THE CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH

TECHNICAL ADVISORY COMMITTEE

DEVELOPMENT OF NEW CGIAR INITIATIVES:

VEGETABLES RESEARCH

TAC SECRETARIAT

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

March 1988

W/S7079

CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH
TECHNICAL ADVISORY COMMITTEE
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31 March 1988

Dear Mr. Hopper,

I am pleased to inform you that TAC at its meeting last month prepared a proposal for CGIAR-supported research on vegetables, as requested by the Group.

The proposal for consideration by the Group is in the form of a TAC commentary that amends and highlights the proposal made by TAC's consultant following an intensive global study and thorough exchange of views and discussions in the Committee. The consultant's report and the TAC commentary are attached.

TAC believes it is responding also to the Group's wishes in recommending a CGIAR effort that puts national institutions in developing countries on a research partnership footing from the beginning.

TAC considers action in and for sub-Saharan Africa an urgent priority. The proposal reflects this view.

Mr. Chairman, should the Group decide to move toward support for research on vegetables, the Committee stands ready to amplify and where desired to clarify its proposal and to consider matters within TAC's scope during the implementation phase of the new initiative.

Sincerely yours,

Alex F. McCalla
Chairman TAC

Mr. W. David Hopper
Chairman, CGIAR
World Bank
1818 H Street, N.W.
Washington, DC 20433
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TAC COMMENTARY ON CGIAR-SUPPORTED RESEARCH ON VEGETABLES

Background

1. From the early 1970s, TAC has recognized the importance of research to improve vegetable production in developing countries. The establishment in 1971 of the Asian Vegetable Research and Development Center (AVRDC) was not seen as sufficient to meet the global needs for research and training. TAC in 1975 commissioned a Vegetable Research Appraisal Mission and in 1976 a Vegetable Research Project Formulation Mission. TAC's deliberations affirmed that research on vegetables should have high priority among activities that deserve support from the CGIAR. A proposal by a strong majority of the Committee to establish a small International Vegetable Research Institute for the Tropics was examined by the Group in May 1979 but not developed further in view of a lack of consensus and of financial constraints.

2. In its 1985 review of "CGIAR Priorities and Future Strategies", TAC assigned highest priority for any new ventures for which resources could become available to research on vegetables. The Committee reported to the Group's May 1986 meeting that it considers research on vegetables to be a neglected field in which considerable impact could be made among others for the following reasons:

- projected demands are greater than those indicated from population increases alone and come from all social strata;
- demands are particularly high from urban dwellers;
- vegetables generate high incomes for small holders;
- vegetables fill nutrition gaps (especially minerals and vitamins) and add protein and fiber to tropical diets;
- there is limited research by national systems;
- some research on vegetables is already included in Center programs (e.g. green bean at CIAT and vegetable cowpea at IITA);
- vegetables fit a variety of cropping systems.

3. On basis of the Group's positive reaction to TAC's views, and making use of the outcome of a "Conference on Research and Development of Vegetables in the Tropics" organized by Winrock International Institute for Agricultural Development in January 1986, the Committee began its work on a proposal with the assistance of Dr. A. Colin MCClung of Winrock. TAC is pleased to acknowledge the hard work, perceptive analysis and innovative synthesis brought to bear by Dr. McClung in his discussions with TAC and evident in his report, which the Committee forwards to the Group for careful study.

COMMENTARY

4. TAC is in general agreement with most of the views and proposals contained in the report of the consultant. In the following the Committee highlights considerations that underlie its advice and proposal to the Group to help establish regional collaborative vegetable research networks and to create and support an International Service for Vegetables Research (ISVR).

5. In line with the goal of the CGIAR, the target beneficiaries of the proposed international research effort will be low-income people, be they producers or consumers. Vegetables are usually grown by small holders in a mixed or multiple cropping system, under irrigated or rain-fed conditions, in a village or on the outskirts of towns. Operations are labour intensive due to the detailed requirements of production and post-harvest perishability. Increased vegetable production, therefore, will offer small farmers the opportunities to increase their income, and will generate employment opportunities in the rural and suburban production areas, and in the processing, marketing, transportation, and export sectors. Increased production can also make possible greater availability and lower cost of vegetables for low-income consumers in rural as well as in urban areas.

Potential for Progress

6. TAC's recommendation that the CGIAR give serious consideration to supporting research on vegetables is based *inter alia* on the high potential for making substantial progress in the short and medium term through collaborative research and networking at the global level.

7. Vegetables are a preferred food among all income groups. Their consumption, which increases with rising income and urbanization, rose at a rapid rate during the 1970s (3.3% per annum) and is projected to continue to grow. The demand is strong in all developing countries, offering an opportunity for small farmers to tap expanding high-value markets for their produce. Such demand scenarios will serve to assist and accelerate the adoption of appropriate technologies by the small farmers.

8. Potential high productivity per unit area of land and high labour requirements make vegetables well suited for production on small farms. Generation of suitable technologies that reinforce comparative advantages of small holders would contribute to achievement of the CGIAR's objectives.

9. Research on vegetables in national systems in most developing countries is limited but regarded as of very high priority. Although varying among and within regions, and often starting from a low or zero base, NARS capability has increased steadily in many countries. Insufficient resources and opportunities has precluded advance in others. The eagerness of scientists from NARS to collaborate in international research networks on vegetables supports the view that sustained progress can be made through this mechanism.

Priorities

10. Species. A key decision in planning CGIAR action in this field is the choice of species. The vegetables chosen should be relevant to specific regions and their consumers, merit research on an international scale, and offer prospects of pay-off. In light of relative importance, of priority assigned by NARS, and of resource and impact considerations, TAC recommends that CGIAR support be limited initially to tomatoes, peppers and onions, and to leafy green vegetables (as a group).

11. Tomatoes, peppers and onions are of global importance and were listed among the top priority species by all scientists and research administrators interviewed in the study commissioned by TAC. Leafy green vegetables were regarded as meriting highest priority by scientists in Africa. Because of this, of their nutritional values and of the potential spillover for other regions, TAC recommends their inclusion from the beginning of the program. Initially, the effort within this group should concentrate on the identification of species with high potential in terms of both production and market demand.

12. TAC debated whether okra and eggplant should be part of the list of species for initial attention. These two vegetables are consumed throughout the world and are among the nine top species in terms of production in developing countries. Both were listed among the top six priority species by many of the scientists and administrators interviewed. Because the assigned research priority was not consistently as high as for tomatoes, peppers and onions, and because of the advisability to start with a small number of species, they are not included in TAC's initial list for biological research. TAC, however, recommends that ISVR carry out studies and consultations with relevant national programs and institutions (NARS) to further clarify the importance of these commodities, and to determine the major constraints to production increases and marketing and their researchability. If these studies confirm the present judgement that these vegetables merit high priority in the research agenda of the ISVR, TAC recommends that the Service be granted the flexibility to phase them in at the earliest possible time.

13. Environments. One critically important research challenge is to obtain adaptation of the selected species to conditions in tropical environments, i.e. to climate and soils, to tolerance to pests and diseases, in seed production, and to production systems and circumstances. Because of this, and because of the needs and potential impact, TAC recommends that highest priority be assigned to supporting research for tropical environments, with activities for subtropical environments to be initiated once those for tropical environments have become operational.

14. Research Thrusts. The main research thrusts of the CGIAR supported effort should depend on the major constraints on productivity and marketability of the chosen species in the various regions. In TAC's view the initial emphasis should be placed on:

- evaluation and utilization of land races and cultivars at selected locations within a range of tropical and subtropical environments;

- assessments of market absorption capacity and marketing constraints leading to the identification of production areas;

- identification of researchable constraints and assessment of potential impact.

15. To overcome the different constraints, research might be needed in such fields as:

- adaptation breeding for various stresses in tropical environments and production systems;

- seed physiology and seed production technology;

- appropriate improved technologies and cultural practices;

- farmers production circumstances and socio-economic constraints;

- plant protection; and,

- postharvest physiology and technology.

Hence in establishing the CGIAR-supported effort provision should be made for research capability in diverse fields, including capability to make use of advances in biotechnology.

Organizational Model

16. In its deliberations TAC considered several alternative organizational models. These ranged from a full-fledged international center to the support of existing and new research networks.

17. The special position and potential of AVRDC was given considerable attention. TAC concluded that the chosen model should provide for tapping the strengths of AVRDC and for maximum collaboration and coordination of efforts. In this regard, TAC welcomed the involvement of AVRDC described in the consultant's report. In addition to collaborative and contractual research arrangements, among the inputs which could be made from the AVRDC headquarters and from its substation in Thailand are facilities for germplasm storage, for documentation and dissemination of information, and for training. TAC considers that any new venture should not compete with research which AVRDC was already conducting on the priority species selected for CGIAR support, but should rather reinforce those inputs of AVRDC which were needed for the development or efficiency of the overall effort.

18. Of the various organizational models considered, TAC recommends one which consists of two major components:

- regional collaborative research networks in Asia, Africa and Latin America; and,

- an autonomous international institution (ISVR) equipped with a small but critical mass of highly qualified scientists capable of providing effective scientific support to the networks.

19. TAC envisages that staff of ISVR will be directly involved in research in a collaborative mode with NARS. This should apply for staff both at headquarters and at the proposed Africa Unit. The Committee further envisages that a substantial portion of the international research agenda will be contracted by the Service with the most appropriate institutions in terms of scientific strength, comparative advantages and cost considerations. These institutions will include AVRDC, units of NARS, and advanced research institutions in developed and developing countries.

20. In TAC's view, such a model should be made operational for a period of 8 years (3 years of start-up, 5 years of full operation) and if proven effective and needed, extended thereafter or revised as necessary.

Locations

21. TAC discussed at length the locational issues implicit in the phasing of the proposed CGIAR support to research on vegetables. Based on consideration of: (1) the need for attention; (2) the potential for progress in research; (3) impact; and (4) for capitalizing on the Asian experience and stock of knowledge for the benefits of work for other regions, TAC endorses the consultant's recommendation to work towards establishment of the headquarters in Southeast Asia.

22. For reasons made clear in the report of the consultant and in TAC's deliberations, the option to locate the headquarters in Africa was not, in the near term, considered to be viable nor in the best interest of improvement in vegetable production worldwide. Nonetheless, TAC firmly proposes that the needs of Africa, and of Latin America as well, should determine the nature and scope of CGIAR support to research on vegetables, along with the needs of Asia.

23. To this end, TAC proposes that regional conferences of scientific and other experts and decision-makers be organized and held first in Africa and Latin America, and last in Asia, in order to define more closely the research needs of each region. The charge to the CGIAR headquarters unit in Southeast Asia should then be to give high priority from the beginning to developing research, training and information services for Africa so as to meet the needs of that region and to foster a strong collaborative research network of NARS in Africa. TAC considers that research on vegetables of priority to Africa might be supported by one or two branches of the Service located in the region, and that at some later period the headquarters might be shifted to Africa.

24. The special needs and circumstances of Latin America should also receive careful analysis of and action on steps to provide effective support, including location of a branch or liaison office in the region.

THE PROPOSAL

25. TAC recommends that the CGIAR establish and support an International Service for Vegetable Research (ISVR) with headquarters initially in Southeast Asia.

Objective and Strategy of ISVR

26. TAC recommends that the central objective of ISVR should be to foster and support research on vegetables and related activities with the goal of improving the nutritional level and wellbeing of low-income people in developing countries.

