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I. INTRODUCTION

1. Although the Consultative Group on International Agricultural Research (CGIAR) has accorded first priority to research on cereals, grain legumes, roots, tubers and beef cattle, its Technical Advisory Committee (TAC) has maintained a continuing interest in the improvement of vegetable production and consumption in the tropics, and the role which vegetables play in the diets of its peoples. As the staple foods have been progressively covered by international research programmes the TAC has concluded that there is a need to look more closely into the case for reinforcement of research on vegetables in the tropics, and particularly to assess in more detail the priority species and their specific research needs as a means of determining the level of support, if any, that the TAC would wish to recommend to vegetables.

2. A number of alternative proposals for international action have been submitted for consideration by TAC. These included proposals for (a) the formation of an International Vegetable Research Institute for the Tropics (IVRIT), and (b) an Inter-country Vegetable Research network in Asia and the Far East. It was eventually decided that a mission should be organized and sent out to visit selected countries in Africa and Asia, with the terms of reference shown in Appendix II(a). The names and addresses of members of the mission are also given in Appendix II(b).

3. Members of the mission rendezvoused in FAO headquarters, Rome, from 11 to 13 November, during which period they were briefed by staff of the TAC Secretariat and the Research Development Centre, the Plant Production and Protection Division, the Horticultural Crops Group and the Food Policy and Nutrition Division, Food Consumption and Planning Group.

4. Thereafter, the mission departed Rome on 13 November to visit Senegal and Nigeria in Africa; India, Thailand and Indonesia in Asia and return to Rome on 11 December 1975. The itinerary is shown in Appendix II(c).

5. In each country, the mission visited several research institutions where vegetables formed all or part of their programmes of work Often this necessitated travelling to different parts within the countries. The mission held discussions with research scientists, research administrators and policy makers. It is noteworthy that in each country the mission visited the centres of nutrition studies and also talked to the scientists there. A list of institutions visited and the people with whom the mission held discussions is given under each country report in Appendix I.

6. During the various discussions, the members of the mission tried at all times to get a clear picture of the overall status of vegetables in each country's agriculture, nutrition, economy and development programmes The discussions were usually followed by field excursions during which members saw things for themselves. The mission tried at various stages to obtain concrete statistical data on the various aspects discussed. Unfortunately, quantitative data were not always readily available, and the mission did not have the time to search for this in libraries and other sources. Consequently, much of the findings are not supported by published quantitative data. The people with whom the mission discussed were, in general, very frank, and as far as members could judge gave the best information at their disposal. Although one cannot rule out personal interests and prejudices from the opinions expressed on certain topics, like the need for and type and organization of international research effort for tropical vegetables, certain clear general patterns emerged. The mission has highlighted these in the body of the report.

7. The fifth term of reference requested the mission, in the event that an international effort is considered justified, to recommend an organizational form and location(s) of any such effort. While the mission has found it possible to make definite recommendations on the organizational form, it decided that it did not have enough basis for concrete recommendations on a particular location. This is because the mission visited only a few countries, and, even then, did not have time to ascertain the necessary facts pertaining to the criteria for selecting an appropriate location.

8. The mission was aware, through the report of the Executive Secretary of TAC (DDDR: IAR/75/21, June 19 5), that Thailand has unofficially offered a site for such a centre near Bangkok, on the new campus of the Kasetsart University.

9. Having defined certain specifications for a prospective site, the mission recommends that a special mission be launched to choose a site, in the event that TAC and the Group decide to set up an international research centre for vegetables. The mission suggests that several sites should be explored for this purpose.

II. SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

i) The Present State of Vegetable Research

10. Research on vegetables* in the countries visited ranges from a highly developed state at several locations in India to programmes which to a large extent have been initiated recently in Senegal, Nigeria, Thailand and Indonesia. In all these countries the research emphasis to date has been mainly on vegetables which are grown on a commercial scale for urban markets or export, with much less attention to native tropical vegetables eaten extensively by rural people Many of the latter vegetables have less prestige and lower market price but more nutritional value and better adaptability to the tropics.

ii) The Economic and Nutritional Contribution of Vegetables

1) The Economic Contribution

11. Due to the fact that the mission did not have much opportunity to locate data pertaining to economic aspects of vegetables in the countries visited, the conclusions have mainly been based on personal discussions and observations. The economic impact of vegetables can be shown in the following ways:

a) Policy-makers in all countries placed a high priority in supporting the expansion of vegetable production. In most countries, vegetable research and extension programmes have been included in their national economic development plans. However, it is noted that the consideration given to vegetables refers almost exclusively to the commercial vegetables, that are marketed in the cities or for export

b) The non-commercial crops, such as native leafy green vegetables, have been found to play a very important role as substitutes for the unavailable or the expensive foods at certain periods of the year for the rural people in all countries.

c) In all the countries, vegetable production and marketing were found to be labour intensive, and therefore have generated employment for many rural and urban people.

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* The term "vegetables" in this report does not in general include starchy roots and tubers or dry legume seeds. However, the leaves, sprouts, young pods, and immature seeds of such food plants are considered as vegetables in accordance with general usage.

d) Vegetable growers in all countries visited were found to be among the high income farmers. In Thailand, more and more rice farmers are going in for vegetable growing because this gives them as much as 4.75 times more income than that derived from growing paddy.

e) The demand for vegetables in these countries will continue to grow in line with growth of population, the increase of real disposable income, and the effort to solve the problems of the undernourished and malnourished people. This indicates the urgent need for serious attention to the accelerated expansion of vegetable production in the tropical countries.

f) In some countries the export of vegetables contributes to the earning of foreign currency.

2) The Nutritional Contribution

12. Nutritionists in all countries stressed the importance of vegetables in supplying vitamins (vitamin A in particular). Some nutritionists also mentioned vegetables as important in supplying minerals, calories, and protein, in providing a good balance of amino acids in diets low in animal protein, and in adding desirable bulk, variety and taste to the diet.

13. While vegetables have long been regarded as rich in vitamins and minerals, it has not been appreciated until recently that some of them, such as the leafy greens, are capable of producing protein and calories at rates equal to those of the most efficient staple crops. There is a growing awareness that vegetables should not be regarded as optional foods for most people in the tropics because they are the main source of some essential vitamins. Neither should they be regarded as luxury foods because many of them pay their way in terms of calories and protein production while providing a free supply of vitamins and minerals. The need for the nutrients supplied by vegetables is especially great among the poorer rural people in the tropics who can afford relatively little meat, but who in general consume grossly inadequate quantities of vegetables.

iii) Crop Species and Problems Needing Additional Research

14. Tomatoes rank at or near the top among the species for which additional research is needed. They were identified for first priority by nutritionists, horticulturists, and government policy-makers alike in every country visited. A scientific base for rapid improvement of the tomato is available because more is known of its genetics than of any other vegetable, large germplasm collections are available, and the main characteristics needed to improve tomatoes throughout the tropics are already known to exist, namely resistance to fusarium and bacterial wilts, nematode and virus resistance, and ability to set fruit at high temperatures. The results of combining these features into a single variety will improve tomato production at all levels from the home garden to large scale production for fresh market and for processing. Eggplant or brinjal (Solanum melongena) and peppers or chillies (Capsicum sp.)are also extremely important vegetables in the tropics and as members of the same family as tomatoes, they share some of its disease and insect problems. It is apparent, therefore, that these crops warrant attention along with the mainstream of research on tomatoes.

15. Leafy green vegetables of the tropics should have priority almost equal to tomatoes. Probably no other single group of crops, vegetable or otherwise, can equal their ability to produce high yields of calories, proteins, vitamins, and minerals simultaneously. Some of them can produce a marketable crop in as little time as three weeks or harvest can be deferred for some time while greater yields accumulate. Successive harvests may be made from the same planting. This flexibility in harvesting makes them well suited for intercropping and relay cropping. It is difficult to say which of the many species in this group should get attention but we suggest the amaranths for initial research because (1) they are eaten by the poor and rural people in every country visited,

(2) their protein percentage on a dry matter basis equals most of the grain legumes and is reported to be high in sulfur-containing amino acids, (3) they have a high content of minerals and vitamins especially vitamin A, (4) they have the more efficient C4 type of photosynthesis, (5) great genetic variation is available as a basis for improvement, (6) they have relatively few insect and disease problems, and (7) they grow readily in semi-wild and under rainy conditions. Ipomoea aquatica (variously known as kangkong, water convolvulus, or swamp cabbage) also seems worthy of attention. It is widely used, highly nutritious, and accorded more prestige than the amaranths in certain areas, but it has been the subject of little research so far.

16. A third priority group is the leguminous vegetables - the immature pods, the immature seeds, the sprouts, and occasionally the leaves of many legumes. As compared with leafy greens, these green pods and seeds have the advantage of less rapid deterioration after harvest and more commercial popularity. The plants also have the ability to fix nitrogen. As compared to the dry seeds of the same species, they have more vitamins, require less cooking, and have shorter duration of growth. We suggest that initial research should be concentrated on the Vigna species - cowpea, yardlong bean, and mungbean - because of their known adaptability to the tropics. Exploratory work is suggested for lima beans, winged beans, and Dolichos beans (now known as Lablab niger). All work on this group of vegetables should be closely coordinated with the work at existing International Centres on the same species grown as grain legumes.

It is difficult to go beyond these three groups in establishing priorities, but some research needs of other vegetables are discussed in the body of this report.

iv) The Needs for Additional Internationally-Supported Research

17. International research on vegetables in the tropics is needed for several reasons: (1) Although some research on vegetables is done in all the countries, it is grossly inadequate - in scope, depth and organization - to meet the colossal challenge of enhancing vegetable improvement and production to the extent most urgently required. (2) International programmes are in a better position than national programmes to do research on those vegetables which are at present of less commercial importance but of great nutritional value to the masses of people. (3) The large number of species used as vegetables makes it difficult for national programmes to get enough support to have effective programmes on most of them, whereas the combined area planted with a given species in the tropics as a whole can justify an international effort. (4) International research could help provide continuity of effort which is often lacking in national programmes by giving information and experimental materials to new and inexperienced people and by providing a planning framework for organizing programmes. (5) It is not economically feasible for most national programmes to assemble and evaluate the large germplasm collections needed for the improvement of each species. (6) Research on disease and insect resistance is more urgently needed in the tropics than elsewhere and yet this is where it is lagging because it is beyond the capabilities of most national programmes. The benefits of resistance to one pest are often not realized because several others may be nearly as serious. Only through coordinated international effort is the required multiple resistance likely to be attained.

v) The Organizational Form, Activities and Location of an International Effort

18. After considering carefully the advantages of a network approach, i.e. giving international support to vegetable research at existing centres, we conclude that this is unlikely to be successful unless it is used in combination with a new international centre. Due to the weakness of national programmes, a network among themselves would not succeed in giving a strong push to vegetable research. We therefore recommend the establishment of a new centre for research on vegetables in the tropics in combination with a network approach. We would recommend that grants and contracts be given to existing research centres for studies requiring environmental conditions, personnel, or facilities different from those at the main centre. For this reason we feel that the new centre could be of modest size.

19. Some of the advantages of the proposed centre over a more diverse effort include: (1) Efficiency in activities which relate to all the species which it undertakes to study. These include training, communications, collection and dissemination of germplasm, and research on such as economics, sociology, and nutrition which cuts across species. (2) The stimulating effect of having vegetables as the focus of thought and activity for the entire staff. (3) Clear rather than diffuse responsibility for considering programme changes, and flexibility in making changes in emphasis. (4) Convenience to workers in national programmes in having a single place to turn to with problems.

20. We recommend that a separate study be made to choose a location according to the following guidelines:

a) An Asian location because of the size and density of population and the very great importance of vegetables for the mass of the people.

b) A lowland tropical location with well-defined wet and dry seasons in order that responses under both humid and drought conditions can be determined.

c) Access to a range of altitudes to provide different temperature regimes.

d) A country with a tradition of good and diverse vegetable growing.

e) A location preferably near a good faculty of agriculture where cooperative programmes of graduate study might be developed.

In addition to these specific points, there are several generally accepted criteria for choosing a site for an international centre such as:

a) A country with a government interested in being host to a centre, willing to facilitate the entry of scientists and the supplies, equipment, and other resources, including seeds, that they require.

b) A location with schools, medical resources, and cultural activities adequate to attract qualified scientists.

c) Adequate communication and travel facilities.

vi) <u>Supporting Action Required in Infrastructural Fields</u>

21. The mission interprets "supporting action .... in infrastructural fields" as meaning action which would not be undertaken through international research in itself, but lack of which would reduce or nullify the effectiveness of research.

22. <u>Seed production and distribution</u> appears to be the main infrastructural field which might require supporting action to bring into use the results of international efforts in vegetable improvement. Lack of it was pointed out in every country as a limiting factor in the application of research results from national programmes. Other infrastructural needs such as availability of water for irrigation, marketing and extension vary from country to country. These are factors which seem appropriately handled by national or bilateral programmes.

III. DISCUSSION

a) Definition of Vegetables

23. No single concise definition of vegetables is universally accepted, but one can say that in general vegetables are parts of herbaceous plants, eaten raw or with simple kitchen preparation, usually as the principal supplement to foods which supply the major part of calories and proteins.

24. Stated in another way, nearly all vegetative and immature reproductive plant parts which are edible are considered as vegetables, whether they come from herbaceous or woody plants, the main exception being starchy roots and tubers. A number of mature fruits, such as tomatoes, peppers, okra, and many cucurbits, are also considered generally as vegetables, these being distinguished from horticultural fruits by coming from herbaceous rather than woody plants, by being seasoned with salt, and by being cooked frequently with other vegetables.

25. In this report the term vegetable does not include starchy roots and tubers nor grain legumes even though they are called vegetables in some places. However, certain plants in both groups produce leaves, immature pods, and immature seeds which are commonly eaten and always called vegetables.

b) The Main Vegetables of the Tropics

26. In this section the aim is to highlight the wide range of tropical vegetables through selected examples. Consequently, the compilation of a complete list will not be attempted. Attention will be directed to vegetables for tropical lowlands, in line with the mission's interpretation of its terms of reference. Furthermore, the use of starchy tubers for vegetables, such as the sweet potato, Irish potato and cassava, will not be considered in detail, partly because such usage is not general and partly because they are already the object of research at existing international institutes. But the use of their young leaves as vegetables will be discussed.

27. Many temperate-zone vegetables (sometimes called European or exotic vegetables) have been introduced into the tropical region and have become well adapted to highlands and higher belts although less so to lowland conditions where they need intensive care. Such vegetables, e.g. lettuce, cabbage, cauliflower, radish, carrot, etc., are often grown mainly for the well-to-do urban population. Because of the high prices which they bring they are too expensive for the ordinary and rural people and have thus achieved a high social prestige. For easy distinction they will be called the "elite" vegetables in contra-distinction to those vegetables which are indigenous or "native" to the tropics and are consumed by the majority of the rural population.

28. For ease of description we may distinguish vegetables into:

(i) leafy vegetables, consisting of those plants in which the primary organs consumed are the tender leaves such as the amaranths;

(ii) fruity vegetables, in which the major organs consumed are the fruits and seeds, such as the chillies, tomatoes, eggplants, etc.;

(iii) sprouts, consisting of germinated seeds, principally legumes - lentils, mung beans, soy beans, etc.;

(iv) others, comprising a motley of plants of which one part or another is consumed, e.g. the root tubers of carrot, the bulbs of onions, the inflorescence of cauliflower, etc.

