance in TAPL No. 628, TAPL No. 651, TAPL No. 796, Leu-Wei-Theu, Bir-co-se-mao-17, Gu-win-gu-gi-goo, Sulai, Dikwee, Maddai Karuppan, IR36, and Ptb 18 is governed by a single dominant gene. Kosatawee possesses a single recessive gene which carries resistance to *N. virescens*. The dominant genes for resistance in TAPL No. 796, IR36, and Ptb 18 are allelic, while resistance in Maddai Karuppan is inherited independently of the above genes. The gene for resistance in Sulai is independent of that present in TAPL No. 796; the relationship of the genes in Sulai and Maddai Karuppan is not known. Similarly, the relationships of resistance genes in TAPL No. 796, IR36, Ptb 18, Maddai Karuppan, and Sulai with the genes in TAPL No. 628, TAPL No. 651, Leu-Wei-Theu, Bir-co-se-mao-17, Gu-win-gu-gi-goo, and Dikwee are not known.

Varietal resistance to insects involves biophysical and biochemical factors that affect insect behavior and physiology, and ultimately determine the degree of insect damage to the plants. It is thus a complex phenomenon and requires intricate studies before any tangible results on exact causes of resistance are achieved. In the present study, efforts were mainly directed towards identifying sources of resistance to *N. virescens*, basic insect-plant interactions between *N. virescens* and resistant and susceptible plants, and genetics of resistance to *N. virescens*, in Bangladesh.

Results strongly indicated the possibility that *N. virescens* in Bangladesh is of a biotype different from that of the Philippines. It is, therefore, proposed that *N. virescens* of Bangladesh be called "Bangladesh biotype" (Bb) and that of the Philippines "Philippine biotype" (Pb).

Information available from the studies indicated that both biophysical and biochemical factors for the resistant varieties were responsible for their resistance to *N. virescens*. However, further specific works in this field may yield more valuable information.

The dominant genes for resistance to *N. virescens* in the varieties in this study appeared to be different from those (Glh 1, Glh 2, Glh 3, Glh 5) identified at IRRI. The resistance genes identified in TAPL No. 796 (allelic to the genes in IR36 and Ptb 18) and Maddai Karuppan are designated as Glh 6 and Glh 7 respectively in accordance with the standard procedure for gene nomenclature (IRC, 1959).

Further studies, however, are required to identify the relationship of the recessive resistance gene *glh 4* (in Ptb 8) with the recessive resistance gene found in Kosatawee in the present study.

Title : *Inheritance of two mutant flower characters in Korean lespedeza*

Author : Muhammad Abdul Hamid

University attended ; The University of Arkansas, USA

Year of completion : 1979

SUMMARY

Crosses were made between a Korean lespedeza mutant line producing flowers with short, purple standards in place of normal standards and normal wings and a mutant line with normal standard and accessory keel petals to determine :

● whether the mutant gene *s*, which prevents normal flower standard formation when present in the homozygous condition and *w*, which inhibits flower wing formation and conditions formation of accessory keel petals when in the homozygous condition, were alleles ;

● whether either gene exhibited dominance over the other if they were alleles ; and

● whether genetic linkage or epistasis was involved if the two genes were not alleles.

The F_1 plants resulting from these crosses all produced flowers having normal standards and wing-keel intermediates with a small pigmented sector near the tip of petals occupying the position of normal wings. The ratio of characteristics in the F_2 progeny indicated that the two genes, *s* and *w*, were segregating independently of each other.

The F_3 flower data from each of the six F_2 phenotypic classes were used to verify the accuracy of the genotypes proposed for each of the parental strains, the F_1 progeny, and the six F_2 phenotypes. It was concluded that the genotypic of each of these phenotypes classes were as follows :

● parental line having normal standards and accessory keel petals (SSww) ;

● parental line having small, purple standards and normal wings (ssWW) ;

- ③ F_1 progeny, which had normal standards and wing-keel intermediates (SsWs) ;
- F_2 progeny, which had normal standards and normal wings (SSWW or SsWw) ;
- ⊖ F_2 progeny, which had normal standards and wing-keel intermediates (SSWw or SsWw) ;
- ⊖ F_2 progeny, which had normal standards and accessory keel petals (SSww or Ssww) ;
- ⊕ F_2 progeny, which had small, purple standards and normal wings (ssWW) ;
- ⊖ F_2 progeny, which had small, purple standards and wing-keel intermediates (ssWw) ; and
- ⊖ F_2 progeny, which had small, purple standards and accessory keel petals (ssww).