27. TAC recommends that the strategy of ISVR provide for:

(i) full capitalization of the existing stock of knowledge;

(ii) effective collaboration and support to the endeavour from advanced research institutions in developed and developing countries;

(iii) effective collaboration and coordination of efforts with AVRDC;

(iv) recognition of the mandates of other Centers working with related crops or subjects (e.g. cassava, beans, cowpeas, genetic resources/seed units);

(v) fostering effective collaboration among NARS through the catalysis and support of regional research networks;

(vi) full participation of NARS in the identification of regional and global priorities for research that merits to be undertaken by the networks, and of those activities that merit to be supported by ISVR e.g. because of their international nature;

(vii) international research on vegetables in or for the regional collaborative networks, to be done in a participatory mode between ISVR and NARS whenever a direct involvement of staff of ISVR is regarded as essential;

(viii) the implementation of a global information network aimed at the needs of developing countries;

(ix) an effective training program aimed at the needs as perceived by the networks;

(x) avoiding potential conflict of interest in the identification and award of research contracts; and

(xi) cost effectiveness.

Implementation Strategy

28. TAC proposes that:

(i) the CGIAR extend its support to research 1/ on vegetables production primarily by small holders and initially in the tropics and subtropics;

(ii) the CGIAR support the creation and strengthening of NARS networks for collaborative research on vegetables in the regions Africa, Latin America and Asia.

(iii) the CGIAR create a support service (International Service for Vegetable Research, ISVR) to foster international research on vegetables conducted in or for the regional collaborative networks.

(iv) ISVR be governed by an international board in the style of the CGIAR. The task of the Board will be to help develop and to approve a strategic plan based on and designed to support effectively the strategic plans of the regional NARS networks;

(v) in preparation for the establishment of ISVR, the CGIAR assist in the creation of:

  (a) regional collaborative research networks of NARS by organizing conferences first in Africa and Latin America, and last in Asia to define major research needs and goals for each region,

  (b) the strategic plans for the NARS regional networks in Africa, Latin America and Asia,

  (c) regional advisory committees and a global advisory committee of NARS representatives to advise ISVR on program needs, priorities, strategies and activities.

(vi) ISVR work principally through research contracts with collaborating institutions, using its resources to fill gaps in critical mass for research wherever it is done.

(vii) ISVR make best use of strengths in vegetables research existing in the developing regions, including those of AVRDC, as well as of those in more advanced countries.

(viii) ISVR headquarters be established at a location in Southeast Asia, with international status. As suggested by the consultant, Thailand (Kamphaengsaen campus of Kasetsart University) might be given special consideration.

1/ Research is to be taken in the broad sense, including training and information exchange.

29. TAC would expect that the details of the research program supported by the Service will be determined by the Board of ISVR based on priorities and feasibility. The Committee reiterates its view that ISVR should take as its priority from the beginning the development of research, training and information services for Africa.

30. On the whole, TAC shares the consultant's views regarding:

(a) Overall size of the effort required.

(b) Relative allocation of resources for ISVR staff and for contractual arrangements and network support activities.

(c) Staff capabilities required for adequate supervision of contracts, adequate support to the networks, and adequate implementation of research and related activities (e.g. training, information, germplasm, seed, socio-economics, postharvest technology).

(d) A need for an African Unit equipped with:

(i) a minimum critical mass of scientific staff for conducting research in a collaborative mode (e.g. joint planning, joint execution, collaborative projects) with, and housed within, one or more national programs in the region; and

(ii) the needed staff for coordination and logistic support of the regional network, including support to seed production/processing.

(e) An anticipated need for a small unit in Latin America made up of the needed staff for coordination and logistic support of the regional network, including support to seed production/processing.

31. TAC views the budget included in the consultant's proposal as tentative. Should the CGIAR opt to undertake the proposed endeavour, TAC will be prepared to comment on concrete budget proposals for ISVR at the different stages of its implementation.

AGR/TAC:IAR/87/29 Rev. 1

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January 1988

CONTENTS

CGIAR-SUPPORTED RESEARCH ON VEGETABLES

SUMMARY

1. This paper proposes that the Consultative Group on International Agricultural Research create an organization to foster research on vegetable crops and to encourage the transfer of technology among developing countries. The new entity would aim to maximize the use of existing resources both as regards scientific personnel and physical facilities. It would stimulate research by funding contracts with existing institutions, by employing scientists to participate directly in specific research projects, and by organizing related training and communication activities.

2. The proposal envisions the establishment of a central coordinating body that would develop a collaborative research network for several important vegetables. The term "collaborative research network" is taken to mean a network in which representatives of participating organizations develop a strategic plan to be carried out under the leadership of a coordinator. The resources of the participants would be augmented by funds provided by or through the coordinating body. It is proposed that there be a worldwide vegetable research network and that it be divided into commodity programs and regional networks. The research staff working on a commodity would predominantly consist of scientists in national research programs working at their home institutions. They would be supplemented by staff of the new entity, and their efforts further augmented by contract arrangements with advanced laboratories in the developing countries or elsewhere. The commodity programs would be coordinated by the staff of the new entity. It is proposed that regional networks deal with topics that cut across commodity lines within a region, such as training, social science research, seed production, and post-harvest management.

3. It is recommended that the headquarters of the coordinating body be located in Asia. This region has a number of active, growing institutions engaged in vegetable research that would provide a strong base for a networking approach. The region also has the largest and most concentrated population, and vegetable production is widespread and long established.

4. It is proposed that the coordinating body will have a branch unit in Africa to help expand vegetable research in that continent. The Africa Unit would lead research on leafy green vegetables and would foster transfer of technology arising elsewhere in the network. The possibility of a branch in Latin America should receive early consideration.

Prepared by A. Colin McClung, of Winrock International, acting as consultant to the Technical Advisory Committee. Prepared September 30, 1987; Revised January 22, 1988.

5. The relationship of AVRDC to the new entity is seen to be that of a major member of the network. AVRDC is well organized to handle functions such as basic germ plasm storage for the network; maintenance of a computerized bibliographic service; leadership for germ plasm evaluation and improvement for selected crops particularly for disease and insect resistance and adaptation to tropical growing conditions; and joint responsibility for training programs in vegetable research and production, seed technology, and other subjects. AVRDC, while being a strong member of the network, would independently continue its research on certain commodities and in certain subject-matter areas.

6. It is recommended that the research program of the new organization focus on tomatoes, peppers, onions, okra, eggplant, and leafy green vegetables. The work on leafy green vegetables would initially consist of screening a large number of species, followed by in-depth research on selected ones. Leguminous vegetables may require some attention as well. However several international centers whose mandated crops have cultivars consumed as vegetables are now studying those cultivars or are planning to do so. In the network, initial emphasis would be on assembling germ plasm from various institutions and on screening cultivars particularly for insect and disease resistance and tolerance to hot weather. Attention would then be given to breeding for improvement in yield and quality. It should be noted that actual delineation of the research program is the responsibility of the network itself working through the coordinating body. Statements made in this report should not be seen as depriving them of this responsibility.

7. Two types of costs are identified: those relating to the coordination function, including workshops, travelling seminars, communication and monitoring and evaluation, and those relating to research implementation. It is proposed that the first type would be fully funded from the core budget of the coordinating body. Supplemental funds to permit more active participation of national research units in the research network would also be provided from the core funds of the coordinating body. All funds provided by the coordinating body would be through contract with the collaborating organization. Collaborating units would be expected to maintain a certain level of activity, to express a commitment to the network for identified objectives and periods of time, to share results in terms of information and materials and to permit monitoring of finances and evaluation of results. Contracts would also be made with specialized laboratories and other especially qualified units in the developed countries to provide specific research services. Training costs would be funded by the coordinating body.

8. Past proposals for the founding of a CGIAR-funded organization to deal with vegetables have suggested various names and acronyms. Some possible names are presented in this report for consideration by the TAC. A preference is expressed for the name "International Service for Vegetable Research."

9. A "first approximation" program and schedule for the new organization is presented in which choices have been made among various options for the purpose of estimating approximate costs for the undertaking.

I. INTRODUCTION

Previous TAC consideration of vegetable research

10. The Technical Advisory Committee (TAC) of the Consultative Group on International Agricultural Research (CGIAR) has long recognized the importance of research to improve vegetable production in developing countries. Since the early 1970s, a number of possible institutional arrangements for achieving this have been considered, including the formation of an "International Vegetable Research Institute" modeled on other international agricultural research centers, an "International Vegetable Research Pilot Project," and an "International Council for Tropical Vegetable Research." Less formally, TAC has also discussed strengthening individual national programs, establishing a network among national programs, using existing international centers, or establishing an international board similar to IBPGR (Annex A summarizes these deliberations). While TAC continues to attach considerable importance and priority to vegetables, the principal contribution of the CGIAR system to date has been through IBPGR projects and farming systems work in several international centers.

11. A review of TAC's discussions and those of the CGIAR reveal an inherent concern that a subject as complex as vegetable research does not lend itself well to the international-center approach. By the end of the 1970s, when vegetable research needs were being evaluated, it appeared that centers that had one or two mandated crops were making more rapid progress than those with more commodities. For vegetables, the list of potentially researchable crops is long. In addition, the methods of production and even the uses of a particular vegetable vary from place to place, perhaps making the group even more difficult to manage than the crops now under study at the international centers. The success of many vegetable research organizations however, attests to the fact that these problems, though real, are not insurmountable. A carefully focused research agenda, combined with good communication with research units elsewhere, has enabled them to deal with this diversity. The demonstrated capacity of many vegetable producers to accept and adapt new technology has no doubt been a factor in the substantial impact that the work of vegetable researchers has had.

12. The May 1986 TAC priority paper stated:

> "TAC considers that research on tropical vegetables is a neglected field in which considerable impact could be made. The rapid growth of towns serves to increase pressure on land use in surrounding areas. In these circumstances, vegetable production becomes profitable and can absorb urban labor. Briefly, the main considerations include:
>
> - projected demands are greater than those indicated from production increases alone and come from social status;
> - demands are particularly high from urban dwellers;
> - vegetables generate high income for small holders;
> - they fill nutrition gaps (especially minerals and vitamins);
> - there is limited research by national systems;
> - some research on vegetables is already included in Center programs (e.g. green beans at CIAT and vegetable cowpeas at IITA);
> - vegetables fit a variety of cropping systems."

13. In January 1986, independently of TAC and the CGIAR, Winrock International organized the conference "Research and Development of Vegetables in the Tropics". A TAC member who participated in the conference reported on it at TAC 39. The TAC chairman suggested that the report of the conference could serve as a useful input to TAC's deliberations on vegetable research priorities and on the organization of vegetable research.

14. The basic organizational structure proposed by the participants in the Winrock conference was a network in which research needs would be determined jointly by national research systems and a small internationally funded coordinating body, or secretariat, and the work would be carried out jointly. This approach would permit a larger number of commodities to be studied and would extend the environmental range beyond that possible for any one international center. Several international centers have used the networking concept to test and to disseminate the results of their work. Winrock participants saw networking as being a feasible primary source of research data when participating national systems collectively have a fairly extensive base of technical personnel. The input of the national research systems would be reinforced by contract research arranged by a small staff of professionals of the coordinating body.

The importance of vegetables

15. As a group vegetable crops have great potential for improving the lives of people in the developing countries. All levels of society will benefit from expanded production of vegetables but the greatest beneficiaries will be the small farmers and rural poor. Many vegetable crops have high market value and may be sources of foreign exchange for developing countries. They are of interest to farmers near market centers and to urban consumers in developing countries. Many vegetable crops are labor-intensive or respond well to intensive management. Some require substantial amounts of manufactured inputs. Others require minimal attention and no purchased inputs, yet contribute significantly to the nutrition of poor farm families. They may raise the incomes of the small farmers who can fit them into their farming systems. Some crops require favorable growing conditions while others are extremely rugged and do well on poor soils or under extremes of moisture supply.

