

INCREASING THE SUPPLY OF NUTRITIOUS FOODS

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"It's a very odd thing, as odd as can be

That whatever Miss Lee eats turns into Miss Lee"

The substance of this nursery jingle is more eloquently expressed in the Taittiriya Unpanishad:

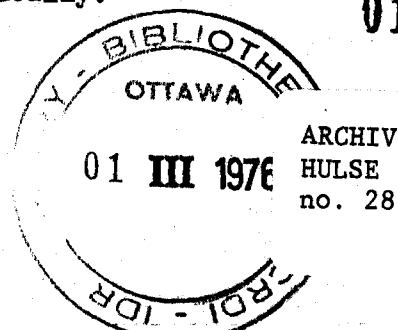
"Life verily is food . . . .

"From food are produced whatsoever creatures dwell on the earth. Moreover by food alone they live. And then also into food they pass at the end".

It is a popular intellectual exercise to speculate if there will be enough food to keep alive all the people on earth in 2000 A.D. Unquestionably there will be. Those who do not have enough food just won't stay alive. Malthus' first hypothesis is valid: Population is limited by the means of subsistence.

It is the second Malthusian convention to which modern technology gives the lie: namely that population increases in geometric progression while food production expands arithmetically. In certain special instances, food production might in future increase logarithmically.

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I propose to give some emphasis to agricultural production since I believe it to be unduly neglected by both food technologists and nutritionists. The food technologist does not exist to elaborate processes and outlets for what the farmer can't dispose of by other profitable means. The food technologist should be an intimate partner of the agricultural technologist and economist in planning what crops and livestock should be harvested and how they can be utilized for the greatest good of all concerned.

In "back to Methuselah" Shaw writes:

"Man need not always live by bread alone. There is something else. We do not yet know what it is: but some day we shall find out, and then we shall live on that alone and there will be no more digging nor fighting nor killing".

According to a scientist in one of the Space Research agencies, future man might be equipped with a digestive system which can utilize hydrocarbons and other high energy fuels.

Nasa research workers are presently studying high energy diets containing 1.3 Butane Diol, 2.4 Dimethyl Heptanoic Acid and Propylene Glycol.

Though future generations may subsist upon these and other unconventional foods, for the most part within our lifetime mankind will probably depend largely upon traditional food sources, the most important of which unquestionably are the cereal food grains.

Cereal food grains provide more than half of the world's total calories and protein. Roughly two-thirds of the cultivated land of Asia is under cereal crops and in the Near East cereals provide more than 80% of the calories and 70% of the protein ingested.

Before the Second World War, the low income countries of the world were self-sufficient in and net exporters of cereals to the extent of 14 million tons per annum.

Unfortunately, by the mid 1960's per capita production had declined to the point at which the same countries now import more than 12 million tons annually. Of the low income regions, only Latin America is a net exporter of 5 million tons, 95% of which originates in two countries: Mexico and Argentina.

The per capita demand for cereals, particularly wheat, in India, the Near East and several African and Latin American countries is continually growing. For example in the Sudan where population is increasing by 2.8% per year, the demand for bread is rising by 8.0% per year. Imports of cereal grains represent more than 45% of the total food imported into Africa.

Until recently, it seemed most improbable that food production in Asia could possibly keep pace with human fecundity. Between 1960 and 1966, the average annual growth rates in food production in India, Burma, Pakistan were 0.1, 0.3 and 1.5 per cent respectively. Between 1966 and 1968 these averages rose dramatically to 7.2, 9.2 and 7.1 per cent per year, largely as a result of the introduction of new high yielding varieties of wheat, rice and maize.

Until 20 years ago, cereal production was generally increased by extending the acreage under cultivation. In recent years, 70% of the increases have resulted from improved yields.

The high yielding variety story began in Mexico in the mid 1940's when the Rockefeller Foundation sent a team "to improve agricultural materials and methods and to disseminate the benefits as quickly and as widely as possible".

During the 25 years since the program began, the Mexican population has grown by 70%; production of the three staple crops maize, wheat and beans has increased more than threefold. In addition, new crops such as soyabeans and sorghum have been introduced and, very recently, success in the production of high lysine maize and high lysine triticultura has been reported.

The Rockefeller study began with a systematic collection of maize, wheat and bean samples from all parts of Mexico to provide a comprehensive inventory of the genetic material available.

