Horticulture's Action Band in the Spectrum of the World's Food Supply[1]

Edwin B. Oyer[2]
Cornell University, Ithaca, NY 14583

It is tempting to overemphasize the role of horticultural crops in man's diet. Horticultural crops rank a poor second after the cereal grains as an energy source (Table 1) (5). It is clear that roots and tubers, fruits, nuts and vegetables contribute less than a third of the dietary calories supplied by the cereal grains. There are several factors which deserve consideration in interpreting these data.

First, fruits and vegetables produced in home gardens, shared by friends or procured at small marketplaces (e.g., roadside stands or farmers' markets), are usually not reflected in gross production or consumption figures. For example, I would suggest that a significant percentage of the root and tuber crops consumed by people in the tropics are not included in these estimates. Also, for many people in Central and South America, plantain is the staple crop and I doubt that its importance is reflected fully in these figures.

Second, and more important, is the fact that caloric intake gives a better measure of quantity rather than quality of the diet, and the horticultural crops are considered as protective foods rich in protein, vitamins, and minerals. It is in the improvement of the quality of the diet that horticultural crops play an important role and should assume a more important role in the future. Food consumption data for populations in tropical areas are difficult to obtain, but such data do exist for the Republic of the Philippines (7). In Table 2 the Filipino diet is compared to that of Americans.

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While differences in consumption are evident in each category and the total, these comparisons contrast a people whose staple food is rich with those who consume large amounts of meat and dairy products so that on a dry-matter consumption basis the contrast would not be so great. Our interest as horticulturists however will center on

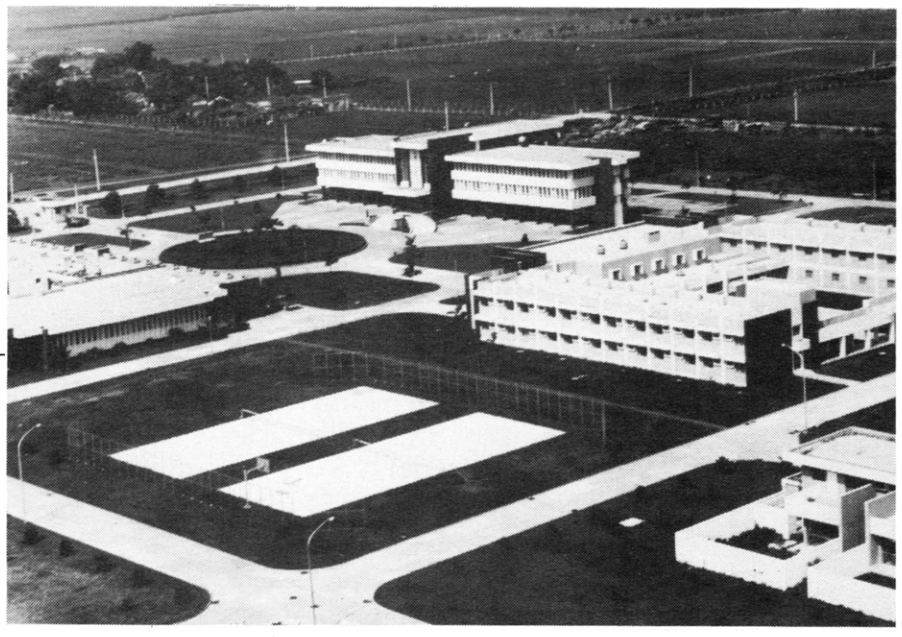
Table 1. Sources of man's food energy. From Brown (5).

Foodstuff	% of energy supplied
Cereal grains	56
Roots and tubers	7
Fruits, nuts and vegetables	10
Sugar	7
Fats and oils	9
Livestock products and fish	11
Total	100

Table 2. Per capita consumption of categories of food for Filipinos and Americans[z].

Food category	Filipinos (kg/year)	Americans (kg/year)
Cereals	144.3	71.0
Vegetables, including dry beans and potatoes	66.8	145.7
Fruits	53.3	95.1
Seafood	34.8	5.7
Red meat	18.8	85.2
Dairy products	12.0	129.3
Poultry meat	6.6	23.0
Eggs	5.2	14.5
Total	341.8	569.5

[z]Source: *American:* National Food Situation, NFS 150, Economic Research Service, USDA, November 1974. *Filipino:* Marketing Research Unit Publication No. 73-21. NFAC, DANR, Quezon City.



