

INVOLVEMENT OF IRRI IN IMPROVEMENT OF RICE PROTEIN QUANTITY AND QUALITY

For the past ten years, the International Rice Research Institute has been concerned with and has been working on the problem of increasing protein quantity and quality in polished rice. This note will provide a brief resume of interests and progress at IRRI.

Shortly after the Institute staff was assembled in 1962, the group began intensive discussion of objectives of the research program. Among the items seriously considered was that of an attempt to increase quantity and quality of protein in polished rice. The subject was controversial at the time: while there was no doubt that improvement of protein quantity and quality would be desirable, there were many other obvious problems - especially high yield - on which progress could clearly be made more quickly.

At that time, yields of tropical rice were extremely low, indigenous varieties were unresponsive to nitrogen fertilizers, and there were a number of bacterial and virus diseases as well as a multitude of insect pests which were taking their tolls. Serious problems of the tropics clearly were present, but causes were unknown. The staff was convinced that it first should try for a quantum jump in yield before imposing the restriction on new varieties that they also be high in protein. Consequently, the staff set out seriously to try to increase productivity of rice for the tropics. But, the question of protein quantity and quality was not ignored.

One of the first international cooperative projects involved the determination of protein levels of commercial samples of rice from countries

throughout Asia. The purpose was to determine the levels of protein in the rice varieties being consumed by the greatest numbers of Asians. Consequently, this initial study involved several score of the leading varieties of Asian countries - those planted over greatest acreages.

Simultaneously, many experiments were conducted to determine the variability in protein quantity and quality associated with cropping season characteristics, level of applied nitrogen fertilizer, maturity of the crop, and other factors. It early became clear that measurement of protein levels in experimental lines is exceedingly difficult because of the great variability associated with environmental factors, and the lack of understanding of the nature of the interactions.

In 1963 the Institute's assistant director visited Dr. Nevin Scrimshaw at the Massachusetts Institute of Technology to discuss the desirability of attempting to increase protein content of Asian rice. The judgement was that adult Asians, because of the relatively high nutritional quality of rice protein, were probably receiving minimum requirements of dietary protein via the daily rice intake. On the other hand, very young children apparently cannot derive minimum daily amounts of protein from rice because their requirements per unit of body weight are higher than for adults; and, they simply cannot ingest enough rice in a 24-hour period to obtain minimum requirements for growth. It was Dr. Scrimshaw's feeling that an increase of 25 percent in the protein level of rice would permit children also to receive minimum requirements for a daily rice ration; this assumes, of course, that in increasing the protein level there would be no loss of quality through changes in levels of important amino acids. Asian rice samples

generally run 6-8 percent protein. IRRI has set as its goal the production of new varieties which have yields at least as high as the high yielding dwarf variety IR-8, which have protein content at least 2 percentage points higher than IR-8, and which have a satisfactory distribution of amino acids (page 10, IRRI 1970 Report, attached). The goal is clearcut and seemingly achievable.

Improvement of rice protein levels and quality in Asia or elsewhere might be expected to be achieved through either of two means (or a combination of them):

1. Development of new varieties which genetically are superior so far as protein content is concerned, and
2. Effects of cultural practices, including increases in applications of nitrogen fertilizers associated with the intensive culture of the new dwarf varieties. It has been hoped that the increase in use of nitrogen fertilizers on the dwarfs could in itself make a major contribution to the nutrition of people who depend primarily on rice for their daily intake of calories. The magnitude of this contribution, if any, is not yet clear.

The question of improving protein content has been complicated, as in the case of other cereals, by the fact that increases in yields normally are accompanied by declines in percent protein. And, increases in protein content often are associated with less advantageous combinations of amino acids. Nevertheless, knowing the complexity of the problem, the International Rice Research Institute staff has embarked on an ambitious program to try to incorporate improved protein content and quality into the high yielding varieties.

Three years ago, the Institute expanded its research on this topic through a contract with the national Institutes of Health, which provided \$48,284 for work of the project in 1970. In addition, the Institute invests a substantial amount of its own funds in the studies.

The 1970 IRRI Annual Report has just been received and attached are several pages from that report which deal with studies now underway. It will be noted that this is an interdisciplinary effort involving chemistry, agronomy, varietal improvement, and statistics.

On pages 9-14, the results from studies by Chemistry of protein content and protein metabolism are given.

The difficulties of pinning down protein levels of experimental materials, or at least the precise determination of them, are revealed by reports from Statistics on pages 69-71.

The agronomists are concerned with varietal differences in protein content as affected by nitrogen level, with cultural practices for high protein rice, and with effects of agricultural chemicals of various types on protein content. Resumes of results are given by Agronomy on pages 131-135.

The statement of objectives of the varietal improvement program is given on page 199 and this is followed by a description of the complex of problems with which the plant breeders are faced. Note that on page 204 there is mention of the work on high yield, high protein varieties.

The Institute has maintained close ties with investigators elsewhere who are concerned with the protein problem. Dr. Bienvenido Juliano, the Institute's competent young bio-chemist, compiled in IRRI's Technical Bulletin Six (August 1966) some 38 pages of data from various sources on

protein solubility fractions of brown rice, milled rice, germ and bran; amino acid composition of brown rice, milled rice, rice bran and rice germ; amino acid composition of rice globulin, albumin, prolamins, and glutelin; biological value of rice proteins; nutritive value of rice proteins (availability of amino acids); changes in the protein fraction during ripening and storage; and the free amino acids of rice.

Considering the complexity of the problem of improving protein in rice, and given the emphasis on high yield and resistance to diseases and insect pests during the first years of the Institute, considerable progress has been made. The Institute has a very clearcut goal of increasing protein content by 2 percentage points while holding the yield level of IR-8. To my knowledge, no other laboratory has committed itself to such a goal. Following its unusually quick resolution of the yield and some of the disease and insect problems, the Institute staff are now devoting, appropriately, more attention to the protein problem. We all hope that they will be successful, and chances are they will.