16. In its earlier studies of possible support to vegetable research, TAC made a number of observations concerning the importance of vegetables for human nutrition and for raising incomes of small farmers. These remain valid and deserve full consideration in current deliberations. Instead of repeating those analyses in the present study, tables from the 1979 TAC document (AGD/TAC: IAR/79/17) proposing the creation of a vegetable research center appear in Annex B. Tables 1 to 3 deal with nutritional content of various vegetable species. These tables are useful background for comparing vegetables with other commodities in terms of their contribution to diets. They are also of help in deciding which species should receive priority in an international research agenda for vegetables. Table 4 is the same as one included in the earlier TAC report, but is updated to 1984. It gives world production figures for vegetables and was provided by Dr. Chamnien Boonma of Thailand.

17. In 1979, the appointed a subcommittee to develop a list of "First priority vegetables suggested for international research." Drawing on data on nutritional value and on other information provided by the earlier review missions, the subcommittee prepared this list in the form of a table. This is reproduced as Table 5 of Annex B and was an important discussion piece in the present mission. This table and those referred to in paragraph 16 are basic to the current study and should be considered an integral part of this report.

18. The earlier reports observed that vegetables are consumed by most people in the developing countries and that they make important contributions to tropical diets. In particular they enrich the vitamin and mineral content of diets, but they may also significantly raise dietary protein levels. The 1979 report concludes that "vegetables are vitally important in the diets of the majority of people in developing countries and, notwithstanding regional differences in preferences for type of vegetables, there is a real need for a substantial increase in average daily consumption." (emphasis added)

19. In a recent paper, Dr. Henry M. Munger points out that many vegetable crops have been underrated as sources of energy and protein because of their high water content. Another reason is that many can be harvested soon after they are planted, and this has seldom been taken into account when comparing crop yields. Tables 6 and 7 of the Annex B summarize his calculations of calorie and protein production per unit area per day. The picture that emerges is that a number of vegetables are as efficient in producing both energy and protein as the leading staple food crops. He comments that "This is not to suggest that these vegetables with high water content can become a major source of calories or protein, but rather that to the extent we would like to see these crops grown to provide vitamins and minerals, they are paying their way in calories, protein, or both, and providing the other nutrients as a bonus."

20. The earlier TAC reports note that vegetable growing is labor intensive and that increased vegetable production can expand employment in rural areas. Vegetable farmers tend to earn higher incomes than most other farmers do because of their intensive land use and the relatively high value of the crops. Vegetable consumption is greater in urban areas than in rural ones and is substantially income constrained. In rural areas, the possibility of producing for home consumption is a way to bypass the income constraint, and it offers an opportunity to improve nutrition with relatively little cash outlay.

The present study

21. At its 42nd meeting in March 1987, the TAC endorsed in principle the Winrock conference's recommendation to establish an entity based on networks. TAC felt, however, that the designation of the entity as a "secretariat" implied that it would carry out a staff function rather than a managerial or leadership one. TAC called for an in-house capacity for research by the coordinating body in association with the research network. Nevertheless, the network would accomplish most of its research and related training activities through a decentralized structure involving collaboration with national and regional institutions including AVRDC.

22. On April 24, 1987, the Chairman of TAC wrote to Winrock International to determine if the latter could work with TAC in assessing the current conditions in tropical vegetable research and in planning a possible CGIAR-sponsored vegetable research undertaking. The President of Winrock International responded favorably on May 12, 1987.

23. The TAC Chairman's letter asked that the Winrock-supplied consultant prepare a report for consideration by TAC that would include a draft proposal covering:

- priority vegetable species
- major research areas
- potential cooperating institutions in both developing and developed countries
- the specific role of AVRDC
- mechanisms of implementation
- location and research scope of the coordinating body
- funding needs

24. It was decided that the Consultant would visit or contact key vegetable research centers and individuals in Latin America, Africa, and Asia to re-examine many of the questions that had been considered by earlier TAC missions. While time constraints and other limitations precluded a comprehensive survey, the aim was to gain a clearer understanding of the current situation and the level of interest in international vegetable research. Visits were made to vegetable research centers in Mexico, Brazil, Nigeria, Kenya, China, India, Thailand, Taiwan, USA, Netherlands, and Japan.

25. In addition, one-day conferences were arranged in The Netherlands, Nigeria, India, and Thailand. Participants included persons from Germany, The Netherlands, USA, Belgium, UK, Nigeria, Senegal, Zambia, India, Kenya, Pakistan, Thailand, Indonesia, Philippines, Malaysia, Taiwan, and Japan. Other potential collaborators were contacted by telephone and mail to acquaint them with the study and to solicit views and expressions of possible interest. Knowledgeable persons in various organizations were contacted as secondary sources of information about current activities in other countries. These organizations included FAO, IICA, TAC, various international centers, universities, and government agencies. A number of private vegetable seed producers were interviewed. A list of some 250 persons interviewed accompanies this report. While none of the information they provided is deemed to be definitive or to constitute a commitment, it does provide a link with past studies by TAC and the CGIAR and a basis for more specific determinations in the future.

II. THE STATUS OF VEGETABLE RESEARCH PROGRAMS

26. The vegetable research situation in the developing countries is interesting. Almost all the research programs are new, yet they are intended to assist an industry based on production practices that often go back to very early times. This industry has, however, demonstrated an amazing capacity to seize ideas and put them into practice.

27. In the post-war years, the developing countries have focused their limited research budgets on basic foodstuffs, particularly cereals, and have largely ignored the vegetables. This is understandable in that the basic

commodities are produced on a large scale and the increase in total food output that might be expected to result from an investment in research is correspondingly higher. But vegetables tend to be high-value crops. Willem Janssen of CIAT points out (private communication) that per hectare, green beans may be worth seven to ten times more than dry beans of the same species. Similar relationships exist for other crops within the vegetable group. Farmers around the world have learned this on their own and, when well situated in respect to market centers, have forged ahead with production of vegetables.

28. Vegetable growers tend to be avid seekers of new technology. If there is no local research output, they find it where they can. Without formal lines of communication, new materials and new ideas have moved to remote places. These farmers can afford larger cash outlays and are willing to pay premium prices for seeds and fertilizers, as well as to invest more in labor. With this kind of driving force, some remarkable changes have taken place in recent decades. New crops have been adopted where they were not known before and old ones are being produced in new ways. The dark side of this phenomenon is that vegetable farmers can also spend more for pesticides and may do so to the point of creating an environmental hazard. It is worth noting, however, that some farmers in Southeast Asia, are starting to protect high value crops with fine-mesh nets, thus reducing the need for insecticides.

29. During this period of change in production systems, a number of developing countries started new vegetable research programs or up-dated and expanded older ones. Although the situation varies from region to region as well as within regions, the general level of staff capability and support resources is substantially better than it was when the last TAC missions reported. It is not unreasonable to suppose that once these programs are fully in operation, new and appropriate technology will find ready acceptance by farmers and quickly make an impact on production and use of vegetables.

30. The purpose of the survey undertaken here was not to assess individual institutions or national programs, but rather to determine whether conditions appear propitious for linking a number of institutions into a collaborative research network. It was also hoped that a closer look at existing activities would suggest how a network might best be organized. Could one network serve all interests or are conditions and goals sufficiently varied so that this would be impractical? The survey also, it was thought, might shed light on where to locate the new coordinating body and on the most appropriate staffing pattern.

Asia

31. Asia has a long history of vegetable usage, and it is also a region with great size and density of population. A high degree of urbanization, which associates with higher vegetable consumption, also characterizes the region. Most Asian countries have been moving to strengthen their national research systems over the past decade or two. It is not surprising therefore, to find that Asia overall has a substantial effort under way in vegetable research.

32. India and China are indeed special cases because of their immense populations and the important place vegetables traditionally have in the diet. Both nations are actively engaged in vegetable research and plan to expand their work. China cooperates with the AVRDC program based in Thailand, and India receives and tests material from AVRDC.

33. India's vegetable research is carried out at institutions funded by the central government, including the Indian Horticultural Research Center at Bangalore and the Indian Agricultural Research Institute. Work is done at a number of agricultural universities and other state-level institutions and by several private seed companies. The All-India Coordinated Vegetable Improvement Project (AICVIP) coordinates the work of many of these organizations. At present India is up-grading AICVIP from a project to a directorate. Officials of the Indian Council of Agricultural Research (ICAR), under which AICVIP operates, indicate that this change in status will result in more in-house research capacity. ICAR is also planning a central onion research institute, which will lead to more intensive research on this crop than is now possible.

34. In China the Vegetable Research Institute functions under the auspices of the Chinese Academy of Agricultural Sciences. The institute, located in Beijing, has a professional staff of about 240, of whom about 100 have the equivalent of at least a master's degree. Its work is divided into vegetable breeding, vegetable production, plant protection, and germ plasm maintenance. Among the crops on which research is emphasized are peppers, tomatoes, cabbage, Chinese cabbage, and cucumbers. Onion research is considered less urgent at this institute. There are 29 provincial academies for agricultural research in China, one in each province, and each of these has a horticultural department doing research on vegetables. The crop species under study at each is determined by local conditions. Also, many of the larger cities have vegetable research institutes that deal with both production and marketing problems. There are other vegetable research activities at several agricultural universities. The authorities at the Vegetable Research Institute indicate that they are very interested in international cooperation, mentioning plant breeding, germ plasm exchange, vegetable production, and tissue culture as particularly important.

35. Thailand does vegetable research under the Ministry of Agriculture and at several agricultural universities. Kasetsart University hosts a cooperative program with AVRDC. There is also an active private vegetable seed industry. Plans are under way to consolidate various Kasetsart activities and to add new ones to create a national vegetable center at the Kamphaengsaen Campus. Program activities will include breeding and genetics, crop management, post-harvest and seed technology, and farm-scale agro-industry. There will be an outreach arm to include training, marketing, and extension. The center will include research on both "export" commodities (baby corn, asparagus, yard-long beans, and mung bean for sprouts), and "domestic" commodities (tomato, peppers, squash, and onion).

36. In Bangladesh, vegetable research is done at the Bangladesh Agricultural Research Institute. It has invested substantially in developing physical facilities and in training staff. Serious consideration is being given to expanding this program and developing it into a horticultural research institute.

37. The Malaysian Agricultural Research and Development Institute is actively engaged in vegetable research focusing on pests and diseases, varietal improvement, and post-harvest and processing problems.

38. In the Philippines, the national research council has assigned a lead role in vegetable research to the University of the Philippines at Los Banos. It also has been an active post-harvest research unit. Work on vegetables is under way at a number of other institutions.

39. Pakistan's research on vegetables is done within the Ministry of Agriculture and by provincial institutions. They are concerned with home gardens and with commercial production for the domestic market and for export. Production problems include lack of local supplies of good seed even though conditions would permit seed to be produced in some parts of the country. Storage and marketing problems are significant. Major constraints to vegetable exports are seen to be lack of grading, poor packing, inconsistent supplies, lack of a market information, and lack of marketing experience.

40. In Indonesia, vegetable research by the Agency for Agricultural Research and Development is divided into two main undertakings: one for "highland" vegetables and one for tropical vegetables. The former has had priority, but work at low humid tropical sites is being expanded under a project supported by bilateral aid from the Netherlands. Indonesian authorities have expressed keen interest in expanding international cooperation and have outlined a network approach that they feel would be particularly valuable at this time. Indonesia's research recognizes the importance of two main types of vegetables, which they identify as "mixed garden" and "commercial." The latter is a relatively new feature of Indonesian agriculture. Home gardens have been traditionally important to nutrition in rural areas.