A view of AVRDC's laboratory building (left), the administration building (center), and the cafeteria-dormitory building (right). Some of the experimental fields are shown in the background.

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[2]Director, Program in International Agriculture and Professor of Vegetable Crops.

the relative consumption of fruits and vegetables. These products make up 35% and 42% of the Filipino and American diets respectively. Those who have traveled extensively in tropical areas will have experienced the lack of vegetables available, especially in the hot and rainy seasons. It is not surprising that availability and consumption levels are so low when one considers the relatively meager research efforts that have been devoted to the improvement of tropical fruits and vegetables. We all know that tropical horticulture has not enjoyed the attention and support afforded that in temperate zones, but it is encouraging that tropical horticulture is now receiving some of the additional attention it deserves. I would encourage horticulturists to follow the development and accomplishments of the Asian Vegetable Research and Development center in Taiwan (AVRDC) and the International Potato Center in Peru (CIP), which are the first two international agricultural research centers to be established for the improvement of horticultural crops.

Table 3. High-yielding sweet potato selections under minimum input conditions.

AVRDC Selection no.	Pedigree or cultivar	Marketable yield[z] (MT/ha)	Flesh color
278-1	Tainung 27/HOK 8	19.5	Yellow
277-1	Red Tuber Tail/OK 6-3-118	18.5	Yellow
276-1	Red Tuber Tail/OK 6-3-106	16.9	White
0122-2	B 6708 (op)	15.5	Orange
272-8	Red Tuber Tail/Allgood	14.8	Yellow
015-10	HOK 6 (op)	14.6	Orange
010-2	HOK 8 (op)	14.0	Yellow
	Tainung 63 (check)	4.5	Orange
	Tainung 57 (check)	10.9	White
	Red Tuber Tail (check)	16.2	Yellow

[z]Planted Nov. 15, 1974; harvested April 19, 1975 (155 days). Based on yield from 10 hills.

AVRDC selection #272-6 (Red Tuber Tail/Allgood) produced a high marketable yield when grown without fertilizers, pesticides, or irrigation during the 1974 dry season.

Root and tuber crops — the unclaimed relatives

While there is little reason to attempt a strict definition of horticultural crops, the root and tuber crops (potato, sweet potato, cassava, yam, tarco and tannier as examples) are not consistently considered as either horticultural or agronomic crops and I would suggest their adoption as horticultural crops. These crops, some of which have received relatively little attention from research scientists, have amazing potential for feeding people, are relatively resistant to attack by pests, and in general produce high and dependable yields with a minimum of costly energy inputs such as fertilizer and pesticides, compared to those needed for high yields of cereal grains. For example, more people can be fed from a hectare of sweet potatoes than can be fed from a hectare of rice and with much less energy input. Dr. Ruben Villareal has provided the preliminary information in Table 3, which shows yields of sweet potato breeding lines produced at AVRDC when planted directly after paddy rice with no inputs of fertilizer, pesticides or irrigation. Some of the lines have higher yields than the controls and also have yellow flesh, which means a higher beta-carotene content. The tips of the sweet potato vines are also eaten in parts of Asia and make a delicious green vegetable. AVRDC's objectives for improving the sweet potato include selecting for high yield in a tropical environment, high protein content, high beta-carotene content, "dry" texture, and stem tips suitable for use as a green vegetable (4).

Cassava and the true yam (*Dioscorea* spp.) are also receiving increasing attention for improvement as both food and feed crops. A significant breakthrough has been made in the true yam by scientists at the International Institute for Tropical Agriculture (IITA) in Nigeria. Parent materials can now be induced to flower readily with satisfactory seed set and germination. This will allow more rapid improvement through breeding methods.

Tropical root crops have even higher yield potential when grown under favorable conditions with adequate inputs of fertilizer. Plucknett and de la Pena (8) reported a yield of 129 metric tons per hectare of taro when grown under optimum conditions. The crop averaged about 35% dry matter. Admittedly, many of the tropical root crops serve mainly as sources of calories as they exist today, but efforts are being made toward their nutritional improvement as well.

