

DEPUTATION REPORT OF DR. M.S. SWAMINATHAN, DIRECTOR,
I.A.R.I., NEW DELHI ON HIS PARTICIPATION IN THE WORLD FOOD
CONGRESS

I arrived at Hague on the 15th June, 1970 after attending the FAO/IAEA Symposium on Plant Protein Resources held at Vienna. From the 16th to the 23rd June I participated along with the other members of the Indian Delegation in the deliberations of the World Food Congress. I confined my regular attendance to the sessions of Commission I which dealt with problems connected with ensuring basic food supplies. In this Commission, two discussion groups were constituted to undertake an analysis in depth of the problems arising from the introduction of High Yielding Varieties. I was chosen as the Chairman of the discussion group relating to the strategy of increasing production through high yielding varieties and a report prepared by me summarising the conclusions of this discussion group (Appendix I) formed the basis of the recommendations of Commission I on "Technological possibilities for increasing basic food supplies" presented to the plenary session of the Congress. The other discussion group related to the dangers and social implications of the Green Revolution.

The basic issue posed for discussion in Commission I was stated as follows in the FAO document relating to this Commission:

"The progress that has already been achieved and is promised for the future by the new movement in plant breeding for the developing regions still rests on very fragile foundations."

Most of the participants agreed that what has happened during the 1960's is only a technological breakthrough and that the major task during the 1970's will be conversion of this scientific success into an agricultural revolution.

Many speakers in Commission I drew examples from experiences in India both with regard to successes and failures. The following aspects were repeatedly emphasised:

- a) Along with figures on gross national food production, figures relating to gross national waste of food should be given.
- b) India has paid very little attention to the harvest, drying, processing, storage and marketing of grains in a scientific manner. For example, Mr. A.R. Tainsh of U.K. remarked that "what is being sold in India as grain is mainly water" (this alludes to the high moisture content in grains). A newspaper report from India that nearly four hundred thousand tonnes of wheat grains might have been damaged by rain in Punjab and Haryana during May-June was cited in support of the urgency of action in the field of post-harvest technology.

- c) Detailed regional planning of agricultural production in a manner which would help to maintain remunerative prices and thereby sustained farmer-interest is yet to be done. What, for example, would be the consequences of a rice revolution in terms of storage, pricing and alternative land-use?
- d) Pricing policy is largely based upon irrational criteria such as colour and lustre of grains. It would be important to introduce scientific principles in pricing policy such as the payment of premium for protein content.
- e) Agricultural production plans must be based upon a synthesis of ecological and economic criteria. This is essential to avoid some of the dangers to which the agriculture of developed nations is exposed as a result of indiscriminate use of pesticides and fertilizers.
- f) The benefits of the green revolution are presently accruing primarily to rich farmers. Steps should be taken to introduce land reforms, land consolidation and other steps which will help the small farmer to take an interest in scientific agriculture and partake in its economic benefits.
- g) The involvement of youth in development programmes is exceedingly important. Steps should be taken to build into each major developmental project opportunities for the participation of youth in that programme.
- h) Agricultural development should not be regarded merely as an instrument of balancing food supply and population growth. It should be fashioned and deployed as an effective instrument of banishing agrarian poverty and unemployment. For this, the human aspects of development should receive the greatest attention.

Organisation of Research: The FAO document posed the following question with regard to the organisation of research:

"Should an institute concentrate on a single crop, as at the International Rice Research Institute, in the Philippines, or work on a number of crops, as at the Indian Agricultural Research Institute?"

The general view was that institutes like the I.A.R.I. which deal with a wide array of crops in an integrated manner would be more relevant to the needs of developing nations.

I made brief visits to the Agricultural University at Wageningen and to a few breeding stations and delivered two lectures. I also addressed the members of the Youth Village on "The ecological and Scientific Aspects of the Green Revolution".

(M.S. Swaminathan)

WORLD FOOD CONGRESS

Commission I

Report of Sub-Committee on

"The Strategy of High-yielding Varieties"

Chairman: Dr. M.S. Swaminathan,
Director,
Indian Agricultural Research Institute,
New Delhi 12, India.

1. Introduction:

The Sub-committee endorses the following view expressed by FAO in document WFC 2 : Com.I

"The progress that has already been achieved and is promised for the future by the new movement in plant breeding for the developing regions still rests on very fragile foundations. Much remains to be done to consolidate the small successes achieved in the past few years."