The varieties were compared under controlled conditions for yield and disease resistance and appropriate crosses were made among the indigenous varieties and with proven imported seeds. The outcome of the Rockefeller program has been an increase in total production of maize from 2 million to 6 million tons per annum, yields having risen from 8 to 14 bushels to the acre. Wheat production has risen from 15 to 60 million bushels, yields having increased from 11 to 30 bushels per acre. The new wheat varieties display markedly increased disease resistance and response to fertilizer and irrigation.

The improved soil fertility gave rise to wheat with longer stems and heavier heads and consequently lodging seriously hindered mechanical harvesting. The best of the improved Mexican varieties were therefore crossed with Japanese dwarf wheats, the results being wheat with longer heads, more kernels per head and short stiff straw. Yields of 8<sup>3</sup> bushels per acre have been reported from Santo Domingo and Baja - California.

At the same time, with funds provided by the Rockefeller and Ford Foundations, the International Rice Research Institute in Los Banos has steadily improved the production of tropical and sub-tropical varieties of rice. The new rice varieties, in addition to giving substantially higher yields, mature in less than 125 days - - - the conventional varieties requiring up to 180 days. Consequently, with controlled irrigation, Filipino farmers are growing three crops with a total yield of 8 tons paddy per acre per year. Previously, the best annual yields in Japan were rarely greater than 2 tons per acre.

In 1966, India imported sufficient short straw wheat seed from Mexico to plant roughly 200,000 acres. In the 1967-68 crop year, 2.3 million Indian acres were under high yielding wheat. Similarly, in 1967 9,000 acres were planted with IR8 rice from Los Banos. In 1968, the acreage under IR8 had increased to 900,000 acres. This year, India expects a record cereal crop of close to 96 million tons - - - 12% higher than last year. 108 million tons, a further 12% increase, is forecast for next year.

Pakistan's wheat production has increased by 50% and Ceylon's rice production by 34% in the past two years and the Philippines, for the first time in 66 years, is now self-sufficient in rice. If present trends continue, Asia, excluding China, might well become self-sufficient in food grains by 1975.

In the Near East, the UAR has 25% of its acreage under dwarf wheats and substantial quantities of Mexican seed have been imported into Turkey, Afghanistan, Iran, Iraq, Syria and the Lebanon.

It is indeed gratifying that none of these countries has been discouraged by the gravestone epitaph of the Saskatchewan farmer:

"Here lies the body of farmer Pete  
Who died from growing too much wheat".

These new cereal varieties display several interesting properties:

1. They are short-stemmed and consequently don't lodge;
2. They are highly responsive to fertilizer and carry more tillers and grains per plant than conventional varieties;
3. They are adaptable to a broad range of latitudes and climates and are thus less rigidly seasonal;
4. They mature quickly and are comparatively insensitive to the hours of daylight. Consequently, they can be planted at any time the climate and water supply permit. With controlled irrigation and fertilization, Asian farmers are able to produce three crops each year.

Their adaptability permits inter-cropping. Where water is limited, maize and sorghum are being grown in the dry season, rice in the wet.

The enthusiastic adoption of high yielding varieties is bringing about dramatic changes in the technology and economics of farming in India and other Asian countries. There is an accelerating demand for fertilizers, better irrigation, improved storage and pest control, seed quality control, farm credit, improved marketing and, most important, competent agricultural managers, planners, technologists and extension workers.

India now spends one fifth of her foreign earnings on the raw materials for fertilizers and has more than doubled her fertilizer consumption since 1967.

Roughly 70,000 new private tube wells are being installed each year in India and power driven pumps have increased threefold in five years.

To maintain the genetic and physical purity of the high yielding varieties requires more reliable plant breeding, seed production, licencing, cleaning, inspection and distribution systems than exist in most low income countries. It is doubtful if any of the Asian countries, with the possible exception of Pakistan, can boast a sufficient number of experienced plant breeders and extension workers to expand the high yielding varieties on the scale envisaged.

Perhaps the principal accomplishment of the Rockefeller program is that it provided Mexico with a trained group of agricultural technologists

equipped and able to continue the program described above. In far too many countries one finds inexperienced agricultural scientists simply playing about with seed imported from Mexico.

Many of the new high yielding varieties introduced from foreign seed lack the evolved resistance of traditional varieties. Stripe rust may prove serious among Mexican varieties introduced directly into several Near Eastern countries. Consequently, each country requires to implement its own selection and breeding program.

To permit movement and distribution of the increased yields, better marketing and transportation facilities are urgently required. In Madhya Pradesh, which has only 6 kilometres of road in every 100 square kilometres of land, most of the produce is still carried to market on the heads of the farmer and his wife.