The genetic data showed that genes *s* and *w* were not alleles and that each was inherited independently of the other.

It also was concluded that gene *w*, when homozygous, inhibits formation of wing petals and allows formation of accessory keel petals in their place. The *w* gene has no epistatic effect on the *s* gene, which conditions the production of small, purple standard formation.

NATURAL CROSSING

A field experiment was conducted to determine the extent of natural crossing in Korean lespedeza using two mutant lines having flowers with fused accessory wings in place of normal flower standards. Gene *a*, when present in the homozygous condition, inhibits flower standard formation and allows the formation of fused accessory wings instead. The variety Summit having the dominant gene *A* that does not inhibit normal flower standard development was used as the pollinator. Two F_1 plants were obtained that had normal flower standards instead of fused accessory wings. The F_2 progeny of these two F_1 plants segregated in the ratio of 3 normal flower standards : 1 accessory wing, indicating that natural crossing had occurred.

It was concluded that cross-pollination took place up to a maximum distance of 2.44 m from the pollinator plant, and that the

extent of natural crossing in one direction was 0.5%. Therefore, the amount of natural crossing in both directions was assumed to be about 1%.

CYTOLOGY

Cytological studies were conducted to detect any visible changes in the chromosomes of a mutant line having small, purple flower standards in place of normal standards produced by irradiation of the Korean lespedeza. The root tip squash technique using the Feulgen method of staining showed a ring in one of the 20 ($2n$) chromosomes of the mutant, but no such rings were present in any of the chromosomes of normal Korean lespedeza. It was concluded that due to irradiation, a chromosomal translocation probably took place in one of the mutant line chromosomes or a lesion formed at the end of the chromosome resulting in the same type of configuration.

Title : *Chemical properties of lipids in developing and mature rice grain*

Author : Mohammad Nurul Hoque Choudhury

University attended : The Graduate School of the University of the Philippines at Los Banos, Laguna, Philippines

Year of completion : March 1979

SUMMARY

Rice lipids occur mainly as storage particles (spherosomes) in bran and embryo and also as membrane components. They also occur in association with starch and protein bodies. They were studied in three rices differing in amylose content. There were two types of lipids present in brown rice :

- extraneous lipids, and
- bound lipids.

Extraneous lipids were mainly composed of 85-87% neutral lipids along with 8-9% phospholipids and 4-6% glycolipids as minor fractions. Triglycerides were the major components (81-83%) of neutral lipids. Glycolipids had 42-46% acyl sterol glycosides, 20-22% sterol glycosides and 14-17% diglycosyl diglycerides as major components. Phospholipids mainly consisted of 44-48% phosphatidyl choline and 38-42% phosphatidyl ethanolamine.

The extraneous lipids were mainly present in bran, germ, polish and subaleurone layer. Inner endosperm did not contribute much to total extraneous lipids in comparison to its mass, and most of the endosperm extraneous lipids occurred in association with protein bodies. Waxy, nonwaxy and nonwaxy high protein rices had similar extraneous lipid content in milling fractions except in inner endosperm. Waxy rice had higher extraneous lipid content than nonwaxy rices.

Extraneous lipids had linoleic acid as major fatty acid followed by oleic and palmitic acids. The fatty acid composition of extraneous lipids were similar in all the milling fractions and in the three rices studied.

In bound lipids, phospholipids (37-54%) were major fractions followed by neutral lipids (28-41%) and glycolipids (18-21%). Lysophosphatidyl choline (41-44%) and lysophosphatidyl ethanolamine (37-40%) were the major components of phospholipids. Neutral lipids were composed mainly of free fatty acids (70-73%). Glycolipids had three major unknown nonlipid fractions (42-45%) together with diglycosyl diglycerides (22-25%).

The bound lipid contents of brown rice and inner endosperm were similar as they originated only from starch. Protein bodies did not contribute any lipids to bound lipids. However, although total lipid contents were similar in brown rice and inner endosperm among rices differing in amylose content, nonwaxy rices had much more bound lipids and less extraneous lipids than waxy rice. Bound lipids seemed to be associated with nonwaxy starch granules.