The Sub-Committee offers the following recommendations for achieving this consolidation. While doing so, it wishes to emphasise that high-yielding varieties offer the major hope for improving productivity substantially and for ending the divorce between labour and intellect which is the bane of agriculture in many regions. The limited successes already achieved have created a climate of confidence in the world's agricultural capabilities but they also make it clear that the so-called "green revolution" has not reached a stage when it can move on its own momentum. What has really been accomplished is a technical break-through in the yield potential of some cereals and millets and it is the duty of FAO and national governments to convert this breakthrough into a green revolution.

2. Pivotal role of research: The main aim of agricultural research is the achievement of a continuous rise in the economic yield per unit area per unit time, without detriment to the long-term productivity of the soil. This implies a dynamic process of evolution in all disciplines basic to crop production. In plant breeding, for example, the term "high-yielding variety" is obviously one related to a pre-existing variety. In general, the approach towards the development of high-yielding varieties involves the breeding of strains which are capable of giving an economic response to better management practices such as the controlled use of water and application of fertilizers.

This would imply a very close interaction between the various components of management practices and the breeding and selection of varieties. The conditions of management which are optimal to a crop variety will vary with regions and seasons. In addition to increasing the yield potential of crops, research should also aim at the identification and scientific destruction of the factors responsible for causing instability in production. With the tremendous increase in population now taking place, widespread instability in production could lead to great suffering and famines of disastrous dimensions.

3. Plant Breeding policies: An ideal variety is a theoretical concept. While working towards it, the varieties which are superior to those under cultivation by the farmers at a given point of time, should be properly tested and released. The testing of varieties should be done in such a manner as to lead to the identification of those which are capable of maximising the benefits of a given ecological milieu and minimizing the ecological hazards. The present tendency of spreading a few varieties over large areas in the developing nations is pregnant with great dangers from the view point of outbreak of disease and pest epidemics. For example, virus diseases are spreading in rice in South-east Asia, as a result of the widespread distribution of one or two strains. Similarly, Septoria diseases are becoming important in wheat in areas where they were not of much consequence until the introduction of new varieties. Varietal diversity and a more rapid replacement of varieties will therefore be essential for sustaining a dynamic production programme. For each area, varieties with diverse genes and mechanisms for resistance should be developed. This is particularly of immediate importance in such of the developing countries where the population pressure is great and great fluctuations in food production ought to be avoided.

In addition to breeding for higher yields in irrigated areas, plant breeding efforts relating to the development of drought-avoiding varieties should be intensified. Since hybrid vigour appears to confer some plasticity to environmental rigour and fluctuation, the development of suitable hybrids for dry-land farming should receive urgent emphasis.

4. Agronomic research: For each variety, the growing conditions and package of practices should be clearly specified after conducting tests both in experiment stations and farmers' fields. The improvement of soil fertility and proper water management need particular attention in monsoon Asia. Land utilization maps should be prepared on the basis of soil surveys in all developing countries. Special moisture conservation and nutrient supply techniques will have to be developed and used in dry-land farming regions.

5. Integrated pest and disease control: The strategy for the control of pests and diseases should involve an appropriate admixture of genetic, agronomic and chemical methods of control. Seed-borne diseases should be avoided by crop and seed sanitation. The use of chemical methods of control cannot be avoided in several cases but their use should be dovetailed to considerations of residues in the edible parts, and environmental pollution. It would be wise for the developing countries to build up a pest and disease survey and surveillance programme and in the case of diseases like the rusts of wheat,

international collaboration, as already developed in the control of locusts, will be very profitable. FAO could help in the organisation of such national and international programmes.

6. Breeding for quality:

(a) Nutritive quality: Plant Breeding can help to upgrade the nutritive quality of the staples by improving the content of protein, increasing the content of essential amino acids and enhancing digestibility and thereby protein utilization.

A major dent on the protein malnutrition problem can be made in the near future only if the basic food grains can be upgraded in nutritive quality, so that the nutrition of the economically handicapped sections of the population can be improved without any special educational effort or added expense. The major plant breeding objectives in this field would be:

- i) Development of high quality strains of cereals, millets, tuber crops etc., without reducing their yield potential.
- ii) Improving the yield potential of grain legumes and increasing the content of methionine in them.
- iii) Development of better quality vegetables and fruits.
- iv) Development of high yielding-cum-high quality fodder crops so as to make up for shortages in concentrates and thereby promote animal productivity.
- v) Development of new protein rich crops like Triticale, Gossypol-free cotton, toxin-free grain legumes etc. There is scope for bringing new plants, under domestication particularly in legumes, after eliminating their defects.
- vi) There is also immediate opportunity for increasing protein content in grains through fertilization. For popularising such methods the introduction of a premium for protein content in pricing policy would be valuable. Such a premium will also have a great educational value.