Food processors in general and grain millers in particular tend to criticize farmers for being more concerned with yield than quality. Samples of poor integration in planning between the grower and the user are all too common. Asian rice millers have commented that some of the newer IRRI varieties tend to fracture and crumble, a defect which is aggravated by poor drying. The cooking and eating properties of the new varieties are noticeably different and are by no means universally acceptable. In West Pakistan, which enjoys a substantial export trade for its Basmati rice, there is a marked reluctance to switch to high yielding varieties.

In several countries, bakers who are accustomed to a high proportion of North American wheat in their flour have expressed the opinion



that the new varieties do not make good bread. As I shall describe in a moment, modified methods of milling and baking can substantially offset inherent differences in the new cereals, but in countries like India where 85% of the wheat is ground in the villages and baked in the homes, and where over 90% of the rice is processed in small widely scattered mills, new technologies are not quickly introduced.

It is evident that the full benefit of high yielding crops will be realized only through a well managed and balanced integration of all of the input factors, including those which influence production and those which control utilization.

To this end, the Ford Foundation is assisting India to introduce the Intensive Agricultural District Program (IADP) or the Package Program as it is popularly called. Already introduced into 15 districts, it will eventually expand to 115 intensive agricultural areas. Each district package includes field testing of new varieties, extension services, fertilizer and water management, crop marketing, rodent and pest control, improved drying and storage.

The major partner in this exciting new enterprise will undoubtedly be the large and more prosperous farmer. The subsistence farmer, lacking the resources of his larger neighbours, will derive little benefit from the Green Revolution until the overall economy gathers sufficient strength to provide him with the aid he needs. Consequently, we may again observe the rich getting richer as the poor get poorer.

Nevertheless, the concentration of production and processing in fewer larger units will facilitate the more rapid introduction of new technologies.

At the same time, new problems of staggering dimension will be presented to Food and Agricultural planners, technologists and nutritionists.

Increased farm mechanization will increase rural unemployment and accelerate migration to the cities. African and Asian city populations are already growing at 3-10% per year. At present trend levels, Calcutta will become a city of 35 million in 30 years.

To feed them will require a rapid expansion of food processing and distributing industries. Should the new processing industries be built in rural areas, close to the crops, or in the cities close to the market? To arrive at the best decision will require educated, intelligent and dynamic planning.

As the low income countries progress towards self-sufficiency in calories, food and agricultural planning becomes immediately more relevant. The increased yields for the first time offer a choice of arable land use. Should the extra acres be used to grow more grain or other cash crops for export or to supply raw materials to technical agricultural industries?

Or should the land be used to improve the quality of local diets?

Recent genetic improvements in maize and trititalia offer hope that one day we shall have a cereal quantitatively and qualitatively adequate in protein for the human animal of all ages. For the immediate

future, however, cereal diets need to be supplemented with some other protein source.

Given the concentration of effort dedicated to the improvement of wheat, rice and corn, the production of pulses and grain legumes, probably the cheapest sources of vegetable protein, could equally dramatically be increased. The Rockefeller team increased Mexican bean production from 150,000 to 500,000 tons per annum and in test plots in India the vegetation period for Bengal Gram has been reduced from 240 to 110 days which would permit inter-cropping with wheat or sorghum.

USAID has introduced soyabeans into India where yields of 60 bushels (about 1000 lbs of protein) per acre in Uttar Pradesh and successful inter-cropping with cotton in Gujarat are reported. Soyabean seed propagation has begun in India and a start made to produce sufficient *Rhizobium Japonicum* for nitrogen fixation.

In India where vegetable oil production amounts to barely 15 lbs per person per year, soyabean production can probably be justified on the basis of import substitution alone.

There is a wide variety of alternatives open to the technologist for the combining of cereal flours with protein supplements, starting with mechanical mixing and simple agglomeration where particle size disparity exists, to the more elaborate systems of extrusion and baking.

The art of noodle extrusion has been practiced by the Chinese for several thousands years. The more modern extruder-cookers, such as the Wenger and Sprout Waldron, are capable of converting an infinite

variety of food materials into dispersible powders, noodles, solid or porous slugs, and the multivarious forms and flavours which appear as cheezies, wheezies and sneezies in the cocktail salons of the "gentile".

Nor are we short of alternative methods of producing full fat soya and other oilseed flours. In addition to the Wenger extrusion process, full fat soya of good quality can be made on a small scale by soaking, steam cooking, drying, dehulling and grinding by hand. Larger scale processes include dehulling by roller milling followed by hammer milling and air classification.