29. Among the ordinary people of West Africa the word "vegetables" is almost synonymous with the "leafy" vegetables. In this region there is a wide range of herbaceous plants whose leaves and young stems are cooked into stews, together with peppers, onions, tomatoes and other condiments. It is noteworthy that in this region most of the vegetables are eaten cooked - often after thorough cooking. This is in marked contrast to the manner in which the "elite" vegetables are eaten - fresh or after very minor cooking. In India, Thailand and Indonesia there are also leafy vegetables but their consumption is somewhat less popular because of the low social status which they have acquired in comparison with the more prestigous "elite" vegetables.

30. There is a dearth of information about the number of species in the leafy group which highlights the need for a programme of exploration and collection throughout the tropics. A few of these leafy vegetables are eaten in all the countries visited, such as amaranths, celosia, and the various spinaches. The water convolvulus (Ipomea aquatica) is also commonly eaten in the Philippines, Thailand and Indonesia.

31. Special attention needs to be called to the leaves of other plants which are eaten. Throughout the tropics, people eat the leaves of legumes, cassava, sweet potatoes and several solanaceous plants and cucurbits. The leaves of several tree and shrub species are also eaten, fresh or dried, such as Adansonia digitata, Tamarindus indica, Vernonia amygdalina, Poinsettia, Gnetum, Moringa. The great advantage of this last group of plants is that they are often uncultivated and, being perennial, provide leafy vegetables during the dry season when the production of the more herbaceous ones has terminated. In many parts of the tropics, the Sahel, India, Thailand, Indonesia, they are reportedly very important as a source of vegetables to the rural population at all times.

32. Tomato is the most commonly eaten fruity vegetable. It is eaten either fresh, as in salad, or cooked into soups or stews. It is truly better adapted to cooler growing conditions such as those on tropical highlands, but its popular usage has encouraged its production in lowlands, where it requires intensive cultural management. Very many varieties of it have been developed, making it possible to grow it under various conditions for various purposes. But in the lowlands its cultivation continues to be constrained by diseases, pests and poor fruit-set under rainy and high temperature conditions.

33. Throughout the tropics the young fruits of three main families of plants are eaten as vegetables. These are the Solanaceae (tomato has already been mentioned, eggplants, chillies), Cucurbitaceae (melons, gourds, squashes) and Leguminosae (peas, chickpeas, cowpeas, French beans). Perennial trees and shrubs also provide a source of vegetable fruits such as the Drumsticks (Moringa oleifera).

34. Two other vegetables that are commonly eaten throughout the tropics are onions and related species, and okra. Onions are eaten in practically every stew. In India, Thailand and Indonesia the production and consumption of onions, shallots and garlic is well known.

c) The Present State of Vegetable Research

35. In all the countries visited, vegetable research up to some years ago received limited and rather scattered attention in comparison to research on the staple cereals and on the major export crops. The relatively low priority in the past accorded to vegetable research is understandable, since most of the countries were faced with the large problem of finding enough basic food for their rapidly growing population and enough foreign exchange needed to import capital goods necessary for both agricultural and industrial development.

36. A growing awareness of the often widespread state of malnutrition and of the essential contribution of vegetables to a balanced and healthy diet, and an increasing interest in growing vegetables for export, have led the governments of the countries visited to pay, in recent times, more attention to the development of vegetable production and, as one of the prerequisites to this, to vegetable research.

37. This is shown, inter alia, by the following:

(a) In Senegal, the Government has established in 1973 a Centre for Horticultural Development, with research as one of its main activities. This Centre will primarily cater for the very large group of market gardeners, operating in the coastal zone and supplying the towns with fresh vegetables. They also produce some vegetables for export. The Government, through the Senegalese Institute for Agricultural Research, also initiated in 1974 some vegetable research in the irrigation projects along the Senegal river, and in a farm family settlement study in the Centre for Agricultural Research in Bambey. There are plans to coordinate these present rather diffuse research efforts.

(b) In Nigeria, the Government last year created the National Horticultural Research and Demonstration Centre, located in Ibadan (high rainfall area), with proposals for centres in areas with different ecological conditions. The Centre has already helped in stimulating the cooperation between the scattered individuals and institutes which hitherto did some vegetable research.

(c) In India, with already a rather longer tradition of vegetable research, but then rather dispersed over many institutions, a National Horticultural (including vegetable) Research Institute was established in Bangalore in 1968. It also started, in 1970, the All India Coordinated Vegetable Improvement Project. This project identifies research problems and their order of priority, and then delegates selected problems to participating institutions. The programme works on a large number of vegetable crops.

(d) In Thailand, where scattered vegetable research was done mainly by some staff members at the Katsetsart University in Bangkok*, a Vegetable Research Centre has been created this year. It is made up of research workers belonging to the Faculties of Agriculture, Arts and Science, and Economics and Business Administration. The Centre's programme for the first three years is focussed on the different aspects (e.g. agronomic, breeding, economic and storage) of tomatoes, cabbages, peppers and peas. The Centre's activities are at present still in an informal way coordinated with those of the two other Thai Universities and the Horticultural Division of the Ministry of Agriculture in the National Vegetable Research Group.

(e) In Indonesia, most of the research work on vegetables is done by the Horticultural Research Institute of the Ministry of Agriculture. The Government has attracted assistance from both the Netherlands' Government and the World Bank to considerably strengthen the research programme. Almost all efforts are directed toward highland vegetables (potatoes, white and Chinese cabbage, French beans, garlic and tomatoes).

38. Despite the progress in relation to vegetable research, illustrated by the above examples, much remains still to be done before the countries will have a research apparatus which can handle all the crops and their problems; most institutions are still small and many of their staff members still young and inexperienced.

39. The mission noted that the "native" vegetables received comparatively little attention (Table1,p.9). This is understandable from the economic point of view (many of these vegetables are not commercially grown but rather raised as a sideline on a home garden scale or collected from wild or semi-wild sources). From the point of view of nutrition and welfare for the rural masses, greater attention to this group of "neglected" crops seems to be justified.

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* Other Faculties of Agriculture are in the Universities of Khon-Kaen (Northeast Region) and Chiengmai (North Region).

Table 1. Analysis of research topics of 5 national vegetable research programmes (for explanation, see below)

	breeding*					Agronomy					Weed cont.					Pl. Prot.					Score
	S	N	I	T	RI	S	N	I	T	RI	S	N	I	T	RI	S	N	I	T	RI	
Tomato	X	X	X	X	X	0	X	X	X	X		X				X	X	X	X	X	15
Eggplants	X	X	X	0	0	0	X	X	0	0		0				X	X	X	0	0	8
Capsicum	X	X	X	X	X	X	X	X	X	X						X	X	X	X	X	15
Cauliflower	X	0	X	0	0	X	0	X	0	0						X	0	0	0	0	5
Cabbage	X	0	X	X	X	X	0	X	X	X						X	0	X	X	X	12
Chinese cabbage	0	0	0	0	X	0	0	0	0	X						0	0	0	0	X	3
Radish	0	0	X	0	0	0	0	0	0	0						0	0	0	0	0	1
Cucumber	0	0	0	0	X	0	0	0	0	0						0	0	0	0	X	1
Muskmelon	X	0	X	0	0	X	0	0	0	0						X	0	X	0	0	5
Watermelon	0	0	X	0	0	0	0	0	0	0						0	0	X	0	0	2
Pumpkins**	0	0	X	0	0	0	0	0	0	0						0	0	X	0	0	2
Courgette	0	0	0	0	0	0	0	0	0	0						X	0	0	0	0	1
Onions	X	0	X	0	0	X	0	X	0	0			X			0	0	0	0	0	6
Shallots	0	0	0	0	X	0	0	0	0	X						0	0	0	0	X	3
Garlic	0	0	0	0	X	0	0	0	0	X						0	0	0	0	X	3
Maize	0	0	0	0	X	0	0	0	0	0						0	0	0	0	0	1
Peas	0	0	X	X	0	0	0	0	X	0			X			0	0	X	X	0	6
French beans	X	0	0	0	X	X	0	0	0	X			0			X	0	0	0	X	6
Cowpeas	0	X	0	0	X	0	X	0	0	0		X	0			0	X	0	0	0	5
Wingbeans	0	X	0	0	0	0	X	0	0	0			0			0	0	0	0	0	2
Broad bean	0	0	0	0	X	0	0	0	0	0			0			0	0	0	0	0	1
Lettuce	X	0	0	0	X	X	0	0	0	0						0	0	0	0	0	3
Okra	0	X	X	0	0	0	X	X	0	0			X			0	X	X	0	0	7
Roselle	0	0	0	0	0	0	0	0	0	0						0	0	0	0	0	0
Carrot	0	0	0	0	0	0	0	0	0	0						0	0	0	0	0	0
Irish potato	X	0	0	0	X	X	0	0	0	X						X	0	0	0	X	6
Asparagus	X	0	0	0	0	X	0	0	0	0						0	0	0	0	0	2
Nat. leafy vegs	0	X	0	0	0	0	X	0	0	0		X				0	X	0	0	0	4

* Hybridizations, selection, variety trials
** Including various gourds and squashes

S = programme 1975-76 of the Hort.Dev.Centre, Cambarène, Sénégal
N = " " of Nat.Veg.Centres in Ibadan and Samaru, Nigeria
I = from progress report 1972-4, All India Vegetable Improvement Project, India
T = programme of the Vegetable Res.Centre, Katsetsart University, Thailand
RI = programme of the Hort.Research Institute, Republic of Indonesia

40. It should be pointed out that several species of wild, often protected trees, are valuable sources of vegetables either in their leaves and young shoots or in their flowers, pods and seeds. These species have been mentioned in III-b. Since, with the accelerated growth of the rural population and the intensive search for firewood the numbers of "wild" trees tend to be reduced considerably, it is important that more research be done on their productivity, and methods of management, under cultivation. This is obviously a long-term programme. Systematic planting will only yield results after several years. Therefore it is important to start now with the collection and planting of "wild" material. The mission noted this as a gap in research which it wishes to draw to the attention of the TAC.

d) The Economic and Nutritional Contribution of Vegetables

1) The economic contribution

41. Most of the comments in this section are based on data and information obtained from personal discussions with authorities concerned in all countries visited. This is because ofthe scarcity of economic data of vegetables in itself and also because the mission did not have much opportunity to locate such data. We, however, believe that the economic contribution of vegetables in the tropics is more than adequate to justify more international attention to its problems.

42. The economic impact of vegetables will be discussed in this section in terms of a) high priority crops, b) importance of native leafy green vegetables, c) generating employment, d) greater profitability, e) rising demand for vegetables, and f) export commodity.

High priority crop

43. The conventional vegetables, namely European-type vegetables, have drawn wide attention from both researchers and policy-makers of all countries. Those government authorities expressed their awareness of the importance of these vegetables, and also the interests and efforts they have put on the development of research programmes for them. Policy-makers in Senegal, India and Indonesia, for example, have included national research programmes on mostly European vegetables in their economic development plans. In short, there are indications from several sources that vegetables, especially the commercial ones, have been regarded as requiring research support.

Importance of native vegetables

44. There has been a consensus in all the countries visited that leafy green native vegetables, which are inexpensive and rich in vitamins, have been widely consumed by the majority of rural people. In some countries, they were even available for sale in the local markets for urban consumers. This group of vegetables is therefore considered as one of the important food items of the majority of people both at the present time and in the future.

Generating employment

45. In most cases, the vegetable growing is labour intensive. It needs special care and attention for some vegetables. This, coupled with growing two to four crops of vegetables per year,results in significantly increased labour demand from the rural area. Apart from this, vegetable marketing systems involvedmany intermediaries which creates employment in the urban area. The employment resulting from vegetable production and marketing will continue to grow in line with the expansion of this industry.

Greater profitability

46. The mission was told in all the countries visited that vegetable farmers earned higher incomes than most of the other types of farmer due to their intensive land use and their risk reduction through crop diversification. This partly explains why other types of

farmers become vegetable growers. Supanee found out about previous occupations of Bangwack vegetable growers in Thailand and 65 percent had been rice farmers, 26 percent orchard farmers, 5 percent upland crop growers, and only 4 percent had no previous farming experience of any type. It was also found that over a six-year period the vegetable farmers earned 4.75 times more income than that derived from their previous farming enterprises. This indicates that high income from vegetable farming contributes to the well-being of those who are involved in the vegetable industry in particular, and to the progress of the community as a whole.

Rising demand for vegetables

47. Apart from the fact that the demand for vegetables will increase in line with population growth, and the increase of real disposable income, there has been a strong belief in all countries visited that the government effort to solve malnutrition problems of the people will result in a sizeable increase in total demand for vegetables. It is noteworthy that in FAO's Indicative World Plan projected growth of demand for vegetables is considerably higher than that for the so-called food staples, averaging 4.0 per cent.

Export commodity

48. In some countries where certain conditions are in favour of the production of particular vegetables at very low costs, a vegetable export industry can be developed. Among the countries visited, Senegal and Indonesia had been engaged in vegetable export for about ten years. Table 2 provides an indication of the continuing progress of vegetable exports for both countries.

Table 2. Vegetable exports, Senegal and Indonesia, 1969-73

Country	1969	1970	1971	1972	1973
Senegal* (ton)	1,365.3	1,093.7	1,659.7	3,402.8	5,520.0
Indonesia** (US$)	238,954	752,790	1,264,593	1,200,139	1,895,250

Source: * Centre for Horticulture Development, Senegal.
** Central Bureau of Statistics, Jakarta, Indonesia.

2) The nutritional contribution

49. Vegetables are recognized as an important source of vitamins and minerals in diets throughout the world. We talked with at least one and sometimes several nutritionists in every country visited and they all expressed the opinion that vegetable consumption is far too low in the tropics. In terms of specific nutrients likely to be deficient, we were informed that the greatest needs among the vitamins and minerals are for vitamin A and for iron. Vitamin C is supplied by both fruits and vegetables and was only once reported as being deficient in certain seasons of the year. Vegetables contribute important amounts of B vitamins in diets that are low in animal products, but again deficiencies in this group are seldom mentioned. Therefore it appears that in the tropics emphasis should be placed on vegetables which supply vitamin A and iron. Massive annual doses of vitamin A are relatively inexpensive but all nutritionists we consulted prefer that in the long run this vitamin be obtained from vegetables because they supply other nutrients at the same time, including some whose requirements are not established and probably some that are still not identified.

50. Carrots are an excellent source of vitamin A in temperate regions, the darker orange varieties supplying as much as several thousand micrograms of carotene per 100 grams fresh weight. The carotene is converted to vitamin A in the body. In the lowland tropics,

where carrots do not grow so well, leafy green vegetables with comparable amounts of carotene can be grown abundantly. Tomatoes and green pods of legumes have several hundred micrograms of carotene per 100 grams fresh weight and are a good source of vitamin A because of the volume consumed when they are available. Sweet potatoes and the fruits of several cucurbits can be very high in carotene if varieties with dark orange flesh are used, but unfortunately many varieties used in the tropics have white or pale yellow flesh and do not supply much carotene.

51. Leafy vegetables as a group stand out above all other plant sources of food as having a high content of iron. However the iron contribution of foods is difficult to evaluate because there are differences in availability of the iron related to the presence of oxalates and phytins in the food and also to the iron status of the individual consuming it. An iron-deficient individual absorbs more iron from the same food than does one who is iron-sufficient. Until more is known about this matter, all we can say is that certain vegetables do contain good amounts of iron.