Palmitic acid was the major fatty acids in bound lipids followed by linoleic acid. Oleic acid content was much less in bound lipids than in extraneous lipid.

Changes occurred in the quantity and composition of lipids in IR42 rice during grain development. The neutral fraction of extraneous lipids increased 11-fold during 3-16 days after flowering (DAF) and remained stationary thereafter. Extraneous glycolipids and phospholipids only doubled in amount during 4-8 DAF, and then became stationary.

At 4DAF, extraneous lipids were very rich in polar lipids (30%), glycolipids and phospholipids. During grain development, the percentage of neutral lipids increased 42-84% of extraneous lipids and those of glycolipids and phospholipid decreased 5-11%, respectively.

The percentage of all fractions of extraneous lipids on the basis of brown rice drymatter decreased during grain development. This decrease was more for glycolipids and phospholipids than for neutral lipids. Triglycerides, the major components of extraneous neutral lipids showed the greatest accumulation during grain development. Phosphatidyl choline and phosphatidyl ethanolamine in phospholipids and acyl sterol glycoside and sterol glycoside in glycolipids also increased per grain. Lysophosphatidyl choline and lysophosphatidyl ethanolamine in phospholipids and diglycosyl diglyceride in glycolipids also increased quantitatively up to 8 DAF, but

decreased afterwards. They probably became progressively associated with starch as the grain developed.

At 4 DAF extraneous lipids were very rich in linolenic acid in all the three fractions of lipids (20% of total fatty acid in neutral lipids and phospholipids and 43% of total fatty acid in glycolipids). During grain development, the percentage of linolenic acid decreased and at maturity total extraneous lipids had only 4% linolenic acid. Linolenic acid is known to be associated with membrane.

The percentage of palmitic and oleic acids increased in all three fractions of extraneous lipids. The increase in palmitic acid percentage occurred between 4 and 12 DAF and that of oleic acid occurred between 16 and 20 DAF. The percentage of linoleic acid remained stationary throughout the grain development.

Fat-by-hydrolysis increased up to 20 DAF and followed starch accumulation. In fat-by-hydrolysis, the percentage of linoleic acid increased and that of linolenic acid decreased up to 12 DAF during grain development, remaining stationary thereafter. Oleic acid percentage slightly decreased 8-12 DAF. The percentage of palmitic acid remained stationary throughout grain development. Fat-by-hydrolysis, which is mainly composed of free fatty acids, probably represents the fatty acid fraction of bound lipids. We found in rice that the content of fat-by hydrolysis could be converted to bound lipid content by multiplying it by a factor 2.1.

The lipase activity of IR42 brown rice increased up to 12 DAF, remained stationary up to 16 DAF, and then decreased up to 20 DAF, remaining stationary thereafter during grain development. The activity of lipoxygenase of brown rice increased up to 16 DAF. In the mature grain, however, activities of both lipase and lipoxygenase were low.

Hull lipids in developing IR42 grain had contrasting behavior to brown rice lipids. The amount and ratio of lipid fractions were constant up to 12 DAF, but the amount of glycolipids and phospholipids decreased progressively up to 20 DAF.

Title : *A study of nitrogen in soil plant system in relation to growth and yield of wetland rice as influenced by N- supply and crop management*

Author : Nurul Islam Bhuiyan

University attended : The Faculty of the Graduate School of Cornell University, USA

Year of completion : August 1980

SUMMARY

Three experiments, two in the greenhouse and one in the field were conducted during December 1978 to January 1980 at the International Rice Research Institute (IRRI), Los Banos, Philippines, to study the behavior of nitrogen in the soil-plant system in relation to growth and yield of wetland rice under different management practices. The Inorganic nitrogen (N_1) levels of the soils, some growth parameters, N-content in and N-uptake by plant tops were measured periodically. Yield components and grain yield were measured at maturity.

In the first greenhouse experiment an increase in tiller number at the maximum tillering stage, i. e. 45 days after transplanting (DT) was associated with an increase in inorganic N in 3 soils, but the tiller number tended toward a plateau at inorganic N levels of 200 ppm. Phosphorus deficiency in a 4th soil and iron toxicity in a 5th soil limited tiller production regardless of inorganic N content.

Dry matter production at the maximum tillering stage (45 DT) followed a pattern similar to tillering in relation to inorganic N in the soil.