An Indian group are proposing lye treatment plus disc-mill dehulling, followed by aqueous pigment extraction and expeller pressing to produce sesame seed oil and a residual 60% protein meal.

Several Indian proposals exist for the commercial production of gossypol free cottonseed flour. In addition to the Dorr Oliver plant in Mysore and a factory in the Punjab, a series of 100 ton per day plants to produce, in total, 50,000 tons of oil and 90,000 tons of edible flour, are proposed. The estimated total cost of these plants is \$13 million. The import replacement value of the oil is calculated at \$53 million.

While from the nutritionists view point bread may be an excellent vehicle for almost any protein supplement, appearance and eating qualities of traditionally fermented loaves are not enhanced by the addition of oilseed meals and non-wheat flours.

Using modified, no-fermentation systems in which the doughs are developed mechanically or chemically, good bread can be made from composites of wheat flour and other cereals, such as maize flour or attrition milled sorghum, supplemented by soya flour, coconut flour or fish protein concentrate. The protein value is significantly superior to that of conventional wheat flour bread.

These new bread-making systems offer several advantages to low income tropical countries:

1. Since there is no fermentation period, the doughs are largely unaffected by ambient temperatures.
2. A higher degree of starch cell damage can be tolerated, consequently simpler flour milling procedures may be considered.
3. Variations in flour quality are of lesser consequence.

While the industrial fortification of flour, bread and extruded cereals with synthetic amino acids presents little technological difficulty, rice fortification offers more of a challenge. The largest lysine manufacturer in Japan, V. Yowa Hakko Kogyo Company, is now making a parboiled, lysine-fortified natural rice pre-mix which is added in the ratio of 1:200 to natural rice. The fortified mixture costs only 1.3% more than ordinary rice.

Though seven original plant calories are required to produce one animal protein calorie and the price ratio of animal to plant protein is of the order of at least 10:1, the potential value of animals as a protein

source cannot be ignored. Animals can be raised on land ill-suited to crops. If all of the 3,000 million hectares of usable land were stocked with cattle, the world's animal protein supplies could be almost doubled.

Where tropical forests are commercially exploited, less than 15% of the trees are profitably utilized.

Studies in Scandinavia, the USSR and North America indicate that wood pulp from deciduous trees can satisfactorily be fed to ruminants. Steam processed wood chips have been mixed with other feed stuffs, and old newsprint is being tested in ruminants feeds. Apparently, when in such thin sheets, the lignin present does not obstruct digestion of the cellulose.

The diet of ruminants on semi-arid land might well be supplemented with a wide variety of agricultural and industrial <sup>waste</sup> materials. The establishment of larger food processing units will facilitate collection and utilization of such wastes.

In many low income countries, animal protein could be more than doubled by improved management and health programs to control pleuropneumonia, tick and tsetse bone diseases. And, apart from the dreadful waste which occurs during the annual ritual slaughter at Mecca, and through religious and superstitious influences elsewhere, much greater use could be made by food technologists of the animals which are slaughtered.

In North America, the meat packer receives for the dress weight carcass roughly what he pays for the live animal, hence his concentration of research efforts upon by-product conversion. Sausage, bacon and other processed meats are virtually unknown in many meat-eating countries. Natural meat can very well be extended by oilseed and other vegetable proteins,

texturised either by extrusion from acid solution into an isoelectric coagulating bath, or in less refined fashion by Wenger-type extruders.

Where the protein cannot alone be readily converted to a stable filament, other colloidal filaments from, for example modified alginates, might be used as carriers.

Though in certain countries of Africa almost anything which walks, crawls or flies is considered game meat, the development, control and utilization of natural game as food is at best haphazard and unsystematic.

Eland have been successfully domesticated in the Ukraine and studies of the relative conversion efficiencies of eland on semi-arid and water buffalo on wetter land in Uganda have been proposed.

Very little attention has been given to the marketing of wild game meats. Much more needs to be known about the total energy flow patterns and the interdependent ecological relationships among coexistent species before the wild game of Africa can provide the protein that it might.

A Toronto newspaper stated recently that fish protein concentrate can solve the world's protein problem.

But one has to catch one's fish before one can isopropanolise it!

Though the annual catch of fish has risen from about 20 million tons in 1950 to nearly 60 million tons in 1966, the proportion used as human food has dropped from 86% to barely 67% in the same period. This represents

significantly less than 10% of the total world protein consumed.