41. Both Nepal and Burma have taken steps to include vegetable research on their national research agendas.

42. The Taiwan Agricultural Research Institute and several other Taiwan agencies undertake vegetable research. They have focused on developing fully integrated production, marketing, and processing systems and have generated materials and procedures that have been widely adopted elsewhere.

43. The Asian Vegetable Research and Development Center is an internationally funded organization located in Taiwan. It is modeled after the international centers of the CGIAR system and will be discussed in detail later in this report. The AVRDC mandate focuses on Asia, but its genetic materials and production technology have found application in other continents.

Latin America

44. Countries of Latin America offer some interesting contrasts in the objectives of the vegetable sector and in research approach. Mexico produces vegetables for its own market and during winter exports substantial quantities to the United States. Some of the research benefits only the vegetable exporters, but most of it pays off for producers throughout

Mexico. Research in certain regions of Mexico focuses on domestic production. While home gardens have been promoted in Mexico, the orientation of the vegetable industry itself is increasingly commercial.

45. In Central American countries, the vegetable industry has developed primarily to meet local demand but also for export during the winter season in the temperate zone. There are some environmental niches that are particularly favorable to certain vegetables that may be processed for export.

46. The Andean countries are oriented to meeting domestic vegetable needs. A wide variety of climatic conditions are created by the mountainous terrain, and almost all temperate-zone vegetables can be produced one place or another. However, transportation problems often restrict commercial vegetable growing to areas near urban centers.

47. The Caribbean countries have great need to increase their production of vegetables and a substantial capacity to do so. Import substitution in support of the tourist industry is proving lucrative as is seasonal to the U.S. market. But the greatest challenge is to foster domestic consumption of local production.

48. Colombia, Venezuela, Ecuador, and Peru all have established research systems that are capable of independently meeting many of their needs, but even the major commodities that they have researched for years have benefited from cooperative research along network lines. The possibilities for vegetable improvement by this route are especially attractive because the number of technical personnel available to work on vegetables is small and the list of vegetables of interest is long.

49. Brazil has large and burgeoning urban centers and a vegetable industry that has grown phenomenally over the past 30 years. It is based on making use of sites near urban centers for commercial vegetable production supplemented by supplies shipped in from major producing areas in the semiarid northeast and the temperate zone of the south. Exporting from the northeast is thought to have major potential. Much of the central part of the country has sufficient altitude to ameliorate temperature conditions somewhat, and hence it produces temperate-zone vegetables. In the equatorial north, however, low altitudes and the prevailing humid tropical conditions limit production to traditional species of the tropics.

50. EMBRAPA, the semi-autonomous national research organization created by Brazil over the past 15 years supports all major agricultural production including vegetables. Several state-level institutions are also active in vegetable research. Brazil's vegetable research benefits substantially from the work of private seed producers and from a producers' cooperative. EMBRAPA will soon launch a technical cooperation project in vegetables supported by the Japan International Cooperation Agency.

51. Argentina and Chile both have national research systems that include work on vegetables. Their interests tend to be in subtropical and temperate-zone production.

Africa

52. Until recently, horticultural research and instruction in Africa have been considered part of agriculture generally and not a separate

discipline or area of study. This pattern was established during the colonial period and has only started to change within the past 10 to 15 years. Thus much of the work on vegetables has been done by persons with backgrounds in botany, genetics, or general agriculture. The establishment of departments of horticulture in several universities has tended to change this orientation as has the establishment of horticultural experiment stations by several ministries of agriculture. Increased attention to vegetable production and marketing has been stimulated by the potential for exporting fresh produce to Europe during the winter.

53. Vegetable research in Nigeria is being done by the universities and the research institutes that they control and by the National Horticultural Research Institute (NIHORT). The latter, which is under the Ministry of Agriculture, received substantial support from FAO when it was started in the mid-1970s. IITA had a vegetable research program at one time, and concern with vegetables continues in the farming systems work of IITA. It has collaborated with AVRDC in practical vegetable production. While Nigeria is short of trained scientists and there are current stresses on research budgets, the importance of vegetable research is well recognized, and there is a framework on which to build. Research priorities include home gardens as well as commercial production. Leafy green vegetables are a high priority in Nigeria.

54. In 1972 the government of Senegal founded the Center for the Development of Horticulture (CDH) and gave it responsibility for vegetable research. It has benefited from UNDP and FAO support and participation. Its multidisciplinary staff concerns itself with production and marketing problems for a range of crops for domestic consumption and for export. Through integration with an extension/training service, it determines what problems are faced by farmers and adjusts its research program accordingly. The same linkage is then used to transfer new technology to the field. The CDH would be a strong link in a collaborative research network.

55. Kenya has a strong interest in vegetable production both for home consumption and for commercial markets. In addition to the domestic market, significant exports are made to Europe during the winter season. Research is conducted by the University of Nairobi and the National Horticultural Research Station at Thika. The latter is funded under the Ministry of Agriculture and is responsible for fruits as well as vegetables. Kenyan research interests run the gamut from temperate-zone vegetables for the highlands to traditional and introduced species for the lowland tropics. Leafy green vegetables are deemed a priority area for research. There is a need for more trained staff and improved levels of support, but the basis for participation in collaborative activities is there.

56. Tanzania has an extensive network of experiment stations, two of which have responsibility for research on vegetable crops. The experiment stations identified for vegetable work provide a range of ecologies from temperate to subtropical and with varying moisture regimes, often in close proximity to one another. The Horticultural Research and Training Institute at Tengeru, near Arusha, works on indigenous and temperate vegetables and conducts a 2-year horticultural diploma course. The institute has been helped by a Dutch aid project. Tengeru, situated at 1250 meters elevation, has done work on seed production. With the proximity of Mt. Meru and Mt. Kilimanjaro, it has access to high-altitude areas for seed production

studies and to warmer, low-altitude locations at nearby experiment stations. The Uyole Agricultural Center near Mbeya in the south of the country, at about 1800 meters elevation, has worked on temperate vegetables. The potential for doing vegetable research in Tanzania is good.

57. Vegetable production is significant in Sudan both in home gardens and in larger plantings. Important commercial crops include tomato, eggplant, onion, cucurbits, and peppers. These plus okra and a number of leafy vegetables are found in home gardens. Vegetable research is the responsibility of the Agricultural Research Corporation, which is headquartered at Wad Medani. It conducts research at five stations along the Nile Valley and at four in Western Sudan. All of them work on onions and tomatoes; six also include okra; four include hot peppers; and three, eggplant. A national coordinator of horticultural research has been appointed to improve cooperation and focus among these widely scattered stations.

Prospective collaborators

58. There is no doubt that vegetable research programs in the developing countries are at a stage where they would benefit from a collaborative research network. If such a network is established, it is apparent that most developing countries would want to associate with it. The greatest concentration of current interest, level of staffing, etc., exists in Asia, but there are also centers of strength in Latin America and Africa. The distribution of interest or capacity to deal with specific issues is such that certain activities might be based in any one of these continents. It should be reiterated that most of the programs and institutions doing vegetable research are young. Many programs that are now considered outstanding did not exist 20 years ago. By the same token, those that are not now able to carry out the desired level of research can rectify the situation if they seriously undertake to develop capable personnel. Since many countries have substantially improved their basic foodstuff situation in recent years, the time is favorable for building strength in vegetable crops.

59. A great deal of enthusiasm for an international vegetable research network was also encountered among scientists at research centers in the developed countries. No attempt was made to obtain a formal expression of interest, but there is no doubt that such could be obtained. To name a few, senior officials of the following institutions attended conferences or were interviewed about the proposed new initiative and all responded with their time, professional inputs, and personal enthusiasm:

The National Vegetable Research Station, UK
The Institute for Horticultural Plant Breeding, Netherlands
Cornell University, USA
Rutgers University, USA
The Agricultural University, Netherlands
National Research Institute for Vegetables, Ornamental Plants, and Tea (NIVOT), Japan

60. These organizations, and many more like them, would probably be willing to provide specialized research services under contract and probably would do so at a lower cost than the new entity could do it itself. This

would be true partly because the capital costs for establishing these advanced research laboratories have already been settled, but also because these organizations often have vegetable research interests in common with those of the developing countries. For example, NIVOT investigates a wide range of species including tomatoes, peppers, and onions. As part of its extensive cytogenetic studies on disease resistance, Japan has cooperated with Malaysia in the project "Joint research on biotechnical development of tropical micro-organisms and plants." Under this project, scientists gathered and screened genetic resources of tomato, eggplant, pepper, and their wild relatives. NIVOT's cell and tissue culture program, supplements and supports this work. NIVOT's protoplast culture work has reached the stage that researchers are now able to regenerate plants of a number of these crops and their wild relatives from cell culture. The scientists expressed strong interest in cooperating on this and other lines of research. Thus biotechnical approaches to vegetable crop improvement might be undertaken by the new organization through cooperating laboratories with a minimum loss of time and at considerable savings.

61. Other organizations that could be helpful are FAO, several of the international centers, and various private organizations. FAO has carried out technical cooperation projects in the past and currently has some 15 separate vegetable projects in the field. FAO personnel have a broad knowledge of the subject worldwide and have been cordial in offering to help this initiative. Several of the international agricultural research centers should be viewed as special kinds of collaborators. Some do research on root crops that are considered to be vegetables by many of the developing countries. Some research grain legumes whose immature form can be used as a vegetable. The network concept being discussed here should lend itself to using this kind of support.

62. It also seems likely that aid agencies will wish to collaborate with the new organization in developing their own bilateral programs. The network mechanism should help disseminate the results of bilateral research undertakings that are now in progress or that may be established in the future. Heretofore, results of bilaterally supported projects have not been extended much beyond the host country in which the work was done. But with the new initiative, the national system in which work is done would quite likely be a member of the network. As such, the results of the bilateral project would become available to other network partners.

III. PRIORITY SPECIES AND RESEARCH OBJECTIVES

63. Perhaps the most troublesome problem facing the manager of vegetable crops research is how to deal with a wide array of species efficiently. Most research systems in developing countries have only a handful of scientists to work on vegetable crops, but a long list of crops of interest to farmers, government, and consumers. All too often programs become bogged down with too many crops and too few scientists, and in the end do little research. The most successful research programs concentrate on a relatively few commodities and aim merely to keep abreast of new technology for the bulk of the species that are of interest to their clients. When they receive inquiries or encounter problems with these crops, they may be able to offer help through published results or by

knowing specialists elsewhere who have pertinent information. A research entity run along these lines will regularly review its progress toward specific objectives and will, from time to time, alter its research agenda by suspending research on one commodity and taking it up on another. While some major commodities can remain on the priority list indefinitely, most vegetable crops in developing countries must be dealt with less thoroughly simply because of their large number and relatively small economic value. This management procedure is recommended for the new entity and the network it supports.

64. The earlier TAC reports listed various criteria for selection of vegetables to be studied. Key considerations included general economic value, geographic distribution, nutritional value, potential for improvement, and present level of research. The TAC Secretariat report of March 1979, "Proposal for the Creation of an International Center for Vegetable Research", contains a table rating 15 vegetables in these categories. It called for research on leafy green vegetables, leguminous vegetables, solanaceous crops, and on a group of "others" consisting of onions, cucurbits, okra, and cabbage. The table is reproduced in the Annex B as Table 5. It was reviewed for this study with horticulturists and others around the world and was seen as generally acceptable at this time. A few investigators felt, however, that some of the ratings on level of research were too high if only tropical research is considered.