52. The next priority seems to be for more protein and calories. Vegetables are not usually regarded as being high in protein, partly because tables of composition report protein in vegetables on a fresh weight basis and of cereals and pulses on a dry weight basis which we believe to be misleading. With protein percentage made comparable on a dry weight basis, many vegetables are as high as legume seeds. Taking examples from the handbook "Nutritive Values of Indian Foods", andconverting protein percentages to a dry weight basis, ten species of amaranth range from 17 to 30 percent protein per 100 grams with an average of 25 percent. For all 18 species of pulses and legumes listed, protein ranges from 19 to 46 percent with an average of 27 percent. Mustard leaves at 39 percent and radish leaves at 41 percent protein exceed all the pulses and legumes except soy beans. Table 3 -P.13. data from the Philippines)bears on the same point by comparing boiled vegetables with boiled rice and pulses. It shows a number of vegetables with protein percentages close to the grain legumes and far ahead of rice.

53. Along with the percentage of protein in various crops it is equally important to consider the yield of protein per unit of time since this affects availability and cost. Kilograms of protein per hectare per day gives a basis for comparing crops with different durations of growth, which vary widely among vegetables from as little as three weeks to several months. Table 4 provides a standard for comparison, showing that among 14 crops listed the highest rate of protein production is by soy beans. For high state average yields in the U.S., protein is produced at the rate of 6.0 kg/ha/day. For record yields the rate is 20.4 kg/ha/day.

54. Wilson at IITA in Ibadan told us that in an experiment with an improved variety of Celosia, a member of the amaranth family, he obtained average fresh yields of 70 tons per hectare, which he considered to be 80 percent edible, in four harvests which ended 119 days after planting. Assuming 2 percent protein as given in the Indian Handbook, this amounts to 70,000 kg x .80 x .02 ÷ 119 = 9.4 kg. protein/ha/day which is in the range of soy beans. Deutsch in recent experiments in Taiwan reports protein yields as high as 10 kg/ha/day for amaranthus harvested 30 days after planting and up to 6 kg/ha/day 24 days after planting. Munger and Villareal in the Philippines found that mung beans harvested 6 times as edible pods gave 9.5 kg protein/ha/day in 67 days from planting. In the same experiment soy beans which matured in 80 days with a yield of 2.3 tons/ha produced 9.3 kg. protein/ha/day(Table 6 on P.15). In short, there are indications from several different experiments that some vegetables produce daily yields of protein as high as those of soy beans (Table 5 on P.14)

55. High yields of protein produced by vegetables can be accompanied by high yields of calories (usually expressed as dry matter, which is closely correlated with calories). The dry matter of the green mung bean pods whose protein yields are given above is compared with high yields of rice and sugar from cane under similar conditions in Table 7 on P.16. When reduced to edible dry matter per hectare per day, the three yields are very close, but it can be noted that the 40 kg. produced by the mung beans had nearly 25 percent protein while the 35 kg. produced by rice had about 10 percent protein, and the 35 kg. of sugar had none.

Table 3. Some cooked vegetables with higher protein percentages than cooked rice (2.2%)

Soybean, boiled (*Glycine max*)	12.8
Mung bean, boiled (*Phaseolus aureus*)	11.0
Pigeon pea, boiled (*Cajanus cajan*)	9.4
Chickpea, boiled (*Cicer arietinum*)	9.3
Papaya leaves (*Carica papaya*)	8.0
Bago leaves (*Gnetum gnemon*)	7.4
Lima beans, boiled (*Phaseolus lunatus*)	7.4
Cassava leaves, (*Manihot esculenta*)	7.2
Beans, boiled (*P. vulgaris*)	7.2
Garlic (*Allium sativum*)	7.0
Malunggay leaves, boiled (Horseradish tree) (*Moringa oleifera*)	6.5
Cashew nut, young leaves (*Anacardium occidentale*)	5.2
Ampalaya leaves, (*Momordica charantia*	5.0
Patola (Sponge gourd) tops (*Luffa cylindrica*)	4.6
Kulitis, boiled (Spineless amaranth) (*Amaranthus gracilis*)	4.4
Broccoli (*Brassica oleracea* var. italica)	3.5
Kangkong, boiled (Water Convolvulus) (*Ipomoea aquatica*)	3.4
Gabi leaves, boiled (Taro) (*Colocasia esculenta*)	3.3
New Zealand Spinach, boiled (*Tetragonia expansa*)	3.3
Cowpeas, edible pods, boiled (*Vigna sinensis*)	3.0
Sitao, edible pods, boiled, (*Vigna sinensis* var. sesquipedalis)	2.9
Winged beans, edible pods boiled, (*Psophocarpus tetragonolobus*)	2.9
Sweet pea, edible pods, boiled (*Pisum sativum*)	2.7
Sweet potato, boiled, (*Ipomoea batatas*)	2.6
Gabi (Taro) (*Colocasia esculenta*)	2.4

Except for broccoli, values are from Food Composition Table, Food and Nutrition Research Center. Handbook I. 4th Revision. Manila, 1968. A number of the values for boiled vegetables are for a single analysis but are not greatly different from those for the fresh vegetables based on more analyses.

Table 4. Production of protein per hectare per day in the U.S; based on FEDS Report 2.

Crop	High state average yields x % protein	Record yields x % protein
Soy bean	6.0 kg/ha	20.4 kg/ha
Beans	4.7	10.0
Peas	4.0	5.9
White potatoes	3.7	7.9
Corn	3.0	9.7
Sorghum	2.9	9.3
Peanuts	2.9	8.4
Spring wheat	2.4	10.3
Rice	2.2	3.0
Barley,	1.7	4.6
Oats	1.6	4.8
Sweet potatoes	1.1	3.9
Winter wheat	0.8	4.3
Rye	0.7	1.7

56. The Celosia experiment at Ibadan produced about 56 kg/ha/day edible dry matter if one applies the 12 percent value for dry matter from the Indian Handbook, and Deutsch obtained some yields of 48 kg/day from amaranthus in Taiwan. Schuphan working in Germany under very different conditions and with different crops has also shown (Table 8) that a vegetable or successive crops of vegetables can produce in a year more protein and calories than cereals while giving high yields of vitamins as well. The foregoing facts do not imply that vegetables should be proposed as the main source of calories and proteins; the concentration is too low to permit eating enough to meet daily requirements, and furthermore some of the most productive vegetables cannot be stored very long. However one can say that enough vegetables, judiciously chosen, can be grown to meet requirements for vitamins without sacrificing the calories and protein that could have been produced by planting staple crops on the same land instead.

Table 5. Rates of protein and dry matter produced by certain vegetables in comparison with soy beans

	Protein Kg/Ha/day	Edible Dry Matter Kg/Ha/day
Soybeans - high state yields in U.S.	6.0	—
Soybeans - experiment in Philippines	9.3	26
Celosia - experiment in Nigeria	9.4	56
Amaranthus - experiment in Taiwan	10.0	48
Mungbean pods - experiment in Philippines	9.5	40

Table 6. Yield and composition of legumes and seed potatoes grown at College, Laguna, Philippines during May/July 1969

Planted April 29 in rows 75 cm. apart and 4 meters long, 3 rows per plot, 4 replicates. Center row of each plot harvested in 3 segments, 1 meter at each of 3 maturity stages. Harvest mostly in rainy season. Phaseolus vulgaris (Contender and Sanilac) produced zero yields in this experiment. Lima bean (Habas) produced abundant pods but all rotted. Cowpeas were unharvestable as small plots because of excessive vines.

CROP	Stage of maturity at harvest	Days to last harvest	Fresh Wt.-Tons per ha.	Dry Matter			Protein (N x 6.25)		
				Ave. %	Tons per ha.	Kg./ha/ day	Ave. %	Kg./ ha.	Kg./ha/ day
Soybean 'Hsih-Hsih'	Edible pod	84	7.16	24.9	1.78	21.2	4.9	358	4.3
	Green shell	61	2.98	32.3	.94	16.4	11.0	326	5.6
	Dry	84	2.32	92.8	2.16	25.7	33.7	784	9.3
Mung Bean 'BPI MG50 -10A'	Edible pod	67	15.36	18.3	2.68	40.0	4.1	632	9.5
	Green shell	48	2.42	37.7	.91	19.1	10.6	257	5.3
	Dry	56	1.18	93.5	1.10	19.7	23.0	272	4.9
Bush Sitao 'Los Banos #1'	Edible pod	77	12.05	13.1	1.64	21.3	3.3	395	5.1
	Green Shell	56	2.16	37.0	.80	14.3	10.0	216	3.9
	Dry	56	1.05	91.9	.97	17.3	22.7	239	4.3

Table 7. Yields of edible dry matter and protein for three crops in the Philippines

	Days to harvest	Tons per hectare	Edible dry matter Kg./ha.	Edible dry matter Kg./ha/day	Protein Kg./ha.	Protein Kg./ha/day
Sugar Cane[1/]	365	12.65	12,650	34.7	0	0
Rice[2/]	105	5.75	3,622	34.5	332	3.26
Mungbean[3/] edible pods	67	15.36	2,680	40.0	632	9.50

1/ According to Dr. C. Jesena, UP College of Agriculture, 200 piculs of sugar per hectare is a high yield for irrigated sugar cane but one obtained occasionally under commerical conditions.
200 x 63.25 kg./picul = 12,650 kg./ha.

2/ According to Dr. D. S. Athwal, IRRI, an early May planting of IR8 rice on good land at College Laguna should produce 5 1/2 - 6 tons/ha. of rice of which 70% would be edible after milling.
5750 kg. x .7 x .9 dry matter = 3622 kg./ha.

3/ Yield from experiment in Vegetable Crops Section, UPCA, May-July 1969. Pods with seeds starting to develope were picked 6 times. 67 days from planting to last harvest.

Table 8. The production of protein, calories and vitamin C by various animal and plant sources

Source	Protein kg./ha./yr.	Calories mill./ha./yr.	Vitamin C kg./ha./yr.
Pigs	48	1.6	--
Dairy cows	107	2.2	--
Maize (corn)	301	11.6	0.06
Winter wheat	329	10.8	0.06
Sugar beet	132	24.1	--
Green kale	600	10.0	25.25
Early carrot/green kale	752	18.4	25.34
Early potato/green kale	720	24.6	26.53
Spinach/early kohlrabi/ lettuce/spinach	1251	22.8	45.09
Lettuce, early kohlrabi, tomatoes	612	32.9	28.25

From Schuphan: Nutritional Values in Crop and Plants. 1965.

e) Crop Species and Problems Needing Additional Research

1) Tomatoes and related solanaceous crops

57. We recommend that tomatoes be given high priority in internationally supported vegetable research because in nearly every tropical country we have visited as a group and individually, this is the vegetable most commonly mentioned as needing research to improve the quantity, quality and seasonal availability. From a nutritional standpoint, tomatoes are an important source of vitamins A and C (the former being frequently deficient in the tropics) but they may be even more important in improving the palatability and thereby increasing the intake of nutrients from other foods with which they are cooked. With the possible exception of onions, it would be hard to name another food plant which is so universally liked by people in all cultures and climates. In the tropics the tomatoes in markets are usually pitifully small in quantity and high in price as well as poor in shape and color. Conditions are favorable for tomato production only during a limited part of the year with the result that there may be over-production for a short time and few or no tomatoes the rest of the year.

58. Tomatoes are grown in home gardens, in small-scale commercial plantings for local markets, on a larger scale for shipment to more distant urban markets, and in several tropical countries they are the first vegetable considered for canning for the local and export market. Most improvements made through research would be applicable to all these uses without great modification, and similar problems are found throughout the tropics. Four main problems are failure to set fruit at high temperatures, bacterial wilt, nematodes and another virus disease which is called by various names but which is insect rather than mechanically transmitted. Breeding is probably the best solution to all these problems and some useful germ plasm is known for each one. However, these are difficult characteristics with which to work, and no single national programme had had the resources to combine them in one variety along with the many other characteristics that are needed.

59. More is known about the genetics of tomatoes than of any other vegetable, large collections of germ plasm are available, and horticulturally desirable varieties with multiple disease resistance bred in temperate regions could be adapted to the tropics by adding the required heat tolerance and additional disease resistance. These resources remain largely unexploited in the tropics, but their availability means that rapid progress should be possible if concentrated effort is applied.

60. Aside from improving the quantity of tomatoes, two quality improvements would be especially valuable in the tropics. A single gene that can be added easily to any variety of tomato increases its vitamin A value 10-fold at the expense of red pigment, giving a tomato of orange-red colour. This may have potential for correcting the prevalent vitamin A deficiency. Both appearance and palatability could also be improved by breeding varieties resistant to "hard-wall" or "blotchy ripening" which commonly leaves part of the outer wall hard and green when the rest of the tomato is ripe.

61. A complete revolution in tomato production in developed countries was triggered by improved varieties followed by appropriate changes in cultural practices. With this experience as a basis, similar progress in a shorter time should be possible if concerted effort is made in the tropics.

62. Eggplant or brinjal (Solanum melongena) and peppers or chillies (Capsicum sp.) belong to the same family as tomatoes and have some problems in common with them. Eggplant is subject to bacterial wilt and peppers to some of the same virus diseases. Both of these species seem better adapted to the tropics and less work on them is required than on tomatoes even though they are presently grown on much larger areas in some of the countries visited. Because of the efficiency related to working on the same disease with more than one crop, and because of the great importance of these two crops, we suggest that consideration be given to a limited amount of work on these species related to the tomato.

Table 9 : Composition of Some Species of Amaranthus (from Nutritive value of India Foods)

	% H20	% Prot.	Protein/ 100g dry	Ca mg/100g	Fe	Carotene mg/100g	Vit C mg/100g
A. spinosus	85.0	3.0	20	300	23	3564	33
A. gangeticus	85.7	4.0	28	397	25	5520	99
A. tristis	87.0	2.8	22	364	38	—	—
A. sp.	80.6	4.5	23	321	18	—	—
A. sp.	88.0	2.8	23	292	2	—	—
A. viridis	81.8	5.2	29	330	19	—	178
A. caudatus	90.0	3.0	30	200	—	—	—
A. paniculatus	86.6	5.9	28	530	18	14,190	81
Celosia argentia	88.0	2.0	17	323	—	—	—
A. polygonoides	90.0	2.8	28	251	27	—	—

2) Leafy Green Vegetables

63. The case for giving research priority to the leafy green vegetables has been largely presented in the section on the nutritional contribution of vegetables. The leafy greens may well represent the greatest unexploited food resource of the world and as such would deserve first priority for research were it not for the universal demand for more and better tomatoes. There are so many species of tropical leafy green vegetables and so little is known about the potential of most of them that we recommend considerable exploratory research to determine what species should receive attention in depth. Initially, however, there is justification for some concentration on the amaranths (i.e., celosia and various species of genus Amaranthus). They were cited as important in every country visited especially for poor and rural people. Their protein percentage on a dry matter basis equals the grain legumes and is reported to be high in sulfur-containing amino acids. Feeding experiments in India showed that adding amaranthus to a cereal and pulse diet improved the protein quality almost to the level of milk. Table 9 shows that they have a high content of vitamins and minerals. They have the more efficient P4 type of photosynthesis, a rarity among dicotyledonous plants. Great genetic variability is apparently present in the genus judging from the range of values in Table 6 as well as from observations. High content of oxalates is sometimes regarded as an objection and could probably be reduced by breeding. They have relatively few disease and insect problems, grow readily in semi-wild or under rainy conditions, and are especially valuable in hot weather when many other species cannot be grown.