Though the inshore waters which can be fished in small vessels are by no means exhausted, a greatly increased harvest necessitates fishing in deeper waters with elaborate equipment, on-board means of preservation and larger docks, harbours and processing plants than most low income countries intend to construct. Harvesting the now abundant krill, once the food of the nearly extinct Artic whale, is certainly more costly and complex than catching sheepsheads in Lake Erie.

Though improved techniques may bring some of the deep water grenadiers lantern fish and baracudiners into the human protein supply, perhaps the best long-term hope lies in controlled aquaculture.

In the natural state, many fish being themselves predators, the overall conversion efficiency of marine organic matter into human food is probably less than one per cent. Where young fish are protected from predators and given an amiable environment, conversion efficiencies rise dramatically.

In Africa, tilapia feeding upon natural vegetation produce about 300 lbs live weight per acre. When organic material from agricultural by-products is added, yields of 2,000 lbs per acre, representing close to 400 lbs of protein per acre, were harvested. Under favourable conditions, the Bay of Taranto has yielded more than 100,000 lbs of raw mussels per acre. In Japan, Korea and several other countries controlled aquaculture gives promise of even higher yields of oysters, shrimps, other crustacea, trout, salmon, and many other fresh and salt water fish.



Perhaps most exciting is the discovery that a healthy fish can be produced in a vessel little bigger than its own maximum volume, provided that the surrounding water is changed at a rate sufficient to supply adequate oxygen and nutrients and to remove waste products.

Herein lies the promise of fish farming closely akin to the raising of poultry in battery houses.

Fish protein concentrate certainly represents an attractive stable concentrated source of high quality protein easy to blend with cereals and other foods. Ideally, it should be made from trash fish, fillet trimmings or other scrap. In many locations, it is difficult to collect such cheap raw material in the quantity and quality needed and the first North American plant will probably start with fillets of red hake.

At a recent Canadian conference which assumed fish fillets to be the starting material, the estimated cost of FPC ranged from 20 cents per pound for a 200 ton per day plant and a raw material cost of 1 cent per pound, to 70 cents per pound of FPC for a 25 ton per day plant with raw fish landed at 6 cents per pound.

It is fortunate that most of the valuable research on FPC has been undertaken in advanced countries, though it is in the low income countries that additional sources of edible protein are needed.

Without doubt the low income countries will need a good deal more information than is presently available concerning the economic and utilization factors before they can compare the true value of FPC with other potential protein supplements.

Their capacity to grow quickly in limited space and upon a wide range of waste material substrates explains the great interest now shown in microorganisms as a source of supplementary protein. Microbiologically produced protein is by no means as new and unconventional as many of us may think.

Vegetable cheeses and related foods richer in protein and/or vitamin content than the starting material have been produced by the growth of yeasts, moulds and bacteria on cereals, grain legumes and root starches for many centuries in Asia, Africa and Latin America. The Chinese have long used minchin produced by anaerobic fermentation of wheat gluten as a meat substitute. For many centuries throughout the Near East, kishk has been made by the anaerobic fermentation of parboiled wheat with yoghurt.

Ragi from rice in Indonesia, ogi and kenkey from maize and tuwo from millet in West Africa are but a few examples of traditional fermented foods. Fresh water algae have been harvested and eaten by the natives of Chad and Cheju for a very long time.

However, the concentrated industrial production of single cell protein (SCP) is of recent history.

The classical comparison is between the theoretical 1,000 lb bullock which produces one pound of protein per day and 1,000 lb of *Candida Utilis* which optimally yields 50 tons of protein daily. On this basis, an acre of sugar cane could be converted to 10,000 pounds and an acre of cassava to over 5,000 pounds of protein per annum. One manufacturer proposes in

Asia to convert cassava starch to protein-enriched feed for pigs and poultry at an anticipated cost of 15 cents per pound of protein.

How much single cell protein the human animal can tolerate in the diet is a matter of some debate. Suffice it to say that a cost of about 8 cents per pound which seems attainable in large production, dried yeast could probably compete adequately as a cereal supplement with synthetic lysine.

The algae have a special appeal because of their photosynthetic ability. Spray dried extracts of chlorella have long been produced and sold on a substantial scale in both Japan and Taiwan, where they are claimed to promote health and beauty, to maintain youthful vigour, and to cure gastric ulcers.

Some recent space agency studies have indicated that natural algae can grow with a photosynthetic efficiency of at least 3%, compared with 0.25% for soyabeans. Under pressurized Xenon lamps yielding over 100 lumens per watt of narrow spectrum light, algae conversion efficiency has been raised to better than 40%.