65. While they did not quarrel with giving importance to nutritional value for setting priorities among species, the horticulturalists and administrators who were interviewed generally placed greatest importance on the economic potential of a given crop. Generally there was a scarcity of sound data on potential demand or other economic aspects. This is no doubt something that the new entity will wish to investigate in the developmental stages of a collaborative network. In the meantime, the strong, almost universal, support expressed by knowledgable persons for assigning high priority to certain crops provides a basis for initial selection. Some species are so highly rated by a wide range of observers that there can be little doubt of their basic value in the market place. When this coincides with good nutritional value, a strong argument exists for attention by a collaborative network. On the other hand there are situations where the outstanding nutritional value of certain species, combined with an urgent need for improving the diets of low income people will argue for high priority to a species that is not widely traded. The prestige as well as the financial impact of attention by an international body could well be instrumental in focusing attention on nutritionally valuable commodities that might otherwise be ignored.

66. The report of the appraisal mission on which the 1979 proposal was based made a number of additional comments on vegetable species on which accelerated research was indicated. Some of the report is reproduced here because current interviews confirmed much of it and it is highly pertinent to this proposal:

> "Tomatoes rank at or near the top among the species for which additional research is needed. They were identified for the 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 germ plasm 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 chilies (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." (From Appraisal Report, Paragraph 14, DDDR's IAR/76, January 1976)

"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 are a main source of some essential vitamins for most people in the tropics and hence should not be considered as optional foods. 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. 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 their harvest can be deferred for some time while greater yields accumulate. Successive harvest can be made from the same planting. This flexibility in harvesting makes them well suited for intercropping and relay cropping.... The leafy greens may well represent the greatest unexploited food resource of the world (emphasis added) and as such would deserve first priority for research were it not for the universal demand for more and better tomatoes." (From Appraisal Report, Paragraphs 13, 15, and 63 DDDR's IAR/76, January 1976)

67. At the Winrock conference, it was noted that the research agendas of several CGIAR centers include grain legumes and that they might be encouraged to include evaluation and improvement of vegetable cultivars of these crops in their investigations. Visits to two of the centers, IITA and ICRISAT, and correspondence with CIAT, revealed that they are already investigating these crops as vegetables or are giving serious consideration to doing so. The coordinating body might have a useful role in improving linkages between these centers and various national vegetable research organizations, but would not need to include vegetable legumes in its own initial research plan. Likewise, it is noted that several of the

international centers include vegetables as part of their research on farming systems for the climatic zones with which they are concerned. Consequently, it does not appear that the new network will have to include farming systems research on its own research agenda.

68. The 1985 TAC priorities paper suggested that CGIAR support should be limited initially to approximately six species: Amaranthus spp., Celosia spp., okra, tomatoes, onions, and Capsicum spp. The paper said the choice of species should depend on relevance to the specific region and their consumers, or suitability for research on an international scale, and on prospects of payoff. Attention was also drawn to the need to consider the conditions for rapid transfer and application of research results, particularly in establishing regional priorities.

69. In the present study, each scientist and administrator interviewed was asked to list six priority species that should be studied. Every person included tomatoes, onions, and peppers. Many also listed okra, eggplant, and cucurbits, including certain gourds with long shelf life.

70. The views on leafy green vegetables were not as consistent. In Africa, they were discussed as being of higher priority than any of the others. Among the leafy greens, amaranth was seen as quite important, but there appeared to be no strong consensus on which crops of this group should be emphasized. From locality to locality, there are major differences in popularity. In Asia leafy green vegetables were seen as important but perhaps less in need of research than the other crops listed. In Latin American countries visited, they were placed well below the others in terms of research priority. This may be because they are primarily grown in home gardens and do not enter much into commerce in major centers. Their use may have declined as urbanization has proceeded.

71. It is proposed that the initial commodities to be researched by the new entity shall be tomato, peppers, onion, eggplant, okra and the leafy green vegetables as a group. The legacy of TAC's prior deliberations on what species should be researched, combined with current readings on priorities within existing national programs, provides an acceptable base on which to outline an initial program for the proposed new organization. The limitation of six species suggested earlier by TAC seems reasonable and in consonance with the management philosophy expressed at the start of this section. It is further recommended that the question of which crops to address at the outset should be one of the subjects considered by the prospective participants in the network.

72. Likewise, which subjects are to be researched (heat tolerance, disease resistance, vegetable quality, etc.) should be decided jointly by prospective collaborators. The key questions in this regard should be resolved during the formative phase while the new organization is being established by the CGIAR. More specific proposals set forth in this report should not be seen as depriving future collaborators and management of their role in these basic decisions.

Tomato

73. The tomato heads the list of species desired by populations in the tropics. The things said about its popularity and role in the marketplace and in diets remain true. Progress has been made in its tropicalization,

but more remains to be done. The varieties best suited to hot weather are generally poor producers of seed under hot conditions, though they have a normal seed level when grown in cooler weather. Thus the seed suppliers must seek a cool location to produce seed, but seed multiplication may be hindered by diseases that occur in cool environments.

74. The difficulties presented by viruses in hot climates have proven to be more complex than was envisioned in the earlier TAC review. It appears that interspecific hybridization will be required in order to deal adequately with some of the virus diseases. This offers an example of the kind of problem for which the proposed new organization could be particularly useful. A coordinated effort can be envisioned in which advanced laboratories in Japan, Europe, and the United States contract to work on some aspects of the problem while virus specialists in India, Brazil, and AVRDC work on other facets of the problem. Other network partners might participate by collecting wild germ plasm, testing materials that are developed, and using them in their own breeding programs.

75. In addition to work on viruses, major research emphases would include resistance to fusarium and bacterial wilts, late blight, and nematodes. Breeding for quality factors such as fruit size, even ripening, firmness, better shelf life, and others related to processing would be included. It seems probable that nearly every network partner would wish to participate in at least some of the research areas envisioned for this commodity. It is also expected that advanced laboratories would be glad to participate for their own ends, as well as to cooperate in an international initiative.

Peppers

76. It is proposed that Capsicum spp. be identified as a commodity for inclusion in the network list. The most urgent problems in production of hot peppers are diseases, particular viruses which can be devastating. Susceptibility to a number of diseases other than viruses such as bacterial leafspot, southern blight, and Phythopthora rot will demand top research priority. The hot peppers are generally adapted to the high temperatures of the tropics, but the sweet bell types encounter fruit setting problems, which deserve attention. Research workers and administrators interviewed in this survey all urged that the new entity make this one of its priority species. Nearly all network partners are likely to participate in network activities which relate to the production of hot peppers. While interest in sweet peppers is not so general, they still command high priority in a number of national programs.

Onion

77. It is recommended that onion be on the initial list of species for study. While the onion is not as rich in vitamins as some vegetables, it is popular throughout the developing world. It is an efficient producer of calories and proteins on a per hectare per day basis. Important goals for varietal improvement of onions would include development of short-day types that are adaptable and can produce bulbs in the tropical environment. Short bulb dormancy to facilitate onion set techniques of production would be useful. Cultivars identified in Southeast Asia that have little or no requirement for chilling to break dormancy should be investigated.

Resistance to diseases such as purple blotch (caused by Alternaria spp.), basal rot (caused by Fusarium spp.), and smut (caused by Urocystis spp.) is needed. Good storability and shipping characteristics under hot and humid conditions are needed. Methods should be developed to improve onion seed production in the tropics by manipulating genetic factors and management during the storage period and by investigating treatment to induce synchronous flowering among cultivars. Improved cultural practices should be investigated as a means to improve yield potential of tropically adapted cultivars and better post-harvest management should receive attention as a means to enhance storability of bulbs in the tropics. It is expected that essentially all network partners will wish to participate in some or all of the above-mentioned research. Expressions of interest were volunteered in interviews in Latin America, Africa, and Asia, with scientists in each region calling for work on precisely the same problems.

Leafy green vegetables

78. The proposed strategy for leafy green vegetables is to screen a large number of species to identify ones in which production or use constraints might be overcome by appropriate research. This screening would include measurement of responses to inputs, but attention would also be given to low input agriculture. Species adapted to adverse soil conditions, poor drainage, drought, and other stresses would be identified for study and use in appropriate situations. The place of various species in farming systems and in farm family labor allocation would be evaluated. Nutritional value would be given attention, including production of nutrients per unit of land area and unit of time.

79. Species listed in earlier TAC reviews should be included in this screening. These were Amaranthus spp., Celosia spp., Ipomea aquatica, Bossella alba, and Corchorus olitorius. In the current survey, various scientists recommended that leaves of root and tuber crops, such as sweet potato and taro, be included in the screening. Several scientists urged that leaves from trees such as papaya, leucaena, moringa, and others be evaluated. Leaves of cowpeas, winged bean, cucurbits, and others were mentioned as interesting for further evaluation. There are well qualified scientists scattered around the world who are quite knowledgeable about this mixed group of edible plants and who are enthusiastic about making them more useful. Some are working in the tropics and others are in research centers and universities in the temperate zone. The network approach is well suited to harnessing this interest into an objective program of testing and research that avoids advocacy and that includes evaluation of social constraints to the production and consumption of these nutritious crops. It is recommended that leadership for this effort be placed in Africa where interest is strongest. It is anticipated that network partners in Latin America and Asia will be helpful in identifying germ plasm, in testing materials, and in otherwise advancing the objectives of this network program. Testing and use in humid tropical areas in the Amazon and in Asia will be of considerable interest.

Eggplant

80. The eggplant, Solanum melongena and related species, is well adapted to the tropical environment and therefore is grown widely in the tropics with less problems than tomatoes and peppers. As a related species,

research on this crop can be added rather easily to an agenda that includes other solanaceous plants. Eggplant is generally inferior in nutritional value to tomatoes and peppers, but it is a good producer of calories and proteins on a per-hectare-per-day basis and is generally more widely available, costs less, and is consumed in larger quantity. Some cultivars have edible leaves, and there are prospects for developing varieties with higher vitamin A content. Because eggplants are widely grown and eaten in the tropics, improvement in this regard could be particularly valuable to the nutrition of poor people. A number of improved varieties, some with bacterial wilt resistance, have been released in USA, India, and Taiwan. Locally preferred landraces are, however, still common in tropical countries where the crop is usually grown mixed with other crops in home gardens or small farms. Some of these local cultivars have small, poor quality fruits, but being extremely rugged and disease resistant, they are easy for small farmers to use. Modest efforts aimed at improving fruit size and quality might pay off rapidly. Limited germ plasm is kept in genebanks in USA, Netherlands, and India. Among diseases, bacterial wilt and Phomopsis blight are most common. Rootknot nematode can be a problem, and fruit borer and aphids are significant problems. Breeding for resistance to these constraints should have priority in eggplant improvement.

Okra

81. Okra, an annual crop that is well adapted to hot weather, is widely cultivated in the tropics. It is grown mostly for its tender fruit, which is a common ingredient in many traditional dishes in the tropics, but the leaves are also eaten. It is especially high in calcium. The fruit is sun dried for storage in many tropical countries. Recently, attention has been given to okra seed as a source of protein and vegetable oil. Collections of germ plasm are kept in USA, Nigeria, Ivory Coast, India, and the Philippines. Insects, nematodes, and diseases are the most common threat to production in the tropics. There are known sources of resistance to some of these and breeding to incorporate them should have priority. It might be possible to develop varieties that start flowering early (30 days after planting) and to extend the duration of the harvest period for up to 6 months. Breeding for higher yield offers promise. Many native cultivars yield around 2 tons per hectare while improved varieties may yield 6 or 7 tons.