Nitrogen content (%) in plant tops at the early growth stage (15 DT) was high and similar irrespective of inorganic N in the soil. Relationship between the tiller number at the maximum tillering stage (45 DT) and percent N at an early growth stage (15 DT) was very poor but the relationship was very strong when correlated with percent N at 45 DT.

A wide range of inorganic N availability in the soil did not produce appreciable differences in tiller number during 15 and 30 DT.

The accumulation of nitrogen by the young plant (0-30 days) was not limited by the amount of N_1 if the N_1 content in the soil exceeded above 40—60 ppm. During the period of rapid growth (30—45 DT), both concentration of N_1 and depletion limited accumulation of N in the plant tops.

An approximation of N losses from and N mineralization of the soils during the period 0-15 and 15-30 DT indicated that losses and mineralization were important and varied among the 5 soils.

During the early period of plant growth (0-15 DT) the rate of mineralization of organic N was much higher than the rate of plant uptake but during the period of rapid vegetative growth (30-45 DT) the rate of plant uptake of inorganic N was much higher than the rate of mineralization of soil organic N.

The rate of mineralization of soil organic nitrogen was much higher in the laboratory incubation test than the greenhouse culture.

The second greenhouse experiment clearly demonstrated that the inorganic nitrogen (N_1) in the soil decreased fairly rapidly and by 45 DT, the inorganic N was uniformly less than 10 ppm regardless of treatment.

During the early period of growth (0-13 DT), there was a rapid decrease in inorganic N when plant uptake was fairly small. This sharp decrease in organic N was considered to be mainly due to the loss of N from the soil-plant system. An estimate of N loss during the period 0-13 DT indicated that about 0.3 of the soil N and 0.44 of basal N was lost. This result suggested that the basally applied N was more susceptible to loss than nitrogen thoroughly mixed throughout the soil volume.

During the period 13-25 DT, mineralization minus plant uptake and loss was greater than zero.

During the period 45-83 DT, the plant tops accumulated an amount of nitrogen equal to 40 mg/tray plus an amount of N equivalent to about 25% of the N in plant tops at 45 DT in those treatments which did not receive fertilizer during this period. The inorganic nitrogen in the soil at 45 DT was low and did not

change after this period; the accumulated nitrogen must have come from a combination of mineralization of organic nitrogen and from the nitrogen in the roots at 45 DT. The observation that the system stored an amount of nitrogen equivalent to about 25% of that in the tops at 45 DT is important, but the mechanism and generality of this observation is unknown.

Some of the treatments received topdressing of nitrogen in the period 45 DT to maturity. In these treatments, an application of 80 mg N tray increased N content of the tops at maturity by 50 mg/tray an amount equivalent to about 60% of the applied N, which is a high efficiency.

Plant density did not influence nitrogen in the plant tops (mg/hill) at 13 DT and so long as the concentration of inorganic nitrogen in the soil was above about 50 ppm (200 mg/tray) at 13 DT, the plants did not respond to more nitrogen.

By 25 DT the combined effect of N loss and plant uptake had largely depleted the N_1 at high plant density, but at low plant density, appreciably more N_1 remained at 25 DT when initial N levels were high.

In general, basal N application increased tillering relative to other treatments early in the cycle. At harvest, a modified split application (N_m -20 kg N/ha at 25 and 32 DT plus 10 kg N/ha at 37-54 DT) was superior to other treatments in LAI, all aspects of yield components and grain yield. Nitrogen recovery rate and the productive efficiency of the applied N fertilizer were surprisingly higher under the modified split (N_m) than under the best split application (N_b -40 kg N/ha basal + 20 kg N/ha at 32 DT).

In general, increasing plant density increased tiller number and panicle number per unit area at harvest, but decreased spikelet number per panicle. Density had a variable effect on % filled grain and LAI. No differential effect on N absorption per unit area was observed with a higher plant density during the reproductive and ripening phases of the crop growth.

Results of the field experiment were strongly affected by extreme variability in fertility within the experimental plots and also by uneven lodging caused by a typhoon.

The inorganic nitrogen (N_1) levels of the soil were found to be strongly associated with location of the experimental plots aside

from N-fertilizer. Application of basal N-fertilizer increased N_1 but the effect was not proportional to the amount added. Estimated value of N_1 at initial stage was then used as an independent variable on which N uptake, N mineralization and yield potential were calculated.