In spite of their comparatively slower growth rate, the microfungi might be regarded as the best potential as a source of protein among the microorganisms. One research group, after screening some 10,000 different organisms, has isolated a microfungus which produces, per litre, more than 30 grams of edible solids, protein content 40%, containing 8% lysine, and a demonstrated NPU of close to 70. In continuous fermentation, it costs about 8 cents per dry pound. In flavour, it is meaty and its fibrillar texture is not damaged by dehydration.

Most of the microfungi studied have been collected in temperate zones and grow best between 20° and 25° C. A large scale screening of microfungi isolated from tropical carbohydrate sources might prove exceedingly rewarding, since the primary need is for organisms that will grow efficiently under tropical conditions.

There is no shortage of substrates, both carbohydrate and hydrocarbon, upon which to grow microorganisms, which represent an excellent means of converting waste into food. Furthermore, much of the basic research can and should be undertaken in the advanced countries. One cannot support a recent proposal that an oil-rich but technologically-poor country of the Near East engage in long-term research to produce single cell protein from petroleum.

There is much to be said for the UN Associate Committee on Science and Technology's recommendation that developed countries devote 10% of their research effort to the problems of low income countries. Canada is proposing to establish an International Development Research Centre for this specific purpose. This Centre will be a Canadian-sponsored, independent, non-profit organization with an international character. The planned purpose of the Centre will be to initiate, encourage, support, and undertake research into the problems involved in the development of the economically underdeveloped regions of the world. It will focus its attention particularly on the adaptation and application of scientific and technological knowledge to the needs of the peoples of those regions for social and economic development. It will also endeavour to assist these peoples to develop their own capabilities to solve the problems of economic underdevelopment which confront them.

It is expected that the Centre will enlist the talents of natural and social scientists and technologists, not only from Canada but from throughout the world. Activities will be directed to the identification of specific development problems and the use of multi-disciplinary techniques in devising practical solutions for them. An important aspect of its work will be in areas of research designed to be of practical use to decision-makers in the formulation and implementation of policies and programmes of action. Special emphasis is expected to be given to programmes and methods of work which will assist the less developed nations themselves to build up the scientific and technical capabilities and innovative skills required if they are to resolve their own development problems.

There are many alternatives and complementary means of increasing food supplies and improving nutritional standards in the low income countries, many more than this sketchy review can embrace.

Nor should we overlook new and exciting means of expanding our knowledge of the earth and oceans resources and potential for expanding our available supplies of food.

The proposed Earth Resources Technology Satellite, equipped with a return beam Vidicon television camera can examine and photograph an area of 100 square miles every 25 seconds. This rapid method of surveying can provide data upon:

- Natural resources including water supplies;
- Land use and crop inventories;
- Fish resources, sea state, ocean depth and currents;
- Pollution;

- Weather patterns; and other important factors.

Some of the technical difficulties and obstacles to achieving the maximum gain from new and improved technologies have already been mentioned.

The most serious limiting factor may well prove to be the supply of competent people both at the giving and the receiving ends of international development programs. Few low income countries employ technologists and economists possessed of the breadth of knowledge, experience, wisdom and vision to enable them to choose among the many alternative development projects available to them.

All too often we take the best young Asian and African technologists and through overseas postgraduate training convert them to narrow spectrum research scientists. A typical example is that of a student from a country with virtually no food technologists who, thanks to an overseas fellowship, is studying the enzyme systems in apricots at a foreign university. His country not only doesn't grow apricots but during his period of study the entire year's production of his country's one canning plant was lost through faulty can seaming and retorting.

What kind of training should we offer to furnish the low income countries with men and women who can study competently and decide upon the best of the alternative courses of action to increase their supplies of nutritious foods?

It is probable that the first essential is for those in advanced universities, colleges and other training establishments which accept students from developing countries, to understand the potential, opportunities and difficulties which exist in those countries.

As was suggested at the outset of this paper, the low income countries, if they are to gain full advantage from the Green Revolution, need a new breed of economist-technologist, one who in consultation with the nutritionists and representatives of the consumers, can plan what crops and livestock should be raised; who can manage and control all of the inputs needed to produce and utilize the various food sources to the greatest benefit of all concerned.

At another level, the low income countries urgently need food and agricultural technologists who are willing to work in the field and on the factory floor guiding the farmer, the processor and the distributor in a useful practical manner.

These are the resources we should provide to the low income countries to enable them in the words of the Unpanishad "to increase their supplies of nutritious food, food which is clean and which is not acquired by begging".