(b) Consumer Quality: The subjective and objective elements of cooking quality will have to receive attention in breeding programmes. Consumer tests should be performed before a variety is finally released.

(c) Processing quality: In this field, the breeder and the industry will have to work together, each making the type of adjustment which is feasible. The food and processing industries in the developing nations should become variety and quality conscious, if export markets are to be developed.

(d) Storage quality: This aspect should also receive attention jointly by breeders and technologists wherever there are serious storage problems. In general, the variety should be adapted to the seasonal conditions, so that dehydration and proper storage do not present serious technological problems.

8. Development of Scientific multiple cropping systems: The tropics and sub-tropics offer unique opportunities for multiple cropping, which if properly exploited, could increase greatly the income and employment potential of small holdings, minimise underemployment and help to diminish pest and disease problems. It can also help to break undesirable linkages such as that between paddy and poverty. Having green plants throughout the year wherever possible will not only help to tap sunlight to the maximum but would also help in fighting erosion and the upward movement of salts in soils. In the development of multiple cropping systems, close collaboration among breeders, physiologists, agronomists, pathologists and agricultural engineers will be important. For each area, a series of alternative rotations should be developed so that farmers can choose from them according to seasonal conditions, their input-mobilizing capacity and the marketability of the produce. Such "multiple cropping Cafeterias" can help to uplift rapidly the economic position of small farmers. It would be important to develop farm implements suited to the needs of farmers with small holdings. The multiple cropping programmes should be designed primarily to help the poor farmers and to increase employment.

In order not to cause harm to soil fertility and increase pests and diseases the following ground rules should be observed in multiple cropping:

- (a) Crops grown in succession should not share the same pests and diseases.
- (b) Legumes should find a place in the rotation.
- (c) Deep-rooted and shallow-rooted crops should follow in succession, so that different layers of the soil are tapped for nutrients.
- (d) The cropping pattern should be fixed after assuring a market for the produce.

9. Organisation of Research:

(a) Support: The allocation for agricultural research is only about 10% of the total science budget in many developing nations. Appropriate inter-se priorities will have to be evolved in countries where agriculture has a dominant role in the national economy.

(b) Organisation: There is no substitute for local research effort and capabilities. Agricultural problems and conditions are very diverse and solutions will have to be found in the area concerned. International institutes should hence supplement rather than substitute the efforts of national research centres. UNDP (Special Fund) support should be used to strengthen national rather than international research institutes. Global

research programmes which include national projects should also receive support.

In the immediate future, there is scope and need for a few international research institutes, on whose Boards of Management FAO should have representation. The scope of these research institutes should be restricted to the following:

- i) carrying out basic research and developing breeding material for distribution to cooperating countries;
- ii) collection, assessment, maintenance and distribution of gene pools;
- iii) providing high-level training and helping to "breed plant breeders";
- iv) collation of bibliography and dissemination of information.

As regards the question whether research institutes working on single or several crops are to be preferred, institutes working on several crops would be preferable in the developing nations both by virtue of possibilities for multiple cropping and the need for making the best use of the available technical and financial resources. Research at the national level should lay stress both on agro-climatic areas and on crops.

10. Conservation of gene pools: The rapid spread of a few high-yielding varieties has aggravated the problem of rapid erosion of germ plasm material. The fruits of thousands of years of natural and human selection would be lost in this way. This problem has received recognition but little financial support. FAO should prepare a Project for the collection, preservation and distribution of gene pools for UNDP (SF) support and get it submitted through appropriate national governments.

11. Seed Production: Since seed is a vital input, greater attention should be paid to research and training in seed technology. Plant breeding without a sound seed industry will be waste of effort. FAO should start a World Seed Programme on the analogy of the fertilizer programme, harnessing the financial help and technical expertise of private seed industry, in addition to Government organizations. FAO can also help national governments in preparing, where necessary, appropriate legislation for ensuring the growth of a healthy seed industry.