Heat tolerance in other species

82. In addition to the above research activities, the suggestion has been made that the network consider supporting work on a range of other species with the limited objective of identifying heat-tolerant lines. The point is that the network technique lends itself to testing of environmental adaptation. By selecting sites at different altitudes, the researchers can subject crops to a range of temperature conditions. By using different planting dates and locations, other sets of temperature conditions can be obtained. While such relationships may be confounded by disease or other factors, some useful material can be identified by this route. Once sites have been selected for testing of the principal crops, additional data can be gradually obtained for other species with modest additional effort. Materials identified as promising could be passed over to interested national research systems, private industry, and others for further study and use.

Social science research

83. It is expected that economists, sociologists, and anthropologists will be integrated into network activities. The economists, for example, would provide analyses of local and terminal markets for vegetables, particularly as regards vegetable prices, market fluctuations, market access, export potential, and similar factors. But gaining a better understanding of social behavior associated with vegetable production, handling, marketing, and consumption would be equally important. To investigate these aspects of the production process requires a sociologist or anthropologist competent in surveying households in order to discern the impact of division of labor on horticultural production and the effect of household social status on access to and utilization of production inputs and technology. The social scientist should also contribute to analysis of the socioeconomic factors affecting dietary status and the uses of vegetables. Information about food likes and dislikes, consumption patterns, responses to innovative nutritional programs, and similar relationships would be important bases for understanding and promoting production and consumption of vegetables. Such a scientist could also be important in effecting technological change. An understanding of farmers' knowledge of local conditions and their ability to accept new technology is important in selecting vegetable research topics and extending research results.

84. These examples suggest that the sociologist-anthropologist should be an integral part of the planning and design stage of vegetable research. The initial staff of the coordinating body, in other words, should include experienced social scientists. Steps might also be taken to include additional social scientists in cooperating countries to broaden the range of expertise.

Seed production research

85. Many vegetable farmers in the tropics find it almost impossible to obtain seed of good quality. Because of the lack of local seed sources, they often must import seed, usually from temperate-zone suppliers. Much of this seed is produced for temperate growing conditions and is generally not an appropriate varietal type for the tropics. Unfortunately, such seed may also be over-age with low germination percentage by the time the tropical grower receives it. Frequently seed is poorly packaged for trade under tropical conditions where high humidity can quickly destroy seed that is not in moisture-proof containers.

86. Some countries have made rapid progress in recent years in the development of a seed industry. The technology is such that similar progress should be possible in many other countries. This type of technology transfer can benefit substantially from close association with research work. In fact, some adaptive research may be necessary in order to identify lines that can be induced to flower and produce seed under environmental conditions available to the seed producers. It is proposed that the coordinating body have staff capability to help countries deal with these techniques. Private as well as public agencies should be able to avail themselves of assistance in these matters.

Post-harvest problems

87. In many parts of the developing world, major losses of vegetables occur because of problems in post-harvest storage, preservation, transport, and marketing--what might be called the agribusiness aspects of the industry. Less obvious, perhaps, but equally serious are losses that take place at the household level and that involve subsistence rather than cash crops. The whole subject needs careful attention by the network in its efforts to find ways to increase real productivity--the amount of nutrition delivered to humans.

88. In viewing the commercial side of the vegetable system, the network must recognize that the profit depends largely on effective handling of the product from the time it is harvested until it reaches the consumer. A starting place might be some case studies of vegetable production systems that have proven to be particularly successful in providing urban populations with steady supplies of high quality vegetables. The cities of China for example have highly developed vegetable production and delivery systems that closely link farm production capacity with market requirements. Sao Paulo, Brazil, has a very different but equally effective system of supplying a large urban population with good supplies of high quality vegetables.

89. A substantial study of this problem was done by two U.S. post-harvest specialists working out of AVRDC. There are several new centers of strength in this subject in Asia and much interest in it by Asian scientists. It is recommended that this be given attention by the new entity and by the network it aims to foster. In order to have maximum impact, it would be necessary to have expertise in both post-harvest physiology and marketing economics. Public leaders are particularly aware of some of these problems and would welcome appropriate technical input.

90. Since many of the storage and preservation aspects of the post-harvest handling of vegetables concern subsistence rather than cash crops, a better understanding of social factors would enhance the network's efficiency in focusing on the kinds of technological change likely to be accepted by producers. This area of applied research would benefit from the active participation of social scientists well versed in household surveys and studies of labor allocation.

91. Small-scale agroindustry at the farm or village level based on preservation of vegetable products by various kinds of processing is growing in parts of the developing world and is starting to be of interest to national research systems. The network should give attention to this subject for it may prove possible to transfer the technology from one region to another fairly easily.

Interactions with nutrition

92. The first goal of the new organization in the field of nutrition should be to encourage interchange between specialists in this field and those in the biological and social sciences. The basic interactions among these disciplines is apparent, yet in practice, specialists often study aspects of the same problems with little communication. The production horticulturist tends to be influenced by the economic aspects and hence may

decide against working with a particular commodity simply because it enters only marginally into commerce. The horticulturalist is aware of the nutritional value of many vegetables and may even cite it to justify support for his research, but in practice, economic factor generally take precedence. Regular communication between nutritionists and horticulturists would be the first step in ensuring that important opportunities to improve the quality of diets are not overlooked. Joint approaches to promoting the production of vegetables in home gardens may be one of the first places to link these two specialties. The real meeting ground for the nutritionist and the horticulturist is in their efforts to influence the production and use of those vegetables that are of unquestioned value for human nutrition, and it is with the small farmer and his home garden, or lack thereof, where the focus in sharpest. If lasting changes are to be achieved, researchers must comprehend the social factors at work. The key actor in obtaining this insight is perhaps the social scientist who understands nutrition or the nutritionist who is at home in social science techniques and approaches. If it is not possible to hire an individual with this mix of expertise, the coordinating body might engage nutritionists as consultants in planning and implementing network-sponsored research. Contractual arrangements for research on nutritional value could also be made once specific commodity programs are started.

Training

93. There exists a great need in all regions for training in many aspects of vegetable research and vegetable production. Training should be done by the new entity directly and in cooperation with network partners and others, and by making use of existing programs now being offered. Some training should be closely integrated with research activities and should provide young scientists with an opportunity to gain experience under the direction of qualified researchers. It is expected that participants will learn the practical aspects of vegetable crop production as well as research methods. Scholars who intend to make their careers in extension or production activities should be given intensive training in crop management and in communication techniques for introduction of new technology to farmers. Emphasis will be on small farmers where vegetable crops are grown in conjunction with cereals and other commodities. Students will learn the art and science of vegetable production itself, but must also understand the whole farming system in which vegetables complement other commodities, providing better diets for the farm family and increasing farm income.

94. Training in special subjects such as vegetable seed production should be offered to selected groups of students. Training courses should be arranged cooperatively with network partners for persons with whom they work in research, in technology transfer, and in special subjects. Many highly qualified horticulturists interviewed in this study expressed willingness to help in organizing these courses and to act as trainers. Also, it is noted that some excellent courses are offered in donor countries. These include the International Agricultural Center, Netherlands, the Japan International Cooperation Agency, and Rutgers University, USA. These should be utilized by the new entity where appropriate in the overall program.

95. The network should also seek ways of improving graduate study opportunities for vegetable researchers. Almost all national systems have shortages of trained people and for some the shortages are acute. As the

new program develops, it may prove appropriate for the coordinating body to seek funds for a limited number of fellowships to be awarded as part of its network-fostering activities. It would also be appropriate for the coordinating body to have funds to permit graduate students to do thesis research at its operations centers or in cooperation with network partners. In considering human resource development, it should be noted that there are few women trained in horticulture, yet a great deal of the production and marketing of vegetables is in the hands of women.

Information services

96. Information exchange is the starting point for a network, and it is proposed that the new entity will make use of modern technology and established principles of communication to accomplish this. Some of the important activities in this area will include:

a) A roster of professionals in vegetable research. The International Society for Horticultural Science and some national scientific societies maintain lists and registers of professionals whose interests are pertinent to this initiative, and efforts will be made to utilize these to the extent possible. However, the network will be an in-house computerized roster that is readily available for reference. In due course, it should be made accessible by modem from sub-units and national program.

b) Bibliographic services. The coordinating body should make efforts to assemble scientific literature for the commodities with which it works. In accomplishing this, it will use existing services where appropriate and contract for others to collect materials, published and unpublished. As noted, it may be desirable to contract with AVRDC to prepare abstracts and to store and disseminate bibliographic materials.

c) A database on experiments conducted by the network partners. Ideally, scientists at cooperating institutions will enter data via microcomputer using software that has been developed for the network for entry, retrieval, and analysis. They will have access to and receive updated versions of the full database regularly. The coordinating body will be responsible for preparation software and for training in the use of database programs and in data retrieval. To accomplish this, they will use contracted services of computer specialists at institutions within the network or outside of it.

d) A newsletter for use of network members and others. The newsletter should keep members informed on what is happening in the network between meetings and generally foster a feeling of a team effort. News items related to the field of vegetable research and development might be included from time to time. Through selective distribution of the newsletter to various public agencies and officials it could be influential in creating support for vegetable research and development.

IV. RELATIONSHIPS WITH AVRDC

97. The Asian Vegetable Research and Development Center (AVRDC) in Taiwan has been engaged in research and training with vegetables since 1973. It has an excellent record of setting objectives and working systematically toward them. Technical problems abound in a program as complex as that of a multicommodity vegetable research center, but AVRDC is recognized as having made steady progress on its research agenda. This has called for improvement of varietal characteristics and production techniques for tomatoes, mungbean, soybean, sweet potato, and Chinese cabbage. They have recently added peppers to this list.

98. AVRDC's political problems, which are based on its location, are mentioned from time to time and are generally recognized as having been a substantial burden. Over time, however, AVRDC has found ways to limit these effects. Its strict adherence to a professional orientation and a dedication to scientific ends and to international service has been respected by its collaborators and its clients, who have demonstrated a similar attitude. The establishment of a separate activity in collaboration with Kasetsart University of Thailand has ameliorated some of the difficulties and they have become steadily less serious over time.

99. The relationship between the new entity and AVRDC should be one of close cooperation. Reasonable efforts should be made to avoid duplicating activities. The new organization is expected to make its greatest impact by stimulating and coordinating the work of others rather than through its own research output. Thus, it should relate to AVRDC much as it would to any other network partner.

100. Looking at specifics, AVRDC has two well-established functions that clearly appear capable of supporting the expanded programs that are proposed for the new entity: maintenance and storage of germ plasm and bibliographic services. At AVRDC these activities are well developed and make use of the latest technology. The IBPGR has already made provisions to maintain certain stocks at AVRDC. The physical facilities are capable of handling several times as many accessions under the same management.

101. The Tropical Vegetable Information Service of AVRDC prepares a bibliography for three vegetables and can regularly supply abstracts to interested scientists. They can also supply the full article in photocopy. The system is computerized and could be accessed by other organizations if this proved desirable.

102. It is also noted that AVRDC's training program operates not only at its home base but also at its sub-base in Thailand. The regional office in Thailand handles this training, cooperative work with Thailand's vegetable research group, and various kinds of consultations with the People's Republic of China.