Results indicated that the variety IR36 consumed a considerably higher amount of N_1 from the soil during 28 and 45 DT than the Kaohsiung even though the soil contained the same amount of N_1 .

The amount of nitrogen mineralized during the later growth stages was largely related to the initial N_1 level of the soil. The higher the initial N_1 the higher was the amount of nitrogen mineralized during the reproductive and the ripening phases.

The yield potential (spikelet no./m²) for each variety was calculated by a prediction equation. In general, the higher the level of inorganic nitrogen, the higher was the yield potential. The addition of split N increased the yield potential only at a low level of initial inorganic N and tended to decrease the yield potential at a high initial N level.

Increasing plant density failed to show any appreciable influence on the yield potential.

CONCLUSIONS

1. The nitrogen requirement of the crop during the first 2 weeks after transplanting was very low. Perhaps the time during which this would be true is slightly less under very favourable growth conditions and is longer than this under less favourable growth conditions. In a greenhouse experiment, iron toxicity in one soil and phosphorus deficiency in another soil prolonged the period of time; this statement was true relative to the other 3 soils.
2. Addition of nitrogen did not benefit the plant at the early stage of growth (0-30 DT) if the soil contained about 50-60 ppm inorganic N during that period.
3. Nitrogen percentage in the plant tops at an early growth stage (15 DT) was not a useful tool for predicting tiller number at the maximum tillering stage (45 DT) and N-fertility of the soil. As the age of the crop increased this parameter became a more useful tool.
4. Nitrogen requirement of the crop appears to be high at the

beginning of the maximum tillering stage and any nitrogen present in the root zone at that time will be effectively utilized.

5. Modified split application of N-fertilizer (20 kg N/ha at 25 DT + 20 kg N/ha at 32 DT + 10 kg N/ha at 37 DT + 10 kg N/ha at 54 DT) improved N-fertilizer use efficiency as compared to the presently practised best split application (40 kg N/ha basal + 20 kg N/ha at 32 DT.)

6. Increasing plant density did not increase grain yield. Probably the nitrogen yield/unit area is most related to the grain yield.

7. Varieties differ substantially in their ability to absorb inorganic N from the soil.

8. Addition of N-fertilizer as topdressing at the early reproductive stage will increase yield potential only at a level of initial inorganic N less than about 50 ppm.

Title : *Suppression of white-backed planthopper, Sogatella Furcifera (Horvath), and rice leaf folder, Cnaphalocrocis medinalis (Guenee), populations by natural enemies*

Author : Nazira Quraishi Kamal

University attended : Gregorio Araneta University Foundation Graduate School, Victoneta Park, Metro Manila, Philippines

Year of completion : February 1981

SUMMARY

The major problem of this study was to measure the role of natural enemies on the suppression of white backed planthopper (WBPH) and Rice leaf folder (RLF) populations. A sampling programme for both pests was developed. Pests were sampled biweekly in 14 wetland and 12 dryland rice crops over a period of 15 months. Parasitization of pests in the field was observed. Predation capacity was estimated through greenhouse experiments and measurements of predators densities in the fields.

WHITE-BACKED PLANTHOPPER

WBPH had a clumped hill to hill distribution varying with time and section of the field, and clumping increasing with density. A sample size of 40 hills was adequate for 1/hill or more, but as density fell below this level, conclusions would be less reliable.

Populations in unsprayed fields were generally low throughout the season, whether in dryland or, wetland fields, regardless of the time of the year. There were usually two or three generations per crop period, the second having the highest density which never exceeded 10 nymphs/hill. Macropterous adult density always exceeded brachypterous adult density, by 7-99 times. Within each wet season crop, population density increased quickly until 60-65 days after transplanting, then declined as emerging macropterous

adults probably emigrated to crops at younger, more favourable stages.

The calculation of stage survivorship was somewhat arbitrary because indigenous adult density could not be separated from immigrant adult density. Therefore, the peak density of 5th instar nymphs was used as a cut off ceiling for estimating adult numbers. In wetland fields egg stage survivorship was variable, averaging 52%, nymphal survivorship was less variable, and averaged 23%, thus about 12% of eggs survived to adulthood. These figures are higher than those for brown planthoppers (BPH) in wetlands but the BPH work included fields with much higher initial egg densities (up to 20 times higher). Density-dependent population regulation may have operated more at these higher densities to produce lower average survivorship.