12. Post-harvest technology: Research and development in the entire field of post-harvest technology including harvesting, processing, storage, marketing and pricing will be essential for ensuring the success of the high-yielding varieties programme.

13. Extension: Proper arrangements will have to be made for the supply of both inputs and knowledge. Research workers and extension agents should have a proper organizational link-up, so that they work in complete harmony. It would be also desirable to entrust the task of organising the first-line demonstrations to scientists. This will

provide an opportunity for scientists to demonstrate their findings in farmers' fields and to identify the problems limiting production under field conditions. Such first-line demonstrations could be used in farmers' training programmes and should invariably be organised in the fields of the poorest farmer in an area, so that the success of the programme will have a right educational and psychological impact.

14. A running chronicle of experiences with high-yielding varieties:

FAO should compile national reports on the progress in the implementation of the high-yielding varieties programme as well as the other four major areas of development proposed by it. Such reports, compiled once a year, should give a critical appraisal of experiences, indicating the factors responsible both for successes and failures.

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WORLD FOOD CONGRESS

Commission I

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Deputation Report of Dr. M.S. Swaminathan, Director,
I.A.R.I., New Delhi to Vienna

FAO/IAEA Symposium - Plant Protein Resources: Their
Improvement through the Application of Nuclear Techniques

I attended the Symposium from June 9th to 12th, 1970. On the afternoon of 12th June and on the 13th June, I attended the Research Coordination meeting convened by the Joint Division of FAO and IAEA to draw up the future lines of work in this field. I was asked to be the Chairman of the Session on "Determining nutritional value of plant protein" and I was also the Chairman of the Drafting Committee set up for drawing up the recommendations of the coordination group. I presented a paper on "The Choice of Strategy for the Genetic Upgrading of Protein Properties in Cereals, Millets and Pulses" (copy enclosed). Dr. A.K. Kaul from the I.A.R.I. presented a paper on "Microscopic and Other Dye Binding Techniques of Screening for Proteins in Cereals" (copy enclosed). Some of the main points made at the Symposium are as follows:

1. New high protein and high lysine varieties: Dr. A. Hagberg from Svalof, Sweden, reported that a barley strain (CI 3947) named "Hiproly" has proved to be very useful in breeding barley varieties with high protein and high lysine because of the fact that the shrunken nature of the seed in Hiproly is not linked with the gene for high lysine. Hiproly was identified in a collection of barley from Ethiopia. From the same collection, another line (CI 4362) has been found containing high protein, but normal amount of lysine. Dr. H. Gaul of Germany reported that auto-tetraploid barley has a protein content of about 18% in contrast to about 14% in the diploid. Dr. V.A. Johnson from the United States announced that a variety of wheat obtained from India (probably from Nepal-PI 176217) is rich in both protein and lysine. Dr. Dumonovic from Yugoslavia found a negative correlation between the weight of grains and yield. In barley also, a negative correlation tended to occur between protein content and yield. However, several workers reported that by appropriate fertilizer application a satisfactory balance between yield and protein content can be achieved.

2. High protein and high lysine crop species: There was considerable interest in the paper from the I.A.R.I. which I had presented in which we had shown that some minor millets like Panicum miliaceum have both high protein and lysine. It was felt that the I.A.R.I. work on producing high yielding varieties of such millets would make a very important contribution to enriching protein resources. Papers were presented about the improvement of the protein properties and yield of soybean and sunflower. Dr. Smutkupt of Thailand reported that the soybean varieties SJ-1, SJ-2 and SJ-3 are early as well as rich in protein. The protein of sunflower would gain in value, if chlorogenic acid can be eliminated.

3. Availability of lysine: Although several crop species and varieties may have satisfactory content of lysine, its availability is poor due to many reasons such as the presence of fibre in the seed. Generally

only 75% of the lysine present in cereals is available. It was, therefore, felt that increasing the availability of protein and improving digestibility should be given adequate attention.

4. Techniques: Among the various techniques available now, the dye binding capacity method and the microscopic section scoring procedure reported by Drs. Kaul and Munck were considered to be the most useful ones at present for rapid screening of material. Other techniques such as micro-biological methods, neutron activation, double isotopic labelling and X-ray spectrometry were also discussed.