64. Ipomoea aquatica (known as kangkong, water convolvulus, or swamp cabbage), also seems deserving of some initial attention. It is widely used in Asia and in certain areas is considered more desirable than the amaranths. It grows well in marshes, ditches or other places too wet for amaranthus or most other vegetables, to some extent utilizing land that would otherwise be wasted.

65. The leaves of certain trees are commonly eaten in the tropics and are unusually high in protein. The drumstick tree (Moringa oleifera) has leaves with 6.7 percent protein (28 percent of dry weight), papaya leaves have about 8 percent, and tamarind about 6 percent. These have advantages in greater availability in the dry season than annual plants, in utilizing land where cultivating a crop is difficult, and of being less subject to loss from domestic animals, a serious problem in many home gardens. No information has been found on the level of nutrient production by such species or about the genetic variability present in them. A modest amount of exploratory work might give a large return in a short time.

3) Leguminous Vegetables

66. Although there has been a gratifying increase in research on the grain legumes or pulses in recent years, the parts of these plants used as vegetables are still receiving relatively little attention. The green pods and immature seeds are popular throughout the tropics. They share some of the nutritional advantages of the leafy green vegetables but are easier to market because they deteriorate more slowly. In addition some legume leaves are eaten and have a high food value. The plants also can fix nitrogen. As compared to dry seeds of the same species, the vegetable parts have more vitamins, require less cooking and have shorter duration of growth to first harvest. This last feature makes them especially useful in fitting into a cropping systems pattern.

67. Some of the leguminous vegetables give their maximum yield when harvested several times as successive flushes of pods reach suitable size while others do not as shown in Table 3. More research is needed to determine when to pick the more important legumes to get maximum nutrient production. It is clear that the varieties bred for dry seed production will frequently not be the best for vegetable use so that breeding for vegetable use will be needed.

68. We suggest that initial research in this group should be concentrated on the Vigna species - cowpea, yardlong bean, and mung bean - because of their known adaptability to high temperatures and their widespread use in the tropics. Exploratory work is suggested

for lima beans, winged beans and Dolichos beans (now known as Lablab niger). Some of these legumes are under study as dry seeds at existing International Centres. Full advantage should be taken of their germ plasm collections and knowledge already obtained, and future work should be closely coordinated with them.

4) Other Crops needing Additional Research Effort

There are a number of other vegetables deserving additional research effort, but we feel that more study is needed to establish priorities beyond the three already discussed. We suggest that consideration be given to three additional crops or groups of crops which we discuss briefly here without attaching priorities.

(a) Onions, garlic and related species. The amounts used and the composition of these vegetables is such that they probably do not in themselves contribute many nutrients. Nevertheless they are used everywhere in cookery and make their contribution to the diet by increasing the palatability of the foods with which they are combined. When they are scarce, onions become front-page news as we saw in India. One of the main problems is storability to have a steady supply throughout the year. Because they are sensitive to photoperiod, storage types from temperate zones cannot be used and most tropical varieties do not keep well. Germ plasm almost certainly exists that could be used for rapid improvement, little having been done so far.

Chinese chives (Allium tuberosum) are grown throughout the year on a very large scale in China but we saw few of them in the countries visited. They are probably more nutritious than onions since the green parts are eaten, and they may deserve some study and promotion.

(b) Cucurbits. A wide range of cucurbits is grown in every country visited and some are extremely popular. Unfortunately many of them such as cucumber, immature squashes or vegetable marrow (Cucurbita pepo), chayote (Sechium edule), and most of the edible gourds of the genera Benincasa, Momordica, Lagenaria, Luffa, and Trichosanthes have little food value - less than 1 percent protein and low vitamin content. The winter squashes (Cucurbita moschta and C.maxima) have varieties with much more dry matter and carotene and the same is true for melons (Cucumis melo). Perhaps similar improvement could be made in the other genera, but in any event, work should be concentrated on species which produce carotene.

These crops are relatively resistant to drought and some of them have fruits which can be stored for several months to provide food in a dry part of the year. In addition, the vine tips are eaten to some extent and are more nutritious than the fruit in most cases.

Because of their present importance, large potential for improvement, and availability in dry seasons, this group deserves consideration for additional research.

(c) Cabbage. This is a crop which is notably adapted to cool growing conditions. Its desirability as a vegetable is indicated by continued attempts to grow it in the tropics, which have recently been rewarded by remarkable improvements in adaptability. Certain hybrid varieties from Japan and perhaps some from Denmark also can even be grown well in the lowland tropics. This might suggest that further research is not needed, but the hybrid nature of the seed presents a problem. New seed must be imported for each crop at a considerable cost in foreign exchange, and this seed is often not readily available to small farmers. It would certainly be possible to develop open-pollinated varieties with heat tolerance and for which seed can be produced within a country.

Furthermore, insect control on cabbage is extremely difficult in the tropics. Resistance to certain insects has been found recently and may be especially valuable in the tropics.

Cabbage produces large amounts of vitamins A and C as well as respectable amounts of protein.

f) The Need for Additional Internationally Supported Research

70. As indicated in Chapter III c, rather limited efforts have until recently been devoted to vegetable research in all the countries visited, except perhaps India. Past efforts have also suffered from a lack of continuity, in common with agricultural research in general. An important reason underlying this appears to be insufficient remuneration of research workers leading to a high turnover of professional staff, so that research programmes have not produced the results anticipated. This in turn has made governments wary of investing more money in research.

71. Of the limited effort which has been devoted to vegetable research a high proportion has been directed to the improvement of temperate type vegetables. Very little attention has been paid to native vegetables even though they are widely consumed and nutritionists have recognized their important contribution to the diet. Reasons for this neglect of native vegetables are probably (a) their relatively low economic value at present because they are not widely marketed, and in some cases difficult to market, and (b) the fact that as a group they are made up of a large number of species, each of which is grown on a relatively small area if considered on a country by country basis.

72. The mission recognizes the important contribution which AVRDC has been making to the improvement of vegetable production in developing countries, but even in its programme, the native vegetables have largely been omitted. Moreover, it is not located in the true tropics and the doubts concerning its future as an international research and training centre for vegetables, are well-known to the TAC.

73. The mission therefore sees an urgent need to reinforce vegetable research in the tropics, which it considers to be critically weak at present, and to this end, recommends additional internationally supported research.

74. The main arguments for establishing such a programme, which the mission recommends should involve both the creation of an International Vegetable Research Centre, and the reinforcement of national institutions to participate in a research network (see Chapter III *g*) - are the following:

(i) While on a national basis many individual vegetable species are relatively unimportant in comparison to the staple food crops, and a large research investment on them is therefore not easy to justify, they occupy a much larger area in aggregate on a world-wide basis. International efforts can therefore be defended more easily. This particularly applies to the native vegetables, and international research directed to these species, followed by recommendations about their use made by scientists of authority, would help to raise them from their present status of a Cinderella to the place of importance they deserve.

(ii) The available germ plasm of many vegetable species is scattered over many countries. An international effort to bring together this germ plasm and to evaluate its potentialities by multi-local testing is likely to yield quicker results, in the interest of national research programmes, than if individual nations were to attempt to undertake this work. This is of particular importance in the case of breeding for resistance to insect pests and diseases, so urgently needed in view of the rising costs and ecological disadvantages of relying mainly on chemical pest control.

(iii) An international effort generally commands more continuity and stability. Any interruption in breeding efforts on a national basis can be bridged over by an international centre supplying breeding material.

(iv) International research effort concentrated on selected species of vegetables should help to accelerate the generation of results from research on those species within national programmes. Hopefully this would induce national governments to give further

support to expanded vegetable research activities.

75. The need for an international programme is exemplified by the tomato, which is discussed in more detail in another part of this report. Improving its ability to set fruit under high temperatures and its resistance to bacterial wilt, nematodes, and virus diseases, are all problems which require an adequate scientific effort with strong financial backing. However, the importance of tomatoes in any individual tropical country is unlikely to justify it receiving a high priority in national research whereas the importance of tomatoes in the tropics in general does merit an international research programme.

Similarly the production of leafy vegetables during the dry season in the tropical countries that have a relatively long dry season, or at least the extension for a few weeks of the period of growth of leafy vegetables, is of great importance for all the countries concerned, and justifies an international effort to tackle that rather difficult problem. However, this effort would probably be out of consideration for any single country.

g) The Organizational Form of an International Effort

76. Once the mission was convinced that additional international support to vegetable research was required, a great deal of time and discussion was spent on determining the form that this support should take. The following possibilities were considered:

(a) the strengthening of individual national programmes;
(b) the establishment of a network amongst the existing national programmes;
(c) the use of existing International Centres;
(d) the setting up of a Centre fully dedicated to vegetable research.

77. The inadequacy of most national programmes and their orientation principally to research on the commercial vegetables are a main reason for ruling out alternative (a). It is difficult to visualize how the reinforcement of these programmes could produce the short-term results needed to transform the production of vegetables in the respective countries, and even more difficult to visualize how this could influence other countries' production.

78. In respect of option (b) the mission feels that a cooperative programme amongst existing national institutions would be unlikely to succeed unless a central institution, international in character, is established to give the network the required orientation, to contribute substantially to the knowledge of vegetables indicated as priorities for the cooperative research effort, and to train national research workers to participate in the network. Because of the weakness of existing national programmes, the latter is considered to be particularly crucial.

79. The possibility that research in vegetables considered as deserving high priority could be undertaken by existing International Centres was also eliminated. Theoretically, such an arrangement could be more economical but each of the International Centres has a well-defined mandate to which it is already heavily committed. In the light of the financial and administrative constraints on continuing programme expansion it seems unlikely that they would be interested in taking on new responsibilities, or if they were to agree to do so, there would be a risk that those responsibilities would be given only second degree attention. Alternatively their on-going research activities could be jeopardized.

80. The mission therefore considers that only the formation of a new International Centre specifically established to resolve the problems of vegetable production in the tropics will be an adequate response to the needs foreseen, if solutions are to be found in the relatively short-term able to make an important impact on the production and consumption of vegetables.

81. The mission recommends that the proposed Centre should conduct its activities mainly the tropics of Asia and Africa, but does not exclude that its findings could be applied in other tropical areas of the world.

82. The Centre should give first and major attention to the solution of problems limiting the production of the priority species selected (see the mission's recommendations, paras 14-16), with the objective of producing knowledge and information that will permit national institutions to better appreciate the advantages of those crops and the contribution that they can make to the nutrition of their respective nations, particularly by providing good quality food at prices accessible to the lowest income groups of the population.

83. The development of varieties of high yielding, high nutritive value, resistant to pests and diseases, and to environmental limitations such as drought and excess of moisture, should be an important part of the responsibilities of the new Centre.

84. The various aspects of preservation of vegetable products after harvest and the economics of their production, marketing and consumption should also be considered as essential elements of its programme.

85. A primary responsibility of the Centre must be the training of national personnel to different scientific levels. This should encompass not only the training of vegetable research workers, but also of production specialists able to further train national staffs in managing production, demonstration, and extension campaigns.

86. As soon as the Centre is created, contacts should be established with the national research organizations interested in vegetable crops to create a cooperative programme that will not only permit the formal movement of information and materials, but also provide a basis for efficient testing of the materials produced in many locations at the same time, and to seek the participation of the national institutions in the activities of the network.

87. Through this network it is also visualized that certain of the national programmes will take responsibility for the conduct of those aspects of the research that require environmental conditions, personnel, or facilities different from those of the main Centre.

88. The proposed Centre must also work in close cooperation with the other International Centres, particularly IITA, CIAT and ICRISAT, which have a major responsibility for cowpea, field bean, chick pea and pigeon pea breeding. These Centres should provide information and materials to the Vegetable Centre for testing for the production of green (pod) peas and beans. As the work of the proposed Vegetable Centre progresses and other crops are included in its programme, further associated programmes can be developed. For example, if the Vegetable Centre at a given time undertakes studies of cassava or sweet potatoes as producers of green leafy vegetables, this work should be conducted in association with IITA and CIAT.

89. In respect of the <u>initial</u> programme of the proposed Vegetable Centre the mission considers that the main effort should be concentrated on the three groups of crops mentioned as primary priorities in paras 14-16. However, some exploratory work should also be considered on the other vegetables that are felt to have a promising potential, such as solanaceous fruits (egg-plant, peppers, and other related species). A more general evaluation should also be made of other leafy green vegetables listed elsewhere in this report (see tables 3 and 9 and Country Reports).

90. Bearing in mind the relatively narrow range of priorities recommended and the fact that the Vegetable Centre must work in close cooperation with other International and national Centres, it is suggested that the total staff be around 15 senior scientists with the required assistants and supporting personnel. It is also suggested that the investment in buildings and other facilities be kept at a minimum. For purposes of calculations, it can be estimated that the new institute will not be bigger in staff or facilities than the AVRDC. The mission considers it desirable to locate the Centre near a reasonably large city, both because of the facilities this might provide (see paras 92 and 93) and because it would permit the staff to live in the city and thus eliminate the need to build houses for them.

91. It is considered that the Centre should be located in a hot, lowland tropical area with clear-cut rainy and dry seasons. The reason for this is that the tropical belt is the area that the Centre will be expected to serve. A location with a clear-cut dry and wet season would permit the Centre to obtain information not only for the humid zone, but also for the semi-arid and seasonally dry areas of which there are many in the tropics.

92. It is also desirable that the chosen location permit of easy access to areas of high altitude where trials can also be carried out by the Centre staff or associated national stations under more temperate conditions.

93. The mission recommends that the Centre be located in Asia, not only because of the size and density of the population, but also because of the notable tradition of vegetable growing in that continent.

94. The other conditions that are desirable for a location are those that apply to all the International Centres, i.e. that the government of the country concerned is interested in hosting the Centre and is also prepared to facilitate the entry and movement of scientists, students, seeds and propagated materials. A location near a university that will permit an association with a college of agriculture where a cooperative programme of graduate studies might be developed is also desirable.

95. Other requirements are adequate medical facilities, schools and cultural activities, communications and a general environment that will be attractive to scientists from different parts of the world.

h) Supporting Action Required in Infrastructural Fields

96. Despite on-going and planned efforts in all the countries visited, much remains to be done to improve the infrastructure required for the efficient production of agricultural commodities including vegetables. Apart from research, which has been discussed separately, more attention needs to be given to:

(a) roads and/or railways connecting producing and consuming areas (markets for fresh produce and processing factories);
(b) the supply of inputs (fertilizers, pesticides, seeds, etc.);
(c) irrigation and drainage facilities;
(d) storage and marketing facilities;
(e) credit;
(f) the organization of production and marketing;
(g) education and extension activities.

97. The mission felt that many of these requirements need action primarily by national governmental and private institutions. However, an international vegetable research institute could assist them in this task by making available information on, e.g. the irrigation requirements of vegetables; available equipment for drip irrigation; required conditions, methods and equipment for vegetable seed production; storage of vegetables, etc. Of these items, vegetable seed production seems to be the one with which the International Vegetable Centre should be particularly concerned. This is because the Centre's activities in developing new vegetable varieties will remain without practical application if the follow-up of seed multiplication is lacking.