Survival in dryland fields was higher than wetland (22% vs 12%) implying that natural mortality was less severe in dryland. This is reasonable because overall density was lower in dryland, about 55% of peak wetland density, so density dependent mortality should be less pronounced. Neither dryland nor wetland showed differences in mortality as associated with wet or dry seasonality of the Laguna region.

A case study of protected and exposed nymphs showed that exposed nymphs had a significantly lower population after 18 days. On the average, four times as many predators, spiders and ripple bugs, were found in the exposed as in the protected cages, indicating that predation was the most important cause of this difference in pest density.

Egg parasitization fluctuated greatly through stages of crops and among different field environments; the overall average percentages in wetland and dryland were similar, 26% and 19%, respectively.

Although a variety of nymphal/adult parasites was reared including dryinids and Strepsiptera, overall parasitization was below 10% implying that it is a minor mortality factor.

A rabbit antiserum to WBPH with a low titre of 1:210 was prepared, but unfortunately it also gave a positive reaction to brown planthoppers and green leafhoppers. This technique showed that spiders—*Lycosa pseudoannulate* *Oxyopes Javanus*, *Argiope catenulata*, *Tetragnatha japonica* and *Callitrichia formosana*, a coccinellid,

Coccinella arcuata, and *Cyrtorhinus lividipennis* feed on hoppers in the field.

Preliminary laboratory studies on predators collected from the field showed that they feed on WBPH in no-choice system. *C. lividipennis* was an effective egg predator, and damselflies and spiders killed more WBPH nymphs and adults than did *Microvelia atrolineata* which may be more effective against newly emerged nymphs.

RICE LEAFFOLDER

The hill to hill spatial distribution of RLF larvae was aggregated. Forty hills sampled per field gave about 20% precision if larvae were at an overall density of 1/hill.

A single generation of RLF developed during each of five wetland and six dryland crops studied. In some other crops infestations did not develop, although RLF were present throughout the year. Within each crop eggs appeared near the middle of the season, followed by larvae and pupae which always peaked in density just before harvest.

Egg survival appeared to be high, about 75%, but larval survival was quite low at 6%. Overall survival of eggs and larvae was estimated to be 4% in both wetland and dryland crops. When RLF eggs on potted plants were placed in wetland and dryland fields, survival of eggs protected from predators was 95% in 24 h; only 25-30% of eggs exposed to predators survived 24 h. This dramatic reduction suggests that the calculated survivorship of eggs (75%) was overestimated probably because eggs disappeared before they could be counted in the census.

Although similar predation exclusion studies on RLF larvae showed significant increases in survival (from 25 to 67%) with protection from predators for 19 days, the exposed larvae showed lower survival (6%) than did larvae in census samples, possibly due to some degree of protection offered by the cages which were only open at the bottom.

The only egg parasitoid recovered from RLF eggs was *Trichogramma* sp. which attacked about 20% artificially exposed eggs in wetland and dryland. In addition 70% of artificially exposed eggs

disappeared in 24 h in wetland or dryland, probably due to predation, giving a total egg mortality of at least 70%, which parallels the estimate from the cage study and is much higher than census-derived estimates.

Twenty-one parasitoid species and a bacterial pathogen were reared from RLF larvae or pupae. Eight braconids, two ichneumonids, and an encyrtid were the dominant parasitoids in both wetland and dryland fields. Percentage parasitization averaged about 14%, including 7% from braconids. Larval mortality was approximately 94% of which only 14% was due to parasitization; this predation was probably more significant as a source of larval mortality.

Rabbit antiserum prepared with RLF larval antigen contained a higher titre (1 : 360) than WBPH antiserum. Four spider species and two beetles gave positive reactions.

In laboratory no choice conditions, a tetragnathid, a coccinellid, and an ant were shown to be voracious egg predators. The coccinellid also preyed heavily on larvae, while *Lycosa pseudoannulata* preyed on adult RLF. *Lycosa pseudoannulata* preferred RLF adults to WBPH adults in a choice test, but showed no preference for larvae of RLF over nymphs of WBPH.

Apparently abundance depended largely on the stage of the rice crop. The minimal differences in abundance and dynamics observed between wetland and dryland crops suggest that the regional population characteristics of WBPH and RLF overwhelmed micro-environmental differences.