Horticultural crops in cropping systems

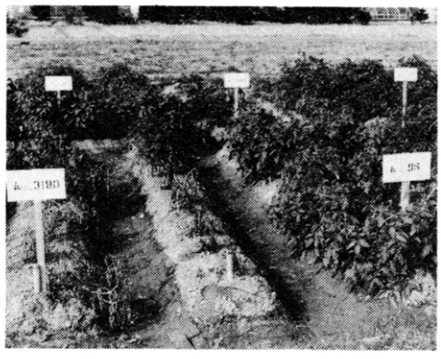
As we are all aware, U.S. agriculture today is essentially mono-cultural. This is true even for horticultural crops except those in home gardens and the few remaining market garden and nursery areas. In many tropical areas, horticultural crops are grown in rotation with the staple crops and are often intercropped. Research on cropping systems is receiving increasing attention at the several international agricultural research centers in tropical areas. One of the pioneers in the study of the physical cropping systems was Dr. Richard Bradfield, who conducted experiments at the field, who conducted experiments at the International Rice Research Institute

Farmers in southern Taiwan often plant soybean immediately following their second rice crop. This practice is referred to as "no-tillage, rice-stubble soybean culture."

(IRRI) in the Philippines (1). The annual report of that institution includes summaries of their current work (2). From such investigations, identifications of optimum cropping sequences and intercropping patterns which reduce insect attack and weed growth have been achieved. Many of the crops in the system are vegetables which supplement both the cash income of the farmer and improve the nutritional quality of the diet.

Probably Taiwan is the outstanding example of a country which practices intensive agriculture in order to provide much of the food for its population, which is one of the most dense per arable hectare of any country in the world. The Chinese have long been recognized for their abilities in intensive cultivation, especially of vegetable crops, and gourmets recognize their cuisine as equal to or second only to the French. A description of the multiple cropping practice on Taiwan has been compiled by the ASPAC Food and Fertilizer Technology Center (3).

Successful multiple cropping systems are not limited to staple crop areas or vegetables. In a recent visit to the Philippines, I saw three and four "tiers" of foliage on the same upland area. Coconut palms were widely spaced and composed the upper tier. The second tier was most commonly papaya, with a third tier of cacao, cassava, or coffee, and a bottom tier of pineapple, ginger, sweet potato, beans or taro. These are traditional and productive land use systems and demonstrate the great potential for horticultural crop production in tropical areas. It should also be emphasized that cropping systems that include horticultural crops provide increases in cash income and improvement in nutrition of the people.



Resistant (Acc. 8, 95) and susceptible (Acc. 3180) tomato cultivars were inoculated with bacterial wilt (*P. solanacearum*). This disease seriously limits tomato cultivation in the tropics.

Horticulture's action band

The major contribution of horticulture to the world food supply will be made more by people (horticulturists) than crops. The present dilemma is how to cope with our present collision course of population growth and food supply. Recently a group of leaders in agricultural research and administration met in Kansas City to assess research areas deserving additional attention and assign priorities to those identified as critical. Of 94 areas identified, those receiving the first 5 priority slots were: 1) energy, 2) improved soybean production, 3) efficient water use, 4) basic problems in plant growth and reproduction, and 5) human nutrient requirements.

I submit that horticulturists are eminently qualitifed to provide leadership in a majority of these areas. Specialists studying energy requirements of agriculture often point to the increase in the ratio of fossil fuel energy consumed to food energy produced with increasing mechanization. While mechanization in horticulture is increasing, ours is still a relatively labor-intensive industry, which could yet be an advantage. Who has had more experience with drip irrigation, the most efficient method of watering, than horticulturists? Also, horticulturists will continue to contribute to the solutions of basic problems in plant growth and reproduction. And finally, while most of our crops are not staples, they are strong contributors to improved human nutrition.

For some time, I believe our profession held a lower position in the "pecking order" of scientific disciplines than it does now, because it was considered more of an art than a science. Recent events have dictated a rethinking of our priorities. In a little book entitled, *Small is Beautiful: Economics as if People Mattered,* Schumacher (9) states: *"What is it that we really require from the scientists and technologists? I should answer: we need methods and equipment which are*

- *cheap enough so that they are accessible to virtually everyone;*
- *suitable for small scale application; and*
- *compatible with man's need for creativity."*

I am sure that the practice of horticulture meets each of these requirements.

The main theme of this paper has focused on food and thereby ignored one of the important segments of our profession – ornamental horticulture. While not providing food for the body, the enrichment of life is certainly essential to man's well-being, and the response of Liberty Hyde Bailey to people who criticized him for publishing bulletins on chrysanthemums or sweet peas when farmers needed bulletins on cabbage is worthy of note. Bailey wrote that he was convinced that farmers *"needed education in flowers and other incidental things quite as much as they did in wheat or potatoes; that it was the lack of cheer and color and interest about the home which was largely responsible for the dissatisfaction of young people with the country* (5)."

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