98. Which of the infrastructural components mentioned above will form an essential complement to the research of the proposed International Centre depends upon the prevailing state of vegetable production and marketing in the individual countries. In some, extension may be the bottleneck, in others roads, in others irrigation facilities, etc. No general rule can at present be given. In the opinion of the mission, a survey should be

made to detect, country by country, the main bottlenecks. This should be taken up by the national institutions with the help of the proposed Vegetable Research Centre; perhaps with the cooperation of international organizations, or through bilateral arrangements.

99. In the last decennia, FAO has been very active in assisting national institutions in developing the infrastructure for vegetable production. The proposed new International Centre should therefore seek close cooperation with available FAO expertise, and vice versa.

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A C K N O W L E D G E M E N T S

The mission would like to express its sincere thanks to all the people in the countries visited who gave much of their time in supplying the required information and guiding the mission in its visits to projects.

The assistance of various UNDP and FAO officials in arranging for transport, accommodation and the necessary contacts with national institutions is also gratefully acknowledged.

APPENDIX I

COUNTRY REPORT - SENEGAL

1. Some Background Information

1.1 Geographical position

Senegal is a small (196 722 km^2) country situated on the west coast of Africa between 12°30' and 16°30' latitude north and 11°30' and 17°30' eastern longitude.

Its capital Dakar with an air and seaport is strategically situated between Europe and South America. Dakar is nearer to West Europe than any other port in a wholly tropical country.

1.2 Climate

This is characterized by one long, dry season (7 months in the south to 10 months in the north) and a short rainy season (5 to 2 months). The average yearly precipitation decreases from 1500 mm in the south to 400 mm in the north. Rainfall distribution from year to year and within the season shows wide fluctuations, making rainfed agriculture an uncertain business. Sunshine in the dry season is abundant; even in the rainy season sunny periods are not uncommon. Temperatures are high throughout the year, in particular in the month preceding the onset of the rainy season. During the dry season, there is a strong influx of dry air from the Sahara. Along the coast the heat and dryness are tempered by more moist and cool air coming from the sea.

1.3 Population

About 75 per cent of the population, which is about 4 million, live in rural areas and also derive their living from agriculture. The other 25 per cent live, for the larger part in the towns and are engaged in trade, industry or services.

Three-quarters of the population is concentrated in the western part of Senegal. Here all the cities are situated and also the densely populated rural areas. The eastern part is sparsely populated, except for a small band along the Senegal river.

Half of the population is in the working age group (15- 59years), 40 per cent younger and 10 per cent older than that.

There is a strong tendency towards abandoning the countryside and seeking a livelihood in the urban centres.

Available labour is plentiful but often unskilled.

1.4 Agriculture

Except for relatively small areas where water is available for irrigation in the dry season, agriculture is of the seasonal rainfed type. Predominant upland crops for food are sorghum and pearl millet as subsistence crops and, if surpluses are available, as cash crops, and groundnuts as the main cash crop. Rice is grown mainly as an upland crop or as swamp rice. Other food crops frequently cultivated are maize, cowpea and cassava. Cotton is an important non-food crop.

Apart from soil preparation for which animal traction is used frequently, most agricultural operations are done by hand. Family labour is common. Crops are often grown in mixtures. Soil fertility is poorly maintained by a system of bush fallow alternated

with cropping. The use of fertilizers, however, is becoming increasingly popular.

Mixed farming, i.e. the integration of livestock keeping with crop growing, is not yet practised widely. The cattle population is largely in the hands of pastoral nomads who are not involved in crop growing.

2. Aspects of the Vegetable Business in Senegal

2.1 Consumption and supply of vegetables

2.1.1 General picture

The majority of the people in Senegal are said to have accepted vegetables as an essential part of their diet (which is based upon a cereal - rice, sorghum or pearl millet - as the staple), and they will consume them if they can get them. In the rural areas fresh vegetables are generally available only in the rainy season, when they are grown for home consumption mixed with the main food crops; some are also obtained from the spontaneous vegetation. In the dry season, one has to make use of (a) small quantities of home preserved (mainly dried) vegetables, obtained from the excess production in the rainy season; (b) leaves and other material collected from the wild vegetation, or (c) produce bought.

In the towns fresh vegetables are generally available throughout the year. They mostly come from surrounding rural areas, where they are often produced by specialist, small-scale growers for a large part of the year in places where water is available for irrigation. During the rainy season, a deficiency in production due to incidences of pests and diseases mainly is made up by the importation of vegetables from abroad. Besides fresh vegetables, tomato puree is consumed currently in relatively large quantities.

2.1.2 Consumption figures

The annual per caput consumption of vegetables was estimated in 1972 to amount to: 10-20 kg for the rural people, 50-70 kg for the average urban consumer, 100-230 kg for the rich urban consumers. There is a tendency towards an increasing consumption of "European" vegetables, in particular in the urban areas.

2.1.3 Imports

Senegal imports every year about 24,000 tons of fresh (non-processed) vegetables 90 percent of which consist of only two commodities, i.e. potatoes and onions. Besides these, 7,000 tons of tomato concentrates are imported.

2.1.4 Exports

As from about 1965, Senegal has become an exporter of fresh vegetables to Europe in the winter season. From the 1966-67 season till the 1974-75 season, the quantity exported rose from 538 tons to 6,345 tons.

In the first years, French beans, produced by the small grower under contract with a dozen or so rather small exporters, were the main export item. With BUD-Senegal coming into production in 1972, a more diversified export package developed, including also melons, eggplants, tomatoes, lettuce, peppers, strawberries and others. Because of insufficient marketability some crops were later deleted from the export programme.

2.2 Production aspects

2.2.1 Species produced

Senegal produces a large number of vegetables. See Table (i) on p. iii.

Table (i)

MAIN VEGETABLES GROWN IN SENEGAL

I. Cultivated vegetables:

Allium cepa	Onions
Brassica oleracea	Head cabbage
Brassica olerocea Botrytis	Cauliflower
Capsicum frutescens	Hot pepper
Capsicum annuum	Sweet pepper
Cucumis sativus	Cucumber
Cucumis melo	Melon
Cucurbita pepo	Gourd
Daucus carota	Carrot
Hibiscus esculentus	Okra
Hibiscus sabdariffa	Roselle
Lycopersicum esculentum	Tomato
Phaseolus vulgaris	French bean
Solanum aethiopicum	Native eggplant
Solanum melongena	Eggplant

II. Leaves collected from spontaneous vegetation or from crops grown mainly for other purposes:

Adansonia digitata (tree)	Baobab
Amaranthus hibridus (herb)	Amaranth
Amaranthus lividus (herb)	"
Amaranthus spinosus (herb)	"
Archis hypogea (herb)	Groundnut
Bauhinia reticulata (shrub)	
Cassia tora (herbac. shrub)	
Ceratotheca sesamoides (herb)	
Corchorus olitorius (herb)	Jute
Cratoeva adansonii	
Cucurbita pepo (herb)	Squash
Ficus gnaphalocarpa (tree)	
Gynandropsis pentaphylla (herb)	
Hibiscus sabdarriffa (herb)	Roselle
Ipomea catatas (herb)	Sweet potato
Leptadenia lancifolla	
Manihot utilissima (woody herb)	Cassava
Moringa pterygos-Perma (tree)	Drumstick
Solanum aethiopicum (herb)	Bitter tomato
Talinum triangulare (herb)	
Trianthema portulagastrum (herb)	
Urena lobata (herb)	
Vigna unguiculata (herb)	Cowpea

Source: Toury, J., et all, Aliments de l'Ouest Africain. ORANA, Dakar, ca. 1965.

2.2.2 Types of production

Several types of production can be distinguished:

a) that for home consumption or sale locally side by side with the main food crops in the rainy season*;
b) that on a small scale for sale in the towns. Production in the rainy season and, near places with a high water table permitting hand-watering also in the dry season**;
c) that for export during the European off-season:

(i) on a small scale. Often practised by the same growers as of (b).
(ii) on a large scale. Practised by a large company named BUD-Senegal.

d) that for processing. Mainly practised in an irrigation project along the Senegal river by a group of farmers under contract to a canning factory.

2.2.3 Government support to production

Both direct and indirect support are important. In the period of the 3rd four-year plan (1969-72), the Government has been able to attract assistance from UNDP for the establishment of the Centre for Horticultural Development (CHD), from BUD-Senegal for initiating the large-scale production of vegetables for export, and from SOCAS for the production of concentrates derived from contract-produced tomatoes.

In the current 4th Plan period (1973-77) the above projects are receiving further financial support from the Government.

The small-scale producers will be supported by an agricultural credit scheme, by helping them to form cooperatives, by increased extension work through well-trained horticulturalists, and by a subsidy on water rates. It is hoped that by 1977 these producers are able to cover the total needs of Senegal for fresh vegetables. BUD-Senegal will receive further support to increase exports.

Various projects aiming to produce a total of 1300 ha of industrial tomatoes will also receive support from the Government.

3. Vegetable-Oriented Research in Senegal

(1) Before the CHD was established, some selection work was done on onions, tomatoes, eggplants and some native vegetables at the Centre for Agricultural Research (CRA) in Bambey. The results helped the small-scale producers, mainly.

(2) In preparation for their large-scale production project, BUD-Senegal initiated research on vegetable varieties, irrigation and agronomic practices on their own farm in 1969. This work is being continued. Results are applied on their own farm and are also available, where applicable, to, amongst others, a group of 22 families settled as "supervised outgrowers" nearby.

(3) The Centre for Horticultural Development, a UNDP/FAO Senegal Project became operational in 1972. It caters mainly for the small growers. It consists of four sections, dealing with:

(a) experimentation on varieties and agronomic practices;
(b) study of plant pests and diseases and their control;
(c) extension and economic studies;
(d) marketing studies and assistance.

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* This type is likely to be practised by a very large number of growers. No data are available on the amount of produce grown.

** There are an estimated 5,100 ha in this category. With an average size of the individual garden of 0.4 ha, one arrives at a figure of some 12,750 market gardeners. Since several labourers are employed per garden, the total contribution of this sector to employment is considerable.

CHD cooperates with the well-developed Division of Nematology of ORSTOM in Dakar in the study of nematode pests and their control. The senior professional staff of CHD at present consists of five expatriate FAO experts (one as project leader and the others on, respectively, agronomy, plant pathology, marketing and extension), three associate experts, and five Senegalese experts (counterparts to the FAO staff).

The 1975-76 research programme mentions work on: tomatoes, eggplants, capsicums, cauliflower, cabbage, mush-melons, squashes, onions, French beans, lettuce, Irish potatoes, asparagus, and strawberries; the economics of vegetable growing; the use of small farm implements; collecting species and varieties of "African" vegetables and exploratory observations on their growth, productivity, and diseases and pests. This collecting, etc., will be done in collaboration with the ITA and the Institut Fondamental de l'Afrique Noire (IFAN).

(4) A Chinese technical assistance mission does a small amount of practical research on vegetable growing. Details are not available.

(5) The Institute of Alimentary Technology (ITA) in Dakar has done work on the preservation of vegetables by drying and canning.

(6) The Organization for Research on Foodstuffs and Nutrition in Africa, based in Dakar, does surveys on food consumption and has analysed the nutritional value of a large number of indigenous vegetable sources.

(7) The Agricultural Research Institute in Senegal (ISRA) has stationed two agronomists in the Dagana Basin Project (part of the projects of irrigated agriculture along the Senegal River) to work on varieties and agronomy of vegetables to be grown in the project. Much attention is given to producing tomatoes for canning.

(8) CRA in Bambey experiment on setting up family-size farms using groundwater for irrigation. Vegetables form part of the rotation. Special attention is given to drip irrigation.

4. Needs for an Increase in Vegetable Production

Senegal has to increase vegetable production for the following reasons:
(1) The consumption of vegetables in especially the rural areas is far below the recommended requirements. This may partly be the cause of deficiencies in protein, vitamin A and Fe which are said to be widespread in Senegal especially amongst the vulnerable groups of the population, i.e. the young children and the pregnant and lactating mothers.

(2) The urban population in Senegal is growing fast. The present trend of a growing demand for vegetables by urban dwellers is likely to continue, hence vegetable supplies need to grow considerably.

(3) Senegal imports yearly a large quantity of potatoes, onions and tomato concentrates. In order to save foreign currency the local production* of these commodities needs to be stepped up.

(4) In order to diversify the exports (which now are dominated by groundnuts), Senegal should use the opportunities for exporting fresh vegetables to Europe in the off-season. Both its climate and geographical position are well suited for this purpose.

5. Requirements for Increasing Vegetable Production and Availability

A summary description of the requirements is as follows:

(a) land - Senegal possesses large areas of unutilized land suitable for vegetable growing;

* to be coupled with improved storage for potatoes and onions.

(b) water - there are still large untapped sources of surface water (the rivers Senegal and Casamance) and of underground water;
(c) proper planting material - a number of suitable varieties is already available, but more research is needed to improve them;
(d) proper growing techniques - much remains to be found out about seedling production, field sowing or transplanting techniques, optimal spacing, water and fertilizer requirements, appropriate pest control measures, harvesting techniques etc.;
(e) proper post-harvest handling and storage - hardly any data on this are available;
(f) an infrastructure of roads, irrigation facilities, sales points for inputs, markets and stores;
(g) a sufficient number of people with the right managerial and technical knowledge and skills;
(h) a system to keep these people's knowledge and skill up to date.
(i) sufficient remuneration to attract people to vegetable growing.

6. Ways to increase Vegetable Production and Availability

(1) By the expansion of the acreage. As stated above, Senegal still has large areas which can be used for vegetable production. To satisfy the local demands, these areas must be able to produce crops both in the rainy season and the dry season. To satisfy the demands of the European market, these areas must be able to produce crops especially in the dry season, being the season which coincides with the winter season in Europe.

To realize production in the rainy it is necessary to deal eventually both with excess water (sometimes over only a rather small number of days during the season) and with a water shortage (again sometimes only for limited periods).

To obtain production in the dry season, one has to deal only with a water shortage.

(2) By higher yields per hectare. Yields of vegetables often remain below standard because of pests, diseases, low soil fertility, lack of water, and unskillful handling of the crop. Appropriate measures to take away the limiting factors are necessary.

(3) By reducing post-harvest losses. Losses due to deficiencies in on-the-farm storage, transportation and on-the-market storage, are often very high. (No quantitative data were available).

7. The Need for Vegetable Research

R Repeatedly in many countries research has been found to be essential in providing vegetable growers with good varieties, the right growing techniques, the best post-harvest handling techniques, etc. Research is also needed to guide growers in the economic and social (nutritional) aspects of vegetable production. Finally, research is needed to provide the planners and managers of infra-structural development projects with advice on how best to proceed with these projects.

8. Actual Versus Needed Vegetable Research

The mission considers orientation of present vegetable research in Senegal in general to be adequate. The mission was not in a position to judge whether the distribution of research time and funds over the different crops and problems studied was in accordance with their present importance.

COUNTRY REPORT: NIGERIA

1. Some Background Information

1.1 Geographical position and climate

Nigeria, a large-sized country (912,000 sq. km) in West Africa, extends from 4°25' to almost 14° latitude north and from 2°30' to 14°40' longitude east. Its tropical climate ranges from humid in the southwest to semi-arid in the north.

1.2 Agriculture

The majority of the population is engaged in agriculture, predominantly in the production of basic food crops for home consumption and for the national market: maize, sorghum, millet, rice, cassava, yams and others. The production of food and industrial crops for export is also important: groundnuts, oilpalm products, rubber, cotton, cocoa and others. Agricultural techniques used are mostly rather simple.