5. Biological value and Net Protein Utilization: Considerable stress was laid on the assessment of these properties since mere data concerning protein and lysine content would otherwise be misleading. True digestibility is influenced by several characters like the morphology and anatomy of seeds, the nature of carbohydrates, fibre content etc. Blood urea content could be used in animals to assess protein quality provided this is done carefully. In vitro enzymic procedures can also be used for assessing the biological value of proteins. The enzymes that are useful for this purpose are: Pepsin, Pancreatin, Trypsin, Erepsin, Pronase and Papain.

Prof. E.O. Eggum of Denmark summarised the current methods of evaluating the nutritive value of protein in grains. He presented data which showed that the wheat variety Sharbati Sonora developed in India has the highest biological value and net protein utilization among all the wheat varieties studied by him in Denmark, as per his data given below:

	Sonora-64 (Mexican)	Super-X (Mexican)	Inia (Mexican)	Average Danish Wheat	Sharbati Sonora (Indian)
Biological value:	52.0	49.0	49.4	59.0	60.5
Net Protein Utilization:	48.4	49.1	44.3	52.9	53.9

6. Production control and Agronomic Enrichment of Quality: The importance of studying protein properties at all stages from the time the crop is harvested to the time it is consumed was stressed. In several countries there is a considerable deterioration in quality during storage. The application of nitrogen during grain development increases protein content but it would be worthwhile for the farmer to adopt such a practice only if there is a premium for protein content in pricing policy. The application of some herbicides like Simazine increases accumulation of nitrate reductase in barley and thereby promotes the accumulation of protein.

7. Importance of protein improvement in developing countries: Since it is now reasonably well established that protein malnutrition in the first few years of a child's life leads to a fewer number of cells in the brain, the urgent necessity for the genetic upgrading of protein quantity and quality in food grains is obvious. UNDP (Special Fund) has given over 1.5 million dollars to the International Maize &

Wheat Improvement Centre in Mexico for intensifying this work. The Government of the Federal Republic of Germany has offered nearly 2 million dollars to the Joint FAO/IAEA Division on the application of atomic energy in agriculture for promoting research in this field during the next five years.

8. General Conclusions:

The general conclusions arrived at the coordination meeting are as follows:

a) The dimensions of the world protein gap are both quantitative and qualitative in character. In many developing countries, the primary nutrition problem relates to inadequate calorie intake, either due to low agricultural productivity or low purchasing power or both. Particularly in such areas, sections of the community such as young children and pregnant mothers may suffer from protein malnutrition. While technological approaches such as lysine fortification, production of protein from petroleum and single cells and manufacture of fish protein concentrates have all some merits, a major dent on the protein malnutrition problem can be made in the near future only if the basic foodgrains can be upgraded in nutritive quality, so that the nutrition of the economically handicapped sections of the population can be improved without any special educational effort or added expense. It is in this context that the genetic improvement of the quantity and quality of protein in the major food crops of the world assumes great significance.

b) The specific approach towards protein improvement will vary from crop to crop and region to region. Therefore, for each crop and situation, the precise problem will have to be identified and the scientific approach towards finding a solution developed. In many cereals and pulses, elevating the content of the limiting amino acid rather than increasing protein content per se has to be the primary aim. In several millets and cereals, enhancement of the net protein utilization is unsatisfactory not only due to the poor amino acid balance but also due to low digestibility. There are several grain legumes like soybean, chick pea, etc. which have a high protein content but whose productivity can be improved by developing better plant types. Improving photosynthetic ability, lodging-resistance and disease resistance all need attention in such crops. The removal of toxic principles can render several legumes which are highly resistant to drought such as Lathyrus sativus, excellent food material.

c) The contribution of plant breeding towards improving protein supply could be broadly grouped into the following major approaches:

- i) Development of high yielding-cum-high quality strains of cereals, millets and tuber crops.
- ii) Improving the yield potential of grain legumes and increasing the content of Methionine in them.
- iii) Development of better quality vegetables and fruits.

iv) Development of high yielding-cum-high quality fodder and feed crops which would be substitutes for concentrates so as to improve animal productivity.

v) Development of new protein-rich crops like Triticale, Gossypol-free cotton etc.

d) In research relating to the improvement of protein properties, there is need for an understanding of the basic biochemical processes concerning storage protein synthesis so that human needs can be harmonised with the physiological needs of the growing embryo for which proteins are synthesised in the seed. Also, the problems have to be looked at in their totality, starting with the innate characteristics of the seed upto its consumption.

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