Neither WBPH nor RLF reached high population levels in any of the 14 wetland and 12 dryland crops. These populations must have been kept at a low level by natural biological control. This conclusion is supported by the evidence obtained in this study. The severe pest suppression by natural enemies, especially predators, suggests that these minor pests are unlikely to become major ones. This is a most significant conclusion for application to pest management. Natural enemies must be conserved so that minor pests do not become major ones.

Title : *Microbial biomass and carbon metabolism in soils*

Author : Mustaque Ahmed

University attended : Waite Agricultural Research Institute,
University of Adelaide, Australia

Year of Completion : February 1981

SUMMARY

Studies on the decomposition of organic substances in soil have been reviewed with particular emphasis on organic fractions defined biologically rather than chemically. Methods available for the determination of microbial biomass in soil were also reviewed. The fumigation technique and the determination of ATP appear to be most suitable for estimating microbial biomass, especially in studies concerning the dynamics of organic carbon in soil. However, the application of the above two methods is limited by the conditions which prevail in the field, and during sampling and handling in the laboratory.

Seven soil samples collected fresh from the field were examined after various pretreatments in terms of content of ATP and biomass carbon. The ATP extracted was markedly and rapidly reduced by air-drying. However, a short wetting phase prior to freeze-drying of air-dried soils increased the ATP content significantly. The increase in the content of ATP extracted during wetting of air-dried soils occurred in the presence of dinitrophenol and therefore was not due to synthesis but to other reactions. The net effect of freeze-drying on the extraction of ATP depended on the physiological state of the organisms. However, the nature of the changes associated with freeze-drying of the soils and their influence on the extraction of ATP was not fully understood. Storage of freeze-dried soils at 25° C and 15° C led to substantial losses of ATP.

The effects of various pretreatments on the biomass carbon content of the soils were compared based on the amounts of CO₂ evolved from the fumigated and unfumigated soils during the 0-10 day incubation period. Biomass carbon content of the soils decreased

after air-drying. The concentration of ATP in the biomass of the field moist, air-dried-freeze-dried, and soils incubated with water did not change significantly and were similar to the values reported by Jenkinson and coworkers. The wide biomass C/ATP ratios in the air-dried soils were thought to be due to incomplete extraction of ATP. By contrast the ratios of biomass C/ATP in the biomass of the field moist and the soils incubated with water after freeze-drying were much lower because more ATP was extracted.

Two soils, viz. the Urrbræ fine sandy loam and the Northfield clay were fractionated based on particle size and density after dispersions using a Spex shaker or an ultrasonic probe. The content of organic carbon, nitrogen, ATP and the monosaccharide composition of the soil fractions were determined. The recovery of ATP from the soil fractions obtained after dispersion using the Spex mixer was poor and ATP was evenly distributed amongst the soil fractions. By contrast after ultrasonic dispersion the concentration of ATP was high for fractions of diameter 5-2 μm and $<1 \mu\text{m}$ in the Urrbræ fsl and silt size particles of the Northfield clay. Determination of the ratios of the galactose + mannose/arabinose + xylose indicated relative enrichment of microbial materials but not necessarily the living organisms in these fractions. A fractionation scheme was formulated based on the amounts of ATP and the organic material contained in the soil fractions obtained by physical means only and was used to study the decomposition of ^{14}C glucose in the two soils.

After incubation of ^{14}C -glucose the proportion of ^{14}C present as biomass was much higher in the Northfield clay than the Urrbræ fine sandy loam. A range of biomass C/ATP ratios for the labelled microbial population in the soils incubated with ^{14}C -glucose is reported. Most of the ^{14}C and ATP in the Urrbræ soil was located in the $<0.5 \mu\text{m}$ fraction during early stages of the incubation but subsequently there appeared to be a transfer of ATP and ^{14}C , presumably as microbial biomass, to the 5.0-0.5 μm fraction. The non-biomass- ^{14}C present in the $<0.5 \mu\text{m}$ and the 20-5 μm fraction was largely responsible for the disappearance of ^{14}C from the Urrbræ fsl as compared to the rapid losses of biomass- ^{14}C from the 5.0-0.5 μm and the 20-5 μm fractions of the Northfield clay. Although the retention of ^{14}C in the two soils was similar, considerable differences were observed in the dynamics of biomass and non-biomass materials.