Farm holdings generally are small due more to the limitations of hand labour in handling a larger area than to a shortage of land resources. However, in certain areas almost all the available land has been taken into cultivation.

Farm productivity often is low due to low soil fertility, the limited use of manures and fertilizers, low-yielding varieties, the low level of phytosanitary measures, and the absence of mechanization. Drought and excessive rainfall also contribute to low farm productivity.

2. Places visited

In Nigeria the mission visited the following institutes:

a) The Department of Animal Sciences (DAS), University of Ibadan Ibadan ;
b) The Department of Applied Nutrition (DAN), University of Ibadan , Ibadan;
c) The National Fruit and Vegetable Research and Demonstration Centre (NFVRDC), Ibadan;
d) The Institute for Agricultural Research and Training (IART), University of Ife, Ibadan ; and
e) The International Institute for Tropical Agriculture (IITA), Ibadan.

Two members of the mission also visited the Kano River Irrigation Project in Kadawa.

Verbal and written information was received from several members of the institutions mentioned and also from the Institute for Agricultural Research of the Ahmadu Bello University, Samaru.

3. Vegetable Research, Production and Consumption

From the information obtained, the following conclusions could be drawn:

a) very small efforts have been given to research in vegetables on the agricultural aspects or otherwise, although some information has been accumulated particularly on the chemical composition and nutritional properties of vegetables;

b) a great deal of interest has developed in recent years. This is reflected in the creation of the NFVRDC and also in the organization of tomato and other vegetable sections at the IART in Ibadan;

c) in two interdisciplinary groups of the IART, some ten scientists provide a good basis to develop an important programme not only for research but also for teaching. The NFVRDC when fully operating, will have a total of 14 foreign experts and a similar number of Nigerians. In the field of nutrition, the two Departments at the University of Ibadan, mentioned above, can also provide good support for an important programme;

d) it seems that a more adequate mechanism for coordination of the national effort will give Nigeria a splendid basis for the development of required research and teaching to increase the production of vegetables;

e) all the persons consulted agreed that in Nigeria the contribution of vegetables to the diet is extremely important, not only with regard to minerals and vitamins, but also for the amount of protein and carbohydrates they provide;

f) the major interest of growing vegetables in Nigeria is for the consumption of the population, although export is also envisaged;

g) it is obvious that a large diversity of physical environments exists in Nigeria. These differing environments require the cultivation of numerous species of vegetables, and research in all the needed species will be practically impossible to promote immediately. To make a very simple and arbitrary division, it can be said that the northern part of the country, with a long dry season, is best adapted to grow species such as tomatoes and onions under irrigation, not only for local consumption but also for internal trading and for export. In the southern part of the country, where rains provide water for a longer part of the year, the cultivation of leafy and other native vegetables assumes much greater importance. The most common vegetables are several species of amaranthus and okra;

h) the consumption of leaves of cassava and sweet potatoes constitutes an important addition to the diet in the zones where these plants are grown - mainly in the south;

i) the leaves of certain trees that remain green for the largest part of the year are known to be used as vegetables and therefore increase the amount of food available particularly in the more dry areas during the dry season. It is not possible to determine, with the information available, just how important the leaves of these trees can be as part of the diet. However, all the persons consulted, with a knowledge of the subject, agreed that the contribution of the "tree vegetables" is very important and deserves more attention;

j) one of the limitations to research and development in vegetables is the small number of Nigerians with adequate training for these functions. This is not only true for scientists at all levels, but also there is a scarcity of people who are efficient in the art of horticulture;

k) the availability of native vegetables is plentiful during the rainy season. It declines thereafter, and during the extremely dry months virtually no vegetables are available. This indicates the need for research into the preservation of vegetables. Some attempts have been made to preserve the leafy vegetables by desiocation and it seems that adequate techniques can be developed that will be a substantial contribution to the provision of food during the dry season.

4. Details about the Places visited

4.1 Department of Animal Science, University of Ibadan

This Department, basically devoted to problems of animal nutrition, has extended itself to the area of human nutrition. Research analysis of many vegetables has been carried out and evidence found of the important contribution that vegetables can make to the diet, not only in minerals and vitamins, but also in protein and particularly in some of the essential amino-acids.

At least three senior scientists have devoted some time to studies of human nutrition and graduate students are accepted in the Department for MS and PhD degrees in nutrition. A paper recently presented at a national seminar on fruit and vegetables summarizes much of the work done in this field.

4.2 Department of Food Science and Applied Nutrition, University of Ibadan

This Department focusses on nutrition more from the medicinal point of view. It has information on some of the problems of malnutrition present in Nigeria. Cases of deficiency of vitamin A causing blindness have been reported. Professor Omolohi, Head of the Department, considers that in the case of vegetables a certain amount of the production is not consumed by the people because it deteriorates before it reaches the consumers.

Some figures obtained show that in recent years, as a result of the increase in the population, the consumption of rice has increased. However, the total consumption of vegetables remains the same. So, even though the situation changes, more problems due to the lack of vitamins and minerals are to be expected.

4.3 National Fruit and Vegetable Research and Demonstration Centre, Ibadan

This Centre was created in February 1974 with financial support from UNDP and the Federal Government of Nigeria. Staff is being recruited and very soon the construction of additional laboratories and other facilities will start on the land which has already been acquired. The total expenditure in construction, equipment, consultants and training for the first five years will be in the order of US$ 18 million. An additional amount will be provided to cover the cost of national staff and operational costs.

In addition to the headquarters in Ibadan, two sub-stations will be established; one in the north at Tiga, near to the Kano River Irrigation Project, and the other in Mbato Okigwe, in the East Central State in the south.

The professional staff at the Centre will be formed of 14 experts from FAO and several more national scientists and a secretarial group of nationals, some of whom are already working in Ibadan.

4.4 Institute of Agricultural Research and Training, University of IFE, Moor Plantation, Ibadan

This Institute has for some years been active in research and teaching, and has an important group of scientists dedicated to vegetable research: a total of about ten scientists of which four are involved in tomato research and the others to other vegetables. The group includes plant breeders, soils and chemistry specialists, plant protection specialists and nutrition specialists as well as horticulturalists.

The Institute has obtained much information on the native leafy vegetables, as well as the eggplant and related species also on the tomato. Some information has also been obtained on the diseases and insect pests of vegetables and their control.

In a preliminary report of the experimental work in progress, some figures are given of yields of Corchorus olitorius (a leafy vegetable), 1,186 kg/ha dry matter 857.5 kg/ha leaf dry matter (the consumable part), and 7.97 metric tons/ha fresh (marketable) weight.

For Amaranthus spp, the highest marketable yield of 33.82 mt/ha was obtained when 10 mt/ha of poultry manure was used.

4.5 Kano River Irrigation Project

This project is already in operation and expanding slowly. Vegetables are considered an important part of the rotation, and tomatoes are already planted on a large scale. The plans are that a total of 1,500 ha. of tomatoes will be planted in the future and this will be accelerated with the development of a processing plant.

In the area of the project, the sub-station of the National Fruit and Vegetable Research and Demonstration Centre will be located.

There is close association of this project with the Institute for Agricultural Research of Ahmadu Bello University at Samaru, and the scarce information concerning the growth of vegetables used up to now in the project comes from that Institute.

COUNTRY REPORT: INDIA

1. Some Background Information

1.1 Geographical position and regions

India, the second most populous nation of the world with some 600 million inhabitants, extends from 8° to 37° north latitude and from 68° to 97° east longitude. Of its total land area of 3.26 million square kilometres about half lies within the tropics.

Geographically, India can roughly be divided into three areas:

1. the north : the Himalayas, an area of high mountains;
2. the middle: the Ganges plain, rather flat;
3. the peninsula: forming the southern part, a plateau of varying height (300–1,000 m) bordered by mountain ranges.

Part of the Ganges plain and all of the peninsula lie in the tropical zone.

1.2 Climate

The climate of India is of the monsoon type, characterized by a dry and a wet season. In general, the dry season extends from November to April; this is the period of clear skies, low relative humidity, warm days and cool nights. April and May are the transition period, with increasing temperatures during both day and night, increasing relative humidity, and occasional rain storms. The rainy season lasts from June until October, and is both hot and moist. Geographical position and relief may cause variants in the above picture.

The onset, frequency and intensity of rainfall in the rainy season may show strong fluctuations from year to year. Late or low rainfall may result in crop failure in areas of rainfed agriculture.

1.3 Agriculture

Agriculture is the most important sector of India's economy. It employs 70 percent of the active population and contributes about half of the Gross National Product. About 150 million ha, i.e. 45 percent of India's land area, are devoted to agriculture. At present four-fifths of this area is only rainfed. The Government gives high priority to the increasing development of irrigation (so important both for reducing crop failure in the rainy season and making cropping possible in the dry season), but even with all the available water used for this purpose, there will still remain 90 million ha of rainfed land. These figures illustrate the importance of studies on both irrigation and "dry land" cropping.

Main food crops for subsistence and cash are rice, wheat, sorghum and several millets, and pulses. Oilseeds, cotton, tobacco, jute, tea, coffee, rubber and spices are important cash crops.

A large proportion of the farming population has smallholdings or is landless. Agricultural techniques are often simple and productivity is low. With the application of modern technology (which requires knowledge, skill, capital, and a massive input of energy, fertilizers and pesticides), India's agriculture is considered to be capable of reaching much higher levels of productivity.

2. Aspects of the Vegetable Business

2.1 The main vegetables

India is blessed with a wide range of vegetables. It had a very rich germplasm collection of vegetables from within and outside the country, under the supervision of well-established institutions. It is not easy to distinguish between indigenous and exotic vegetables, because many of the varieties were reportedly imported very many years ago and have adapted very well into the Indian environment, farming systems and diet. But it is estimated that out of the 45 or so vegetables grown commercially in India, most of them are introduced. The following are most probably indigenous: eggplant, the bitter gourds (Lageneria and Luffa spp.), and Dolichos lablab.

Most of the cultivated vegetables are the "fruity" types, of which the primary organs consumed are the fruits, such as the tomatoes, chillies and eggplant, melons and gourds, legumes (peas, pigeon pea, chick peas, French beans, cowpea, Dolichos) and okra. "Leafy" vegetables of various types are also very common, such as lettuce, cabbage, spinach, spinach beet and the amaranths. Cauliflower, onions, radish and carrot are also produced and consumed.

A host of other plants, especially trees and shrubs, which grow wild, semi-wild or "protected" for their edible value, provide additional sources of vegetables such as the drumsticks (Moringa oleifera), Agathi (Sesbania grandiflora) and bamboo. The sprouted seeds of some legumes (e.g. mung bean, soya beans) are consumed as vegetables.

2.2 The pattern of consumption

Although there is a dearth of published statistical information on this matter, the information available from the Indian National Institute of Nutrition 1/ and from discussions shows very interesting patterns.

It is estimated that the average per capita daily consumption requirements for vegetables is 235 g (leafy vegetables 110 g, other vegetables 125 g). But as of 1966-67 only 53 g was available for consumption per capita from national production. Apparently India imports some vegetables to supplement its requirements. The All India average per capita daily consumption is estimated at 92 g (leafy vegetables 21 g, others 71 g). Two facts stand out very clearly. Firstly, India produces much less vegetables than it needs. Secondly, the Indian people consume much less vegetables than they require.

Other features of the consumption pattern are noteworthy. Firstly, in any given location or social group there is very little difference in the amount of vegetables consumed in the vegetarian and non-vegetarian diet, both of which appear to be predominantly based on cereals, pulses and dairy products, with a sprinkling of vegetables. Secondly, much more vegetables are consumed by the metropolitan and urban than the rural population. Thirdly the types and quantities of vegetables consumed in India vary markedly from place to place and among different social groups.

The fact that the urban population eats more vegetables per capita than the rural population was repeated over and over again during discussions, and supported by two survey data of the Indian National Institute of Nutrition, e.g. in areas around Maharastra and Hyderabad. (Table (i) on p. xiii).

1/ "Diet Atlas of India", National Institute of Nutrition, Indian Council of Medical Research, Hyderabad, 1971.

Table 1.

Pattern of Vegetable Consumption in Rural, Urban and Metropolitan Areas in two Areas of India (g/capita)

Area		Metropolitan	Urban	Rural
Maharashtra 1		60	39	20
Hyderabad	Leafy	-	31	6
	Others	-	147	79

However, there were other opinions which contested the veracity of this pattern. The main basis of argument was that most of the people in the rural areas do not eat what may be termed the "elite" vegetables, such as the melons, gourds, lettuce, cabbages, etc., upon which the survey data may have been collected. It was pointed out that such "elite" vegetables are produced principally for the urban populations, whereas the rural people eat mostly what may be termed the "native" vegetables, many of which are collected from young leaves, flowers and fruits of wild, semi-wild and cultivated plants whose existence and consumption are largely ignored in surveys. The team was not in a position to verify the above. But in view of the fact that the same pattern was reported in Thailand and Indonesia, it would appear reasonable to maintain that more vegetables are eaten per capita by the urban than by the rural population.

It was further explained that in the rural areas people subsist mainly on the local breads eaten with cooked onions, chillies and salt. This is due partly to the fact that traditionally most farmers do not produce vegetables on their small farms and partly because they do not have the means to purchase available vegetables.

However, many are able to supplement their diet with vegetables collected from volunteer plants during the rainy season. But during the subsequent dry season, which may endure from upwards of six months, they do entirely without fresh vegetables. Some eat dried and otherwise preserved vegetables, or if and where available, pick the leaves, fruits and other edible parts of perennial trees and shrubs.

Thus, we see that there is a marked difference in the types and sources of vegetables eaten by the urban and rural population. However in both groups of the population vegetable consumption per capita is inadequate, range from zero to high depending on the state and socio-economic group.

Nutritionists stressed the important role which vegetables could be made to play in the diet of the rural masses. However, there is a general deficiency, especially Vitamin A, and also of Iron. As a short-term measure the Government is promoting the intake of large doses of concentrated vitamin A to 1-5 year old children. This is stored in the liver from where it is released to the body as needed during a period of 6-8 months. The dose is repeated every six months until the children are 5 years old.

Leafy vegetables could alleviate these deficiencies if consumed and this is seen as the long-term solution. For instance, although the intake of iron from other food sources is large, the availability to the body is low because of the combining phytates in the cereal diet. Vitamin C intake, which enhances the absorption of iron, is low. Unfortunately the rural population does not like to eat the leafy vegetables because of the low social value accorded to them. To achieve the desired long-term solution to the problems, much social work is required to popularise the consumption of leafy vegetables. It was suggested that first the people should be educated about their nutritional importance, followed by the dissociation of the low, social prestige value. Thereafter, the vegetable should be made available cheaply , (or in other words, let the people produce it).

2.3 The pattern of production

In all parts of India, most of the vegetables are produced by a myriad of small farmers. For convenience, we may distinguish three categories of farmers, namely, the principal producers, the more minor producers and those who do not traditionally produce vegetables in their farming systems.

In most parts the principal vegetable growers are congregated around the outskirts of the cities and the more immediate hinterland. From this position, they direct all their efforts to supplying vegetables to the urban population. It is also reported that from them supplies also filter through to the rural population further afield. Being oriented to the urban markets, the farmers produce mostly those vegetables that are commercially popular, such as the solanaceous plants, the cucurbits and legumes, and other vegetables that have acquired some social status of prestige - like lettuce and cabbages. Consequently, they pay little attention to the formal production of what may be described as the "native" vegetables that command low social and economic values - even though they may be more nutritive than the "elite" vegetables and are consumed by most of the rural population.

