I was extremely fortunate to have had the opportunity to be a member of the International Rice Research Institute (IRRI) team of scientists assigned to the varietal improvement project that led to the development of IR 8, IR 5 and other rice varieties, the building blocks to increased rice production throughout the World.

Let us review briefly the events that brought about drastic shortages of rice and other food grains beginning in the late 1930's and in some areas even earlier.

During the 80 year period, 1850 to 1930, World population doubled from one billion to 2 billion. This was followed by another doubling of population in only 35 years, (1930 to 1975), to 4 billion people. By the year 2010 World population is projected at about 8 billion. This means that 1975 rice production must be double by 2010.

Agricultural production of our food grains started to intensify as population expanded in the late 1800's meeting the demand for food grains for the expanding population.

When I began my career as a rice breeder in 1931 at the Texas A & M Experiment Station near Beaumont, Texas, there had been little intensified production of rice except in Japan.

By 1945 there were some critical shortages of rice, particularily in tropical Asia. Urban populations were exploding, which intensified rice shortages.

Tropical Asian farmers produced rice for their families and neighbors but not a sufficient amount for the rapidly expanding urban populations.

Due to the extremely critical shortages of rice occurring in South and Southeast Asia some tropical Asian countries were importing large amounts of rice from surplus producing nations. By the mid 1950's it was obvious that something had to be done within the tropical Asian countries to increase domestic rice production.

In 1960 steps were taken by the Ford and Rockefeller Foundations that led to the founding of the International Rice Research Institute in the Philippines in 1962 with the mandate "why are rice yields so low in tropical Asia and what can be done to improve them ? "

High yielding varieties from temperate regions had been brought to tropical Asia but they were unable to withstand the rigors of the adverse tropical environment-floods, drought, weeds, diseases, insects, rats and soil problems.

The tropical indica rice varieties grown throughout tropical Asia could withstand the droughts, floods and the other environmental adversities most of the time but yields were very low with farmers producing little more than immediate area requirements.

Nitrogen fertilizers, so effective in increasing yields in temperate regions, did not increase grain yields of the late maturing, tall, profuse tillering tropical indica varieties because of their excessive plant height. Applied nitrogen fertilizer increased lodging and actually reduced grain yields.

When the simply inherited semi-dwarf genes were found in China and Taiwan, a method of reducing plant height of tropical indica varieties was available to plant breeders. Such genes had been available to sorghum breeders since the late 1920's and to wheat breeders since the 1940's.

IRRI breeders were fortunate in that the eighth cross (Peta/Dee-Geo-Woo-Gen) made at the Institute produced IR 8 which possessed a number of the essential traits that were required in tropical Asia. These traits were :

- Short plant height
- Sturdy stems
- High tillering ability
- Erect leaf habit
- Nitrogen responsiveness (produced very high grain yields when nitrogen fertilizer was applied)

○ High grain yield

Within one year from the time IR 8 was selected in 1964, agronomists were producing yields approaching 12 t/ha. This was at a time when farm yields in tropical Asia were below 2 t/ha in many countries.

The tropical indica parent of IR 8 was Peta from Indonesia. It was tall, high tillering and late maturing but had erect leaves.

Dee-Geo-Woo-Gen the semi dwarf parent from Taiwan possessed early maturity, the simply inherited dwarf gene and sturdy stems.

IR 8 selected from this cross combined all of the desirable traits of both parents.

Seeds of IR 8 were sent to all Asian countries along with suggested farming practices for producing high yields. Overnight there was a wide spread interest in developing similar varieties adapted to each interested country which included most Asian rice growing countries as well as other World countries.

In some countries, varieties slightly taller than IR 8 were better adapted. This gap was filled by IR 5 selected from a cross between the Peta variety and a moderately tall variety, Tankai Rotan from Malaysia. IR 8 and IR 5 and the breeding methods used at IRRI revolutionized rice breeding programs throughout Asia.

IR 8 and IR 5 varieties proved that it was possible to produce high grain yields in tropical Asian rice fields. The characteristics previously described made it possible to utilize the vigorous growing tropical indica varieties which could withstand the adverse environment of tropical Asia.

The food crops needs of the World can be met through the 20 th Century, but it will require close cooperation and interaction between scientists from many disciplines as well as strong government support.

Rice was first domesticated in southern China and northeastern India——probably independently——about 8,000 years ago. Constant human selection for improved traits has modified domesticated rice varieties from their wild progenitors so much that domesticated rices can no longer survive in the wild state. The simple acts of reaping and sowing for example are selective. Primitive humans may not have known it, but they started the first rice breeding programs when they began to grow rice plants for their own use. Most primitive farmers have a keen eye and a sensitive feeling for plants. Millions of rice farmers have applied this keen insight and sensitivity for thousands of years to select better varieties.