103. Taking these points into account, and recognizing that the network would have to concur, AVRDC would undertake to provide, through appropriate contracts, the following services to the network:

a) Primary responsibility for maintenance and long-term storage of network germ plasm along the lines recommended by IBPGR. This would not preclude the operation of national storage centers, but it would mean that the new organization would not start or fund another general maintenance activity. It might also be desirable to arrange for storage of duplicates at locations in Africa and Latin America, perhaps at IITA and CIAT. Seed of a given crop would be multiplied in an appropriate environmental location and not necessarily at the storage center.

b) Lead responsibility for bibliographic services for those commodities on the network's research agenda. However there might also be other contracts to identify and collect published and unpublished material in other parts of the world or to maintain separate libraries or document files.

c) A leadership role in the evaluation of genetic materials and improvement of certain crops with particular regard to identifying sources of disease and insect resistance and to adaptation to tropical growing conditions. Its role would not be exclusive, but for tomatoes and peppers, it would be predominant. Other commodities could be added to this list as agreed upon.

d) Joint responsibility, with one or more other entities in the network, for training, particularly in the Asian region, but initially for the whole network.

104. It is of course recognized that AVRDC has many activities that would remain largely separate from network programs. The close association of AVRDC with the coordinating body and network partners on some topics would not prevent AVRDC from carrying on independent activities.

V. SOME COMMENTS ON NETWORKING

105. The use of the networking approach has been growing steadily over the past two decades, and a body of experience is now available for guidance. Some useful discussions by a network of the Special Program for African Agricultural Research[1] are particularly pertinent to this report. They point out that "....a critical mass of scientists is needed to develop new knowledge through basic and applied research. Experience has demonstrated that successful research in commodities has usually required the team efforts of 8 to 12 scientists working in a range of disciplines--breeding, entomology, pathology, agronomy, soils, and economics--often making use of more basic genetics, plant physiology, and other information...." If the critical mass of scientists is not present in a national program, it may be possible to compensate by linking researchers from several countries and collaboratively focusing on specific problems through networking.

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1. Prepared under the auspices of the Special Program for African Agricultural Research (SPAAR) Brussels, Belgium, July 7-8, 1986

106. Donald L. Plucknett and Nigel J.H. Smith[2] have identified seven "principles" of a successful network: (1) the problem is clearly defined and a realistic research agenda is drawn up; (2) the problem is widely shared and participants feel that they are likely to gain from the venture; (3) strong self interest exists; (4) participants are willing to commit resources such as personnel and facilities; (5) outside funding is available to keep the network functioning for at least the first few years; (6) participants have sufficient training and expertise to make a contribution; and (7) there is a strong and efficient leadership in whom the participants have confidence. To these might be added: (8) There is good communication among component parts of the network, and (9) there is a sense of belonging to a common effort.

107. The SPAAR conferees identified several types of networks including information exchange networks, scientific consultation networks, and collaborative research networks. The latter, with some modifications, is what was envisioned in the Winrock conference proposal for an "International Vegetable Research Secretariat." It would involve joint inter-country planning, implementation, and monitoring of research and the free exchange of results and materials. The Winrock proposal envisioned contract arrangements to fund agreed-upon units of research. It was expected that research contracts would be drawn-up with cooperating national research units within the network, but also with advanced laboratories, public or private, in other parts of the world.

108. The funding of collaborative research is critical to the success of a network. It is expected that participating members will continue to finance research on the network subject at a level at least equal to that existing prior to the start of the program. That is, governments would be expected to at least maintain financial support for their own vegetable research rather than using network funds to permit shifting of resources to other activities. It is also apparent that expanded research activities will require additional funds, and experience has shown that, for a network, the needed resources must come from outside sources. This poses the question of how to allocate and account for funds on an objective and businesslike basis. At least two international centers, CIP and IBPGR, have developed contracting procedures in which collaborating entities formally agree to conduct discrete units of research for the center.

109. Restricted core and special project funds might also be used to support collaborative research. For such funding, more flexibility should be permitted to meet requirements of the donor as well as of the network. The SPAAR group has considered a variety of funding situations. Several points they set forth can be summarized as follows:

a) An overall network strategic plan would be developed by a small steering committee comprised of selected scientists from national programs and the network coordinator.

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2. Abstracted from article: Networking in International Agricultural Research by Donald L. Plucknett and Nigel J. H. Smith, Science, Vol. 225, Sept. 7, 1985

b) An estimate will be made by the network coordinator in consultation with the steering committee of the funds needed to supplement the national program budgets and to manage and monitor such supplemental support. Funds will then be solicited from one or more donors to provide the supplement to national programs.

c) Representatives of the steering committee and the coordinator, augmented as appropriate by outside consultants, will decide on the allocation to national programs.

d) Donors could provide funds directly to national programs, the donors managing the funds themselves.

e) Donors could provide support through in-trust arrangements with the coordinating body. If this is done, the coordinator will negotiate with appropriate national government officials the terms of reference for the support to be provided. The terms should include such items as assurance of continued national commitment for network activities, willingness to permit monitoring of financial transactions and evaluation of results, and assurance that the national program will provide support of specified types and amounts.

VI. THE COORDINATING BODY

110. TAC's intent in commissioning this study was to consider action that the CGIAR might take that would in turn result in the founding and operation of a vegetable research network. To arrive at a recommendation, TAC must consider the nature and procedures of the entity it would create, the nature and procedures of the network that would be formed, and finally the interaction between the two. In this section of the report, the coordinating body will be examined along with some of its interactions with the network. Section VII will deal directly with the form and functions of the network and will further examine of some of the interactions with the coordinating entity.

Functions

111. The main effort of the coordinating body will be the operation of a collaborative research network. This will involve working with network partners in a continuing evaluation of constraints to vegetable production and consumption and in identifying problems on which research should be concentrated. An inventory of research under way as well as research needs should be a continual undertaking.

112. For the CGIAR the principal mechanism of funding network research will be contracts between the coordinating body and network partners and others. This will also be true for much of the training and for germ plasm storage, bibliographic services etc. Thus a major activity of the coordinating body will be related to contract development, monitoring, and evaluation.

113. The coordinating body will propose CGIAR funding for a program of research for which it will arrange implementation. The research will be done (a) by network partners in the developing countries, (b) by advanced

institutions, (c) by individuals employed by the entity for outposting in national research systems and (d) by the coordinating body's own headquarters staff working in partnership with the host country program.

114. The coordinating body will propose funding for various kinds of training that will enhance capacity to carry out research and will improve the vegetable production techniques used by research and extension staffs and ultimately by farmers. It will also propose funding for maintaining a roster of professionals in the vegetable field, for a bibliographic service, and for other types of information storage and exchange. Such activities will, to the extent possible, be implemented by network partners or by other interested institutions.

Name

115. Several people interviewed in the course of this study proposed names for the new organization. Among them:

International Vegetable Research Secretariat
International Vegetable Research Council
International Vegetable Research Board
International Vegetable Research Network
International Network for Vegetable Research
International Service for Vegetable Research
International Collaborative Research Program
International Vegetable Research Program

116. Presumably the choice should be one that describes the organization concisely and well. The functions of the organization as set forth above and the activities of the staff as discussed elsewhere certainly suggest an organization dedicated to service. To refer to the new entity as a "service" would emphasize this important characteristic. Since an acronym is likely to emerge, it would be well to avoid a name whose acronym could easily be confused with others or would otherwise give problems. Subject to further checking to minimize conflicts along these lines, it is recommended that the entity be called, "International Service for Vegetable Research."

Location--principles

117. One great advantage of the network approach is that many different environmental locations can be included in the total research program by simply arranging for network partners to carry out particular studies. Thus the conditions at the headquarters of the new entity are less critical than for a traditional international research center. Nevertheless, it is expected that scientists at the headquarters will be involved at least part time in research and that they will work closely with a dynamic host country program. For selecting a headquarters site, it is, therefore, recommended that the guidelines proposed by the 1976 Appraisal Mission of TAC be referred to. Among their recommendations were the following:

a) The site should be in the lowland tropics with well-defined wet and dry seasons in order that responses under both humid and drought conditions can be determined.

b) It should have access to a range of altitudes to provide different temperature regimes and to facilitate seed production.

c) It should be in a country with a tradition of good and diverse vegetable growing.

d) The location would preferably be near a good faculty of agriculture where cooperative programs of graduate study might be developed.

e) A prospective host country should be interested in having the coordinating body and be willing to facilitate the entry of scientists and the supplies, equipment, and other resources, including seeds, that they require.

f) It should be in a location with schools, medical resources, and cultural activities adequate to attract qualified scientists.

g) There should be adequate communication and travel facilities.

118. A stated intention of the network approach is to maximize the use of existing facilities, and there is an implicit understanding that a network is less permanent than a center. It is proposed therefore that an additional criterion be added, namely:

h) Facilities should be available that might be lent or leased to the coordinating body for use as a headquarters.

Location--specifics

119. A number of suggestions were volunteered as to where the headquarters might be located. Some were general. For example, the center should be in Asia because of the size and density of population, the existence of a long tradition of vegetable production, and the presence of several relatively well staffed vegetable research groups. Another idea was to place it in Africa where food problems are serious, vegetables are vital to nutrition, and environmental conditions offer a stern challenge in some heavily populated areas. The statement was that this would ensure that African problems would get fair attention. A compromise between these positions would place the headquarters in Asia with a branch unit in Africa. This scenario called for a liaison unit in Latin America, perhaps at CIAT, to foster network interests in that region. There were also proposals that the coordinating body be located in a developed country, possibly in the Netherlands. Those advocating this view also emphasized the role of the new entity as coordinator. Rome was also mentioned as a location.

120. Several more specific proposals about locating the headquarters within Asia were made by third parties. Three of them are recorded here for the TAC's information. (1) Ask AVRDC to move its headquarters away from Taiwan and to assume the responsibility for the new entity. (2) Make arrangements with IRRI and/or the University of the Philippines, Los Banos, to provide physical facilities that could be lent or leased. (3) Enter into an agreement with Kasetsart University, Thailand, to locate the new entity at its Kamphaengsaen campus. The physical facilities both in the Philippines and in Thailand are excellent and most of the criteria mentioned in paragraphs 117 and 118 are met.

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121. No serious discussions were held with any of the suggested host organizations and in fact the principals named in some of these scenarios are unaware that the ideas were put forward. Among these proposals, however, are some viable alternatives.

122. To place headquarters in Asia makes eminent good sense for the reasons stated. In particular it would build on strength and would allow the new mechanisms to be tested and developed under conditions with the greatest probability of success. To take less than full advantage of what now exists in Asia would be a serious mistake.

123. Within Asia, Thailand offers many advantages. Its location allows easy communication, it has the necessary physical facilities to accommodate a program such as this, and its authorities have a long-standing attitude favoring international cooperation. The Bangkok metropolitan area has adequate housing facilities, schools, health services, etc. and it is well regarded as a residential location by people from all over the world.

124. At the Kamphaengsaen campus of Kasetsart University, exceptional facilities have been recently completed. They include dormitories and classrooms for special non-degree training. The laboratories are fitted with a range of modern equipment. The administration is interested in maximizing the utilization of their resources. It is noted that Kasetsart University already hosts regional activities for IRRI, CIMMYT, CIAT, CIP, and AVRDC. Most are at the Bangkhen campus, which is near the airport in urban Bangkok. The AVRDC unit in Thailand uses experimental fields and training facilities at the Kamphaengsaen campus, which is about an hour's drive from Bangkhen.

125. The proposal of a branch unit in Africa is reasonable. Properly situated, it could be responsible for certain activities for the whole network as well as for coordinating activities uniquely of concern to Africa. Subject to further discussions, an early undertaking of this unit would be research on the leafy green vegetables. It is proposed that the Africa unit would be hosted by a national research system. In selecting the specific site for this unit, it would be desirable to have experimental fields at different altitudes. This would facilitate work on seed production, which is a particularly important problem in Africa. Also a location with distinct wet and dry seasons would be advantageous for seed production work and for research on leafy green vegetables. In the more humid areas, adapted species of the leafy greens appear to be quite productive both in the wild and under cultivation. In areas that are less humid, the leafy crops need more tending and more research is needed on cultivation and breeding. In selecting a site for this unit, it is essential that the needs of an international organization as regards movement of staff, trainees, and visitors, and of genetic materials be well recognized. It appears that a location in either Kenya or Tanzania should be considered. Cameroon or Ethiopia might also have suitable conditions and might be interested in hosting this unit.