In general, most of the rural farmers further away from the urban centres produce little or no vegetables, partly because of inadequate land, transport and marketing facilities. By sheer force of circumstances and priority, they are compelled to grow only their staple food crops on their limited, smallholdings. In some cases, they grow vegetables on a small part of their land (home gardens) or as part of tested traditional farming systems, either mixed with the staple crops or as relays to them. This appears to be especially true for the solanaceous plants, the cucurbits and legumes. Traditionally, the native leafy vegetables are usually not grown as field crops, but where possible, are produced within the home garden systems. It is partly for this reason that international organizations like UNICEF are cooperating in MINIKIT promotion for home gardens.

Climate and soil constrain the production of vegetables to certain seasons and areas. Around Bangalore,for example with equable climate throughout the year, vegetables are produced more or less continuously but on the Deccan plateau vegetable production, like other crop production is very seasonal except in areas where the watershed has been properly managed (e.g. around Hyderabad) to conserve water in tanks (ponds) or where the rivers are available to provide water for irrigation. Generally water is scarce, especially in the interior and non-availability of water for irrigation places a big constraint on the continuous production of vegetables.

India produces much less vegetables than it needs. The estimated daily consumption requirements per capita of 235 gr are obviously not met by the internal production which made available only 53 gr in 1966-67 and 46 gr in 1970. The fact that the All India average per capita consumption is 92 gr indicates quite clearly that India must import much vegetables although this fact has not been verified. The production for 1966-67 was 1.98 million tons. The estimated requirements for 1975 were 53 million tons and the national target was to produce 12 million tons. This target posed a colossal challenge of increasing production sixfold in under ten years. Even if this target were to be achieved, India would still be producing less than one-quarter of its requirements. It is quite clear, therefore, that any national drive to promote vegetable consumption would be gravely constrained by availability, unless the miracle of green revolution occurs in India's vegetable production.

3. The Status of Vegetable Research

Research on tropical vegetables is organized in a number of institutions in India. The principal among these are (1) Indian Agricultural Research Institute (IARI), New Delhi; (2) Indian Institute of Horticultural Research (IIHR), Bangalore; and (3) several agricultural universities. In addition to the separate projects conducted by the above institutions, there exists an All India Coordinated Vegetable Improvement Project in which research is done

through a network of seven main centres and 17 other establishments, with the coordination cell located in the Division of Vegetable Crops and Floriculture, IARI, New Delhi.

In three institutions in Hyderabad, namely, the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), the Soil Conservation and Dry Farming Research Centre, and the Regional Centre of IARI, vegetables per se are not included in their research programmes, but some of their work on farming systems involves the use - and hence the partial study - of vegetable producing plants like chickpeas, pigeon peas, peppers and tomatoes.

Research work at the main centres such as IARI and IIHR is organised on a multi-disciplinary structure. In all cases, the objectives are to do comprehensive research on selected vegetables, with the usual aims of crop improvement through breeding, management and related activities. In this regard, important facts are noteworthy. Firstly, all research effort appears to be concentrated on those "elite" vegetables required for the urban population. Thus, the programmes are characterised by intensive work on the solanaceous plants (especially tomato and egg plant) and cucurbits. Less intensive, but still appreciable, work is done on cabbage, cauliflower, okra and some legumes especially cowpea and pea (Pisum). The "native" vegetables eaten by the rural masses are given scant attention.

Secondly, there is a generous pool of trained scientists which makes the staffing of individual projects easy, and concerted, multi-disciplinary effort possible in each selected crop. For instance, during the last five years, the All India Coordinated Vegetable Improvement Project involved 160 scientists. This has resulted in several achievements culminating in the development and release of some improved and disease resistant varieties of vegetables. Also considerable training programmes and facilities for advanced students exist in the various agricultural universities and at the IARI.

More specifically, research on diseases and pest control receives special attention along two lines namely, breeding for resistance and crop protection. More attention seems to be given to crop protection. Tomato, egg plant and okra receive special attention. The most common and serious tomato disease is the curly leaf virus, against which some resistant lines have now been developed. The yellow-vein mosaic virus of okra is very common, and the tolerance of varieties previously developed is breaking down. In egg plant Phomopsis blight and leaf curl ravage the crops and some resistant lines have also been developed.

The seed production industry is well organised in India through the National Seed Corporation and a network of certified seed growers. India produces all the vegetable seeds it requires - both tropical and temperate types. It does not import seeds and is itself reportedly trying to export some.

4. Places Visited.

In India the mission visited the following places:

a) Office of the Indian Council of Agricultural Research, New Delhi;

b) Indian Agricultural Research Institute (IARI), Pusa, New Delhi;

c) Regional Centre for the IARI, Hyderabad;

d) ICRISAT, Hyderabad;

e) Institute of Applied Nutrition, Hyderabad;

f) All India Coordinated Project for Dryland Agriculture at the Soil Conservation and Dry-farming Research Centre, Hyderabad;

g) Andra Pradesh University, Department of Horticulture, Hyderabad;

h) Indian Institute for Horticultural Research, Bangalore.

COUNTRY REPORT: THAILAND

1. Background Information

1.1 Situation and climate

Thailand, a country of 514,000 square km, lies to the north of the equator between 5°4' and 20° 30' latitude, and extends from 97° 30' to 105° 45' east longitude. The three seasons in Thailand are the hot dry season (February-April), the hot rainy season (May-October) and the cool semi-wet season (November-January). Thailand has a tropical humid climate influenced by the monsoon. Average annual rainfalls for the central, north, northeast and southern regions are 1,500, 1,300, 900, and 2,375 mm respectively.

1.2 Population

Thailand has a population of 41 million in 1975 of which 65 percent are engaged in farming. Its population density is approximately 80 persons per sq km.

1.3 Agriculture

The distribution of agricultural enterprises in Thailand can be shown by figures in Table i Paddy farming constitutes about two-thirds of arable land. Upland crop farming and fruit tree plantations rank second and third, in terms of area occupied. Only one percent of arable land is used for commercial vegetable growing, and no estimation has been made on the area for vegetable home gardening. Thailand's main agricultural exports are rice, rubber, maize and sugar.

2. Aspects of the Vegetable Business

2.1 Production and consumption

Like all the countries visited, vegetable production in Thailand falls into two main types - commercial growing and home gardening. Both types are popular and very well developed in the areas of adequate water supply. It was estimated that about two-fifths of total vegetables consumed in urban areas of Thailand are from the all-the-year-round vegetable producing farms. Thai people produce leafy green native vegetables in a considerable quantity but there is no way to quantify it. Main vegetables in Thailand, in order of importance are onions, garlic, cabbage, pepper, tomato, chinese kale and sugar pea. The total vegetable production for the country, expressed in terms of index numbers, for the years 1969, 1970, 1971, 1972 and 1973 is 100, 109, 120, 132 and 160 respectively.

Table ii illustrates percentages of both the quantity of vegetables consumed, and the amount of money spent for vegetables by the Thai people in 1963. These percentage figures are getting bigger and bigger for Thai people because they tend to consume more vegetables as prices of other food items continue to rise relatively higher than the vegetable prices. However, the present level of vegetable consumption for Thai people which is about 100 gr/day for Bangkok dwellers, and 55 gr/day for rural people is still far below the recommended daily requirement level.

Apparently rural Thai people consume native leafy vegetables to supplement their diets mainly in lieu of meat and other expensive food items.

2.2 Production techniques and marketing aspects

Production techniques of vegetables used in Thailand are traditional. Most of the work is done manually. However, in some commercial vegetable growing areas, highly developed techniques in water management, fertiliser application, insecticide and herbicide application, and harvesting are normally practiced. The vegetable marketing problems in Thailand are regarded as one of the constraints of the vegetable industry. Vegetable growers have to rely heavily on local dealers in marketing of their products. Most of the produce is handled on a fixed rate or fee basis. Dealers usually do not incur any losses. If prices go down, farmers have to take the losses. Growers are well aware of the advantages of group marketing of their produce but they are adverse to this because past experience has revealed serious faults due to the inefficient operation and poor management.

2.3 Vegetable species cultivated

These are listed in Table iii on page xx.

3. The Present State of Vegetable Research

In Thailand research on vegetables was started only recently. It is being done separately by three different parties, namely the Horticulture Division of the Ministry of Agriculture and Cooperatives, three agricultural universities and private seed companies.

The Horticulture Division of the Ministry of Agriculture and Cooperatives has confined vegetable research work to the following areas: 1) variety improvement, which is mainly dealing with breeding and selection; 2) regional trials on its 10 experimental stations located in different parts of the country; 3) stock seed production for supplying them to the Department of Agricultural Extension for further seed production and sale; 4) cultural practices; and 5) seed technology. Vegetables of their interest now include cucumber, tomato, pea (Pisum), chili, lettuce and chinese radish.

The university vegetable research work has been done by three agricultural universities, namely Kasetsart, Chiangmai, and KhonKaen. Every year, researchers from all three universities hold a meeting for discussion of the research work done, and for planning of future research effort. Out of this group, Kasetsart University has been involved in several vegetable research projects in the integrated form. Their main components are seed production and technology, breeding, cultural practices, soil fertility, plant pathology, entomology, toxicology, quality analysis and utilization and economics. Their integrated research programme is only two years old and for the first three years they have been concentrating on tomatoes, peppers, lettuce and peas.

Little work on vegetable research has been done by Chiangmai and KhonKaen University groups due to their limited research personnel and funds.

Vegetable research done by private seed companies is primarily concerned with seed production and little information is revealed to the public.

4. The Need for expanding Vegetable Production

It is realized that there is a need for expanding vegetable production in Thailand to be able to keep up with the increased demand resulting from growth of population, higher real disposable income, and the relative increase in prices of other food items such as pork, beef, chicken and fish. The vegetable production expansion could be in both types of vegetables namely, the introduced, and the native vegetables.

5. The Need for More Research on Vegetables

Presently the extent of research work on vegetables in Thailand is very small compared with that on other crops such as rice and maize. This situation has arisen due to the small number of scientists engaged in, and the limited budget in support of, vegetable research. Clearly there exist areas of vegetable research to be urgently dealt with and these include breeding, seed production and multiplication, cultural practices, and cropping systems. In short more attention should be paid to initiating and supporting the research work on vegetables so that the country can move ahead with the plan for expanding vegetable production.

6. Concluding Remarks

Although Thailand is one of the tropical countries which has favourable conditions for vegetable growing, research on these crops has received little attention from the Government and authorities concerned. It is only recently that vegetable researchers all over the country got together and organized themselves as a group to help develop the vegetable industry. The success of the group and the future of Thailand's vegetable industry will depend upon the appropriate planning and support by all parties concerned.

Persons Consulted

1. Director of the Horticulture Division, and Head of Vegetable Branch, Department of Agriculture, Ministry of Agriculture and Cooperatives.
2. Rector, Vice-Rector for Academic Affairs, Assistant Vice-Rector for Academic Affairs, Dean, Faculty of Agriculture, Dean, Faculty of Economics and Business Administration, and Director of Research, Kasetsart University.
3. Administrators and researchers at Kasetsart University Vegetable Research Centre.
4. Director and Assistant Director, Institute of Food Research and Product Development, Kasetsart University.
5. Drs. D.L. Umali, Sala Dasananda, D.H. Parish, Bhakdi Lusanandana, and S.D. Chaudhuri, all of the FAO Regional Office for Asia and the Far East.
6. Dr. G. Schütz, SAA/FAO Country Representative in Thailand and Mr. Thomas F. Power Jr., UNDP Regional Representative.
7. Agriculture officers and researchers of Maejo Agricultural Experiment Station, Chiangmai.
8. Dean, Faculty of Agriculture, Drs. Vichian Pusavang, Manu Sitisarn, Earl Kellogg and Dawson of Chiangmai University.
9. Mr. Sawaeng Tadtiang, a vegetable farmer in Chiangmai.
10. M.R. Chaktong Tongyai, President, the Thai Agricultural Science Association, under the King's patronage.
11. Dr. F. Haworth, Coordinator of Plant Production Research in Thailand (UNDP/FAO).

Table i: Utilization of Arable Land of Thailand by Region, 1971
(unit: 1 000 ha)

Region	Total Arable Land	Land Use						
		Housing area	Paddy land	Upland crops	Fruit trees	Vegetable and flower	Wood land	Others
Northern	2 878	115	1 971	620	72	29	55	14
Northeastern	6 856	170	5 383	754	80	48	34	78
Central	1 289	31	977	197	39	13	6	25
Eastern	1 131	27	661	130	200	9	36	69
Western	1 180	39	705	154	118	52	68	42
Southern	1 889	42	682	35	999	9	57	65
Total	15 223	425	10 380	1 890	1 508	160	565	294
Percent	100	2.8	68.2	12.4	9.9	1.0	3.7	1.9

Source: Division of Agricultural Economics, Ministry of Agriculture and Cooperatives, Bangkok

Tableii: Percentage of Average Quantity and Average Expenditures of Selected Food Consumed Per Capita in a 7-day Period, Thailand, 1963

Item	Quantity		Expenditure	
	Town	Village	Town	Village
Rice, cereals and flour products	61.5	73.9	27.7	35.7
Meats	7.6	3.0	20.9	17.6
Poultry	1.6	1.0	2.9	0.1
Fish and sea food	5.9	4.2	15.3	14.1
Vegetables	14.0	7.8	11.3	11.1
Fresh fruits	6.5	6.6	6.9	5.6
Eggs, milk, fats, oils, sugar, spices	2.9	3.5	15.0	15.8
Total	100	100	100	100

Source: Household Expenditure Survey B.E. 2506, National Statistical Office, Bangkok, 1963.