Selection was first practiced on the variable and heterogeneous wild and semi-wild populations, which must have narrowed genetic variability. However, several mechanisms in primitive agriculture, such as the introduction of varieties from one region to another and occasional natural crosses enhanced variability for further selection. Natural crosses between the domesticated crop and the weed complexes were another source of variability. The third source of variability were the varietal mixtures that primitive agriculturists grew as a protection against disease epidemics. Occasional intercrosses between component varieties gave still more variability. This conscious and unconscious selection by humans led to the development of over 150,000 varieties grown around the world.

The foundations of modern plant breeding were laid between 1700 and 1900. The 1694 discovery of sex in plants and hybridization beginning in 1719 paved the way for the artificial creation of variability. During this period, scientists proposed the "cell theory" and discovered the existence of nucleus, chromosomes and reduction division to produce gametes and fertilization . The phenomenon of sterility was noted in interspecific crosses and the inheritance of characters was studied. Dawin's books on *The Origin of Species* by means of natural selection and the effects of cross and self fertilization in the vegetable kingdom enhanced interest in plant breeding.

The scientific basis of plant breeding has been enhanced tremendously during the 20th century. New breakthroughs have resulted in the refinements of two phases of plant breeding: The evolutionary phase (creation of variability) and the evaluationary phase (selection of superior combinations).

The International Rice Research Institute (IRRI) was established in 1960 to apply science to agriculture to increase the production of rice, which provides more than half of the total food of one of three persons on earth. In 1962, IRRI scientists crossed Dee-Geo-Woo-Gen, the same chinese variety that had given TN1 its semidwarf plant stature, with Peta, a vigorous variety from Indonesia. In late 1966, IRRI released the variety IR8 from that cross. Because of its lodging resistance and response to nitrogen, IR8 could yield to two three times more than traditional varieties. IR8 matured in 135 days vs. 160 70 180 days for traditional varieties.

By the late 1960s, IR8 was planted widely in several countries of Asia. But IR8 had several faults. It was susceptible to diseases and insects, and its grain quality was generally considered poor. It was attacked by Tungro virus and bacterial blight diseases, and by the brown planthopper. Fortunately, IRRI launched efforts immediately after the release of IR8 to incorporate disease and insect resistance, good grain quality, shorter growth duration and tolerance to poor soils into a series of high yielding varieties. The first inprovements on IR8 were IR20 released in 1969 and IR26 in 1973. Twenty two others were doveloped in succession. These varieties are widely grown in tropical and subtropical countries of Asia, Africa and Latin America.

IR36 became the most widely planted variety of any food crop in the world by 1982, when it was planted on more than 10 million hectares of rice land. The widescale popularity of IR36 is due to its genetic resistance to a dozen diseases and insects, in addition to its high yield potential and grain quality. IR36 also performs well under adverse condition such as drought and poor soils. It matures in only 110 days. Farmers who plant IR36 can grow another crop of rice or an upland crop either before or after rice.

Today, Thousand of breeding lines developed at IRRI are shared with national rice improvement programs in other countries. Improved varieties developed by IRRI and cooperating countries are now planted on 55 percent of the third world's rice land, and their increased production feeds two-thirds of a billion people. World rice production increased from 257 million tons in 1965 to 468 million tons in 1985 ——92 percent in 20 years. Most rice-producing countries have become self sufficient, some are diverting rice lands to other crops because of over-production.

However, we cannot afford to be complacent. Today's world population of 5 billion will reach 6 billion by the year 2000 and 8 billion by 2020. Most of this increase will occur in Asia, where more than 90 percent of the world's rice is grown and consumed. Therefore the major challenge rice breeders now face is to breed varieties that yield higher, with greater yield stability.

Innovative breeding methods and emerging techniques of biotechnology are being used to achieve these objectives. Hybrid rice with 15-20 percent yield advantage over the current range of improved varieties has become a reality in China. Genes from wild species are being moved with greater ease than before. Tissue culure expedites the breeding cycle. Recombinant DNA technique will soon be available that will permit movement of useful genes from any living organism to rice. The conventional breeding methods when supplemented with the emerging techniques will help achieve the rice improvement goals.

Rice breeding today is an international effort, involving scientists worldwide. IRRI is supported by an informal organization of 34 donor agencies called the Consultative Group on International Agricultural Research (CGIAR). The government of Japan is third largest donor to the CGIAR. Numerous Japanese scientists have made notable contributions to rice science and improvement. Half of the world's yearly scientific literature on rice science is published in Japan.

The recognition of IRRI's work by the awarding of the 1987 Japan Prize will vastly help generate additional support for rice improvement in the developing nations. This will help achieve the noble goals of "peace and prosperity for all", set by the Japan Science and Technology Foundation.