126. It is recommended that the possibility of establishing a Latin American unit of the organization be examined during the first organizational meetings with potential network partners. Unfortunately this survey included fewer contacts with potential users in Latin America than in Africa and Asia, and specific recommendations are thus more difficult.

However, an impressive number of knowledgable people who commented upon the draft report during International Centers' Week were of the opinion that many Latin American institutions will be keenly interested in network membership and that a branch unit will be essential to foster their full participation and utilization of the network.

127. If the decision is positive, serious consideration should be given to placing the Latin American unit with either CIP or CIAT. Both these centers are aware of the proposed vegetable initiative and have been most cordial in offering their assistance. CIAT, as noted elsewhere, may expand its bean program to include green bean cultivars. CIAT is collecting some data that will help the new vegetable entity chart a course. They point out that since vegetables are easily substituted in production as well as in consumption, an individual commodity such as green beans can only be studied in the context of other vegetables. Alternatively or in addition to collaboration with these centers, the new entity might wish to establish a direct relationship with one or more national programs in Latin America.

Research activities of the coordinating body

128. Questions of what kind and how much research the coordinating body should do itself without doubt elicited greater differences of opinion than any other subject related to the creation of a collaborative research network for vegetables. A number of those interviewed took the position that if the coordinating body is itself directly involved in research it may tend to relegate network affairs to a secondary level of importance. Over time, this argument went, the new entity would become increasingly involved in research and the collaborative network concept would languish. Equally forcible arguments were put forward that an implementation plan that did not call for in-house research would be severely limited. Without a direct input from the coordinating body, these individuals felt, the gaps in national systems' capacities were such that the network would not on its own be able to generate the steady flow of technology that would be essential for success. The opinion was also expressed that it would be hard to interest the right kind of staff in employment if they could not expect to be involved in research.

129. While both points of view have certain validity, neither appears to be fully acceptable. It seems reasonable to expect that the review process of the CGIAR system would ensure that in-house involvement in research would not predominate over network needs. Certainly this potential problem is not an adequate reason for ruling that the coordinating body should not be directly involved in research. The entity must be constantly "working itself out of a job." In fact it may prove easier to phase out a staff research activity in a coordinating body supporting a network than it is in an international center.

130. The gaps are evident in the national research systems' current capabilities to do certain needed vegetable research. In the absence of a base research facility of its own, the network could find itself hampered when collaborating members are unable to generate the needed materials or information. Some of the more obvious examples in this category are in advanced research areas but the built-in concept of the network is that contracts will be arranged with advanced laboratories to do this "up-stream"

research. A more troublesome problem would be work that must be done in the tropics but for which no network partner is equipped or staffed to do the job.

131. The recommended procedure is for the coordinating body to do its research by participating in collaborative projects with national programs rather than by conducting separate studies. The coordinating body should be prepared to post appropriate staff into existing national programs when necessary to get essential research done. By appropriate contract, it should be possible to ensure that gaps will be filled by such personnel until local staff can be found. The institutions would be strengthened by this process and the network would gain the necessary flow of technology. At the headquarters and at the branch units, research participation would be in direct partnership with the host countries' national programs. As a result there would not be an area set aside at the headquarters which would be identified as the separate work of the coordinating body.

132. The coordinating body would supply personnel to research projects that at a given stage in the evolution of the system could not be done adequately by the network partners alone or that could be done more efficiently with participation of the coordinating body. Earlier in the report (paragraphs 71-96), a prospective research agenda for the network was outlined. Procedures for turning the tentative agenda into an action program will require consultation between network partners and the coordinating body to decide not only what research is to be done, but who will do it. At that time, the specific research activities of the staff of the coordinating body will be decided as well. These activities will be regularly reviewed and revised. Since this research will be in cooperation with network partners, it is presumed that much of it will eventually be fully turned over to them.

133. For the first several years, much of the research in which staff of the coordinating body will directly participate will be in the area of varietal improvement. The network will need a steady flow of early generation breeding materials of appropriate type. Only with tomatoes does it appear that a reliable flow of materials can be expected at the outset. For most commodities, to achieve a high level of activity quickly, it may be necessary for the coordinating body to out-post staff to an interested network partner. If this is not feasible, or fast enough, the coordinating body might, together with national research scientists at the headquarters or one of the branch units, engage in varietal improvement. A variant of this approach might be "in-posting" staff from one or more partners for a collaborative undertaking at the headquarters. One or more scientists from among the network partners might transfer to the headquarters for 2 to 4 years in order to pool breeding programs into a joint program serving the entire network. After a time, these scientists would return to their home countries with greatly enhanced breeding programs, which they would continue at their home institutions.

134. The balance of the research of the headquarters group would emphasize subjects that are important to the expansion of vegetable production and consumption, but that are now given little attention by national programs. These subjects were mentioned in the section of this report that deals with recommended research initiatives for the network. They include socio-economic constraints and critical bottlenecks such as seed supply and post-harvest handling.

135. The proposed research agenda for staff of the coordinating body should not be seen as minimizing the importance of many production aspects such as fertilization, pest management, planting procedures, water management, and similar subjects. Rather, it appears that national programs are generally prepared in terms of staff and facilities to deal with these more location-specific subjects. Where this is not the case, the coordinating body should consider other actions. An example might be irrigation management for vegetable crops. Where water supplies are limited, allocation to high value crops such as vegetables is indicated. While individual vegetable producers recognize this and use available resources accordingly, most vegetable research groups have little in-house capacity on water management. The new organization might consider attention to subjects such as this.

VII. THE PROPOSED NETWORK

136. During the interviews, opinions were solicited on how to organize a network for vegetable research, how decisions might be made, and so forth. TAC has requested that, where appropriate, alternatives be set forth in this report. Some of the alternatives on key issues follow.

Commodity versus geographic orientation

137. Should there be one worldwide network or should there be perhaps three regional networks, one in Asia, one in Africa, and one in Latin America? Or would it be better to organize along commodity lines and relegate geographical considerations to secondary importance?

138. The answer seems to be that for certain subjects global treatment is necessary, but for others a regional approach would be more appropriate. For dealing with commodity problems, the orientation and experience of the international centers provide pertinent guidance. The commodity orientation is central to their approach and they are organized into integrated commodity research programs. IRRI has a rice program, CIMMYT one on maize and one on wheat, CIAT one on cassava and other crops, and so on. Some of these crop mandates have, from the start, been stated to be global, while others have been seen as regional, or at least not global. But each of them looks at a crop as the basic unit of concern and undertakes a research program aimed at constraints on its production and use. It seems clear that the structure of the network should reinforce the stated intent to develop technology for selected crops. It is, therefore, the recommendation of this report that the new entity shall have commodity programs that are global in their orientation. Each will deal with constraints to that commodity on a worldwide basis. Basic decisions and funding would be made along these lines.

139. It is recommended that regional networks be considered as a second organizational concept. A number of regional concerns will cut across commodity lines. Some might be related to training, others to marketing, seed production, or similar subjects. Also, it is recognized that people can get together more easily for conferences, program evaluation, etc. on a regional basis than they can on a global basis.

Network nomenclature

140. For the sake of clarity, a system of nomenclature that does not over-use the term "network" is recommended. Perhaps it would be well to refer to the world wide partnership as the "International Vegetable Research Network" and to the regional groupings as the "African Vegetable Research Network", "The Asian Vegetable Research Network" and so on, but to refer to the commodity units as "programs" rather than to call them networks.

Type of Network

141. The several types of networks described by the SPAAR conferees (see section IV) provide a basis for analyzing network functions, but they appear to be unnecessarily elaborate for operational purposes. The new initiative is seen as providing a framework for information exchange, for scientific consultations, and for collaborative research. Therefore rather than envisioning three networks, it is proposed that it be identified as a collaborative research network that offers information exchange and scientific consultation features. Some members might engage in one or two broad categories of collaboration, while others would participate in all three.

Network membership

142. Two alternatives were considered for network membership. Under one plan, membership in the collaborative research network would be restricted to organizations that have sufficient expertise to make a significant research contribution, and that are willing to commit resources such as personnel and facilities to the network and to share results and materials. But this plan might seem arbitrary and would limit participation of interested groups in activities that would be of benefit.

143. A second procedure would be to have one network potentially open to all national programs (national research systems, universities, etc.) engaged in vegetable research. Some would participate only through information exchange activities, including training, while others would participate in collaborative research through contract operations arranged with the coordinating body. A key distinguishing characteristic among members would be the extent to which they participate in contractual research. The more advanced partners would be strongly involved in research, while the less experienced would not.

144. The latter procedure is recommended, with the understanding that participation in specific network activities would depend on availability of funds. There would be no prior commitment to support travel to conferences or training functions or to fund research in an unrestricted fashion. Rather all these activities would have to be based on an acceptable strategic plan, implemented through an approved work plan.

Developing and maintaining a network research agenda

145. A basic premise is that a collaborative research network should be so structured and managed that decisions and actions reflect the combined views of the collaborating units making up the network and that they also fit the mandate or guidelines of the coordinating body.

146. Among the earliest actions of the prospective network will be to hold organizational meetings, which will aim to outline the research needs and goals for the network as seen by the scientists and administrators of the national research systems. It is proposed that such meetings be held in Latin America, Africa, and Asia and that broad participation be sought. The network organizers should prepare the participants so they arrive knowing what is being proposed and ready to discuss their current work, perceived needs, and aspirations. The results of these meetings should be summarized to serve as a reference in future meetings and discussions. Staff of the proposed new entity should take a leading part in structuring these meetings and eliciting views and opinions. Outside specialists might be invited as participants or consultants. Donor agencies may also wish to have observers at these formative sessions.

147. The total output of this series of meetings will probably yield a program that is substantially larger than can be accomplished in the near term. There may be some regional differences of point of view that will expand the overall scope of activity. To help mold the output of these meetings into a manageable plan for the network, it is proposed that network delegates be identified from among the participants. Perhaps three members from each geographical region might be selected. They would join with the regional and commodity coordinators to form a network advisory committee. This committee would develop a strategic plan for the network.

148. The next step would be for the entity staff (regional and commodity coordinators) and the Director General to prepare the work plan and budget. The work plan should set goals and time schedules for a period of 5 years, which would be modified annually and used as a basis for annual funding requests. Research involving staff of the coordinating body as well as contract research would be addressed to arrive at an appropriate program within the mandate of the entity and within funds available. Following review by the program committee of the Board of Trustees, the Director General would present the whole plan and budget to the full board for approval and authorization to seek the needed funds from CGIAR sources in accordance with accepted practices of the CGIAR.

149. Periodically the process of regional meetings would be repeated to assess accomplishments and propose changes. Again the procedure would be to seek a broad participation and to refine the output into recommended programs that would be feasible and within the mandate of the organization. Ultimately, it would be the responsibility of the Director General and his staff to propose a revised program for funding through the CGIAR system and to implement the program through contractual programs with national systems and others.

150. The process of bottom-up development and maintenance of the research program is shown schematically in Figure 1.

Preparing research contracts

151. As noted in paragraph 112, the principal mechanism of funding of network research by the CGIAR system will be contracts. Several of the CGIAR centers have established procedures for contract research that can guide the new entity. Under the Board of Trustees, the Director General