Table iii: Types of Vegetable Crops commercially grown in Thailand

1. Perennial Crops

Asparagus : (Asparagus officinalis)

2. Potherbs or Greens

Spinach : Chinese type (Spinacia oleracea)
Basil : (Ocimum basilicum; O. sanctum; O. canum)
Coriander : (Coriandrum sativum)
Summer Chrysanthemum : (Chrysanthemum coronarium)

3. Salad Crops

Celery : Chinese and European type (Apium graveolens)
Lettuce : (Lactuca sativa)
Corn : Sweet corn (Zea mays)
Parsley : (Petroselinum hortense)

4. Cole Crops

Cabbage : (Brassica oleracea var. capitata)
Cauliflower : (B. oleracea var. botrytis)
Broccoli : (B. oleracea var. italica)
Brussel Sprout : (B. oleracea var. gemmifera)
Kohlrabi : (B. caulo-rapa)
Chinese Cabbage : (B. pekinensis, B. chinensis)
Leaf Mustard : (B. juncea)
Headed Mustard : (B. juncea var. rugosa)
Kale : Chinese type (B. albograba)

5. Root Crops

Radish : (Raphanus sativus var. longipinnatus) : Chinese and Japanese type
Carrot : (Daucus carota)
Ginger : (Zingiber officinale)
Colocasia : (Colocasia antiquorum esculentum)
White Potato : (Solanum tuberosum)
Sweet Potato : (Ipomoea batatas)

6. Bulb Crops

Onion : (Allium cepa)
Shallot : (A. ascalonicum)
Garlic : (A. sativum)
Chive : Chinese chive (A. tuberosum)

7. Peas and Beans

Sugar Pea and Edible-podded Pea : (Pisum sativum)
Yard Long Bean : (Vigna sesquipedalis)
Snap Bean : (Phaseolus vulgaris)
Cow Pea : (Vigna sinensis)
Wing Bean : (Psophocarpus tetragonolobus)

8. Solanaceous Fruits

Tomato : (Lycopersicum esculentum)
Egg Plant : (Solanum melongena) and many native varieties
Chili - Peppers : (Capsicum frutescens : C. annuum) and many native varieties

9. The Cucurbits

Cucumber : (Cucumis sativus)
Musk Melon : (C. melo)
Water Melon : (Citrullus vulgaris)
Pumpkin : (Cucurbita pepo)
Squash : (Cucurbita maxima)
Luffa : (Luffa cylindrica; L. acutangula)
Bitter Gourd : (Momordica charantia)
Coccinia : (Coccinia indica)

10. Miscellaneous Crops

Okra : (Abelmoschus esculentus)
Roselle : (Hibiscus sabdariffa)
Water Convolvulus : (Ipomoea reptans)
Nymphea : (Nymphea lotus)
Acasia : (Acasia insuvis)
Spices : vanilla, ginger, cardamom, cumin, coriander, cloves, black pepper, mints, basil
Bambo Shoot
Mushroom
Neptunia : (Neptunia oleracea)
Manchurian rice : (Zizania latifolia)

COUNTRY REPORT: INDONESIA

1. Some Background Information

1.1 Situation and climate

Indonesia, a country consisting of five large and thousands of small to minute islands, stretches from 6° latitude north to 11° latitude south, and from 95° to 141° longitude east. The overall climate is tropical, with at sea level no month colder than 18° C and an average precipitation of at least 1500 mm per year. But due to the differences in geographical position and altitude, local climates may vary greatly from hot to cool and from ever moist to having a pronounced dry season lasting from two up to seven months.

1.2 Population: numbers and densities

Of a total population of about 130 million, 65 percent live on the island of Java, 16 percent on Sumatra, 4 percent on Kalimantan, 7 percent on Sulawesi and the remainder spread over the other islands. This distribution does not follow the relative size of the various islands: Java has an average population density of around 500 persons/km^2, Sumatra 33, Kalimantan 7 and Sulawesi 37. While in Java almost all land is taken up for agriculture, the other islands mostly still have large tracts of natural forests.

1.3 Agriculture

At least 90 percent of the population lives in rural areas and exists on agriculture by being either a farmer or a labourer on a farm or a plantation.

Rice is the main food crop; it is grown largely for self-subsistence, and to a small extent as a cash crop. The cultivation of wetland rice is the most common system. Other important food crops grown for subsistence or cash are cassava, sweet potato, maize, groundnuts, soybeans, pulses, different fruits and vegetables and coconuts. Important plantation cash crops are rubber, coffee, oilpalm, tea, tobacco and sugarcane.

2. Aspects of the Vegetable Business

2.1 Consumption and production

Generally most Indonesians like to eat vegetables and will do so if they are are available at a reasonable price. The rural people often grow some vegetables around the homestead, or are able to collect them from the spontaneous vegetation. They may also buy small quantities at the local markets. The town dwellers are almost entirely dependent on buying vegetables in the markets.

No data were readily available to indicate what proportion of the total vegetable consumption in Indonesia is derived from home growing plus from "collecting", but certainly it must be very large. The only data on vegetable production available refer to acreages and quantities, produced primarily for sale*. Tables i and ii give data on areas and production in the last four years. The number of people involved in homestead production of vegetables for home consumption is to be counted in tens of millions. The number of commercial growers

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* After this report was written information was received that in 1969 the area of the home gardens put under vegetables amounted to 2.256×10^3 ha for the whole of Indonesia, as against 600.3×10^3 ha of cropping fields vegetables. Respective figures for Java alone are 1.881×10^3 ha and 506.7 ha.

is much smaller,& although no exact data on this number are available, one can estimate it to be 1 to 2 million, in view of the generally small size (often less than 0.5 ha) of the growers' enterprise. Vegetable plantations are very rare.

Commercial production is geared towards sale of non-processed vegetables in nearby towns. The inter-island or export trade of such vegetables is as yet relatively unimportant. Production for processing purposes is very limited. The main processed product is dried peppers. The most important centres of commercial vegetable production are found in Java. The hills supply the highland vegetables (notably potatoes, cabbage, Chinese cabbage, garlic and French beans), the plains around the cities the bulk of the lowland vegetables (the green leafy ones, several species of beans, most cucurbits, shallots and capsicums).

2.2 Production and marketing patterns

These are generally rather simple but they may give produce of a good quality. As with other forms of food farming, the cultivation of vegetables is generally done by hand from soil preparation to harvesting. This is due to an abundance of available labour at low prices. (The daily wage of unskilled farm labourers is often less than half a U.S. dollar). Farmers appreciate the value of proper varieties, good seed, care in growing, fertilizers, irrigation and chemical pest control.

Marketing techniques do not involve sophisticated equipment, except for motor vehicles for long distance transport . The marketing channels range from a direct link between producer and consumer to a system involving several intermediaries

2.3 Vegetable species cultivated

Besides the species named already in Table i., many other species are cultivated, albeit on a smaller scale. Some of these are: Amaranthus spp.,and Celosia argentea, Basella spp., red beets, lettuce, sweet potatoes (used both for their roots and tops), cassava (for its leaves), cauliflower, a dozen cucurbits (mainly for their fleshy fruits), several Dioscorea yam species (for their roots), bamboo species (young sprouts) and water convolvulus.

The group of "other beans" in Table i includes lima beans, Dolichos beans, sword beans, and various types of cowpeas. A number of vegetables is obtained from the leaves, fruits and seeds of trees: e.g. the papaya (young fruits), Moringa oleifera (pods and leaves), Parkia speciosa (pods), and Tamarindus indicus (pods).

A list of all the species used as a source of vegetables would include several hundred items. It can be said in conclusion that Indonesia is able to produce a very rich diversity of vegetables.

4. Present State of Vegetable Research

Apart from small contributions made by university departments of horticulture and and by some growers, all vegetable research is carried out by the "Lembage Penelitian Hortikultura" (LPH), the Horticultural Research Institute of Indonesia. The Institute, formerly under the Directorate-General of Food Crop Agriculture in the Ministry of Agriculture, now comes under the Agency for Agricultural Research, an institution within the same Ministry now supervising all aspects of research within the Ministry, i.e. pertaining not only to crops, but also to livestock, fisheries and forestry.

The LPH works on three branches of horticulture, viz. , on fruit crops, vegetables and ornamentals. For its work the LPH has a head office in Pasarminggu and several branches and field stations in West Java, East Java and North Sumatra.

Most of the present vegetable research work is devoted to Irish potatoes, white cabbage, tomatoes, hot peppers and French beans with variety testing, spacing and fertiliser trials and chemical pest control, the main research topics. Some attention is paid to Chinese cabbage, garlic, shallots, leaf onions, cucumbers, cowpeas, lettuce and maize. The important lowland vegetables, including amaranthus, water convolvulus, various gourds and different beans are at present left out of consideration. The LPH is aware that the latter crops need more attention; a shortage of staff is said to be the limiting factor.

4. The Need for an Expansion of Vegetable Production

The Government of Indonesia considers the expansion of vegetable production as one of the goals to be realized in the present, second five-year plan (1974-8). The aim of expanding the production of vegetables is fourfold:

a) to increase the income of the vegetable growers;
b) to increase the amount of employment;
c) to improve the nutrition of the people;
d) to increase exports.

The mission had insufficient time to discuss all these aims in their quantitative aspect with Government planners. From limited discussions held, the following points emerged clearly: nutritionists and nutrition improvement planners repeatedly stressed that cases of protein-calorie malnutrition (PCM), vitamin A deficiency and iron deficiency are widespread. Part of these cases are due to ignorance or reluctance with regard to the use of available food sources, including vegetables. An important part however is due to the non-availability of these food sources.

On a short-term basis, Fe and vitamin A deficiencies will be attacked by governmental salt fortification and high dose intake programmes, respectively. The long-term solution must come from increasing the availability of foods high in Fe and vitamin A. In this respect, vegetables, in particular the dark green leaves and the fruits and tubers rich in carotenes (such as tomatoes and yellow sweet potatoes) will be promoted.

As to PCM, much emphasis is placed on increasing the production of crops typically rich in calories and proteins, i.e. the cereals and pulses. It is realized however that leafy vegetables especially constitute an important source of supplementary protein.

The economists stressed that vegetables in several areas of Indonesia are the main cash earners and the main sources of employment. Crops like garlic and shallots were particularly large absorbers of hand labour. They also stressed that there is a demand for certain types of vegetables such as cabbage, shallots and peppers in foreign countries.

The mission found agreement with the several arguments raised in favour of an expansion of vegetable production.

5. The Need for More Research Work on Vegetables

The required expansion of vegetable production must come either from increased yields per ha or an expansion of area or a combination of both. The expansion should go hand in hand with raising the net profit to be made on vegetable growing so as to attract growers to this business, and with lowering the retail price of vegetables so as to make them available to more consumers. It was generally realized in Indonesia that, at least in already heavily populated Java, preference should be given to increasing yields per ha.

Much emphasis was rightly put on the important role of research in improving present production techniques, including the use of improved varieties. Besides research, attention was also given to extension, the provision of inputs, and improved marketing.

The need for more vegetable research is being met by an expansion of the research staff and facilities in West Java with the assistance of the World Bank. Most of this assistance will go to research on highland vegetable crops.

Notwithstanding this advance the mission felt that the important factor of lowland vegetable crops, to which belong many nutritionally important crops like green leafy vegetables and beans, as well as the important cash earners, peppers and shallots, should not be neglected.

6. Concluding Remarks

Indonesia and in particular Java has a rich variety of ecological conditions favouring the production of a wide range of vegetables. Labour is plentiful and cheap, at least in Java. There is a good tradition of vegetable production, both on the home and the commercial scale. With the favourable prospects for economic development, incomes are likely to rise in the forthcoming years and more people will be able to afford to buy vegetables. Stimulated by an educational campaign, vegetable consumption is likely to rise.

Research is needed to improve the yields and the economic return on vegetables, both necessary for a growth in the vegetable supply. While highland vegetables already get research attention, lowland vegetables are, until now, a neglected field. As far as conditions in Indonesia are concerned, international research should fill in part of this gap.

Persons Consulted

1. Staff members of the highland vegetable breeding, pathology and agronomy stations of the LPH in Cipanas, Segunung and Margahaya.

2. The Director and some staff members, LPH, Pasarminggu.

Table i Area of Commercialiged Vegetables (in 10^3 ha) in Indonesia in 1973

	All Indonesia	Java	Sumatra
Shallots	39.0	26.9	4.3
Red peppers	110.9	90.9	14.8
Cucumber	30.1	23.7	4.3
Egg plant	118.5	85.1	25.0
Other lowland vegetables	384.3	320.0	20.4
Potato	21.8	16.2	4.2
Cabbage	19.3	15.4	3.1
Chinese cabbage	12.4	7.1	3.7
Tomato	13.1	7.4	4.1
White radish	3.2	2.1	0.9
French bean	6.1	3.3	2.2
Leaf onion	7.7	5.5	0.9
Carrots	3.4	2.3	0.9
Garlic	5.9	3.0	0.8
Other beans*	222.7	194.2	6.7
Other highland vegetables	54.3	42.3	3.4

* Whether this refers to beans grown as a dry pulse or for their green pods or seeds still needs to be established.

Table ii Production of Commercial Vegetables (in 10^3 ha) in 1973

Shallots	173.8	117.5	22.0
Red peppers	302.1	254.5	35.7
Cucumber	174.6	123.3	26.0
Egg plant	118.5	85.1	25.0
Other lowland vegetables	348.3	320.0	20.3
Potato	173.1	131.6	37.9
Cabbage	224.7	157.2	61.3
Chinese cabbage	85.3	38.3	40.0
Tomato	60.4	23.0	32.2
White radish	18.7	10.1	8.0
French bean	22.6	14.1	7.0
Leaf onion	30.3	19.7	4.6
Carrots	27.2	16.9	9.3
Garlic	20.4	12.1	0.9
Other beans	308.4	278.0	16.4
Other highland vegetables	206.4	174.8	9.4

COUNTRY REPORT - KENYA

The terms of reference of the mission did not include Kenya, but taking advantage of a stopover in this country, some brief interviews were held. The information obtained can be summarized as follows:

1. In Kenya vegetables are of great importance for export and also for national consumption.

2. A special programme has been set up, i.e. The Horticultural Crops Production and Marketing Project, financed by UNDP, FAO and the national Government, to help the already existing Horticultural Crop Development Authority (HCDA) to promote the production of vegetables, fruits and flowers.

3. There is only one small experiment station in the country dedicated partly to vegetable research. A project has been submitted to UNDP to reinforce this station, but no final decision has been reached in this respect.

4. The consumption of vegetables for the nationals is expected to grow as fast as the increase in the growth of population. The production for export is also expected to grow mainly because of the increasing demand in Europe and the existence in Kenya of the climatic conditions which enable them to grow the vegetables required in Europe. Finally there is a growing demand for processing vegetables by the several factories which have been set up in recent years.

5. Very little attention has been given to native vegetables, but it is recognized that they make an important contribution to the nutrition of the people of lower incomes.

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APPENDIX II

DETAILS OF THE MISSION

Terms of Reference

The objective of the mission is to review and evaluate the present situation of tropical vegetable research in selected countries of Asia and Africa from the economic, nutritional and social points of view, as a basis for determining the needs for, and likely benefits from, further internationally sponsored strengthening and coordination of research, either through the establishment of an international centre, a network or networks, or any other mechanism which, in the opinion of the mission, would serve to achieve the desired results.

In particular the mission will:

i) Review the present state of vegetable research in the countries and regions visited;

ii) Evaluate the economic and nutritional contribution of vegetables to those countries;

iii) Identify the principal crop species and problems to which additional research effort needs to be directed, and from which most rapid benefits might be expected as a guide to priorities;

iv) On the basis of the above findings to decide on the needs for additional internationally supported research;

v) In the event that an international effort is considered justified on technical, economic and social grounds, to recommend the organizational form and location(s) of any such effort; bearing in mind the location and mandates of other internationally supported research institutions, including the AVRDC;

vi) To recommend what supporting action might be required in infrastructural fields such as extension, marketing, price policies, etc., and whether other external assistance in those fields would be an essential complement to the research proposed.

On completion of its enquiries the mission will report to the Chairman of the TAC. It is understood that the mission shall make no commitments on behalf of its sponsors, the Technical Advisory Committee, or the Consultative Group on International Agricultural Research.

Members of the Mission

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Itinerary

11.11.75	Mission arrived in Rome
13.11.75	Mission departed Rome and arrived Dakar, Senegal
19.11.75	Mission departed Dakar and arrived Lagos, Nigeria
23.11.75	Mission departed Lagos and arrived Nairobi, Kenya (overnight stop)
24.11.75	Mission departed Nairobi and arrived Bombay, India
28.11.75	Mission departed Madras and arrived Bangkok, Thailand
06.12.75	Mission departed Bangkok and arrived Djakarta, Indonesia
10.12.75	Mission departed Djakarta and arrived Singapore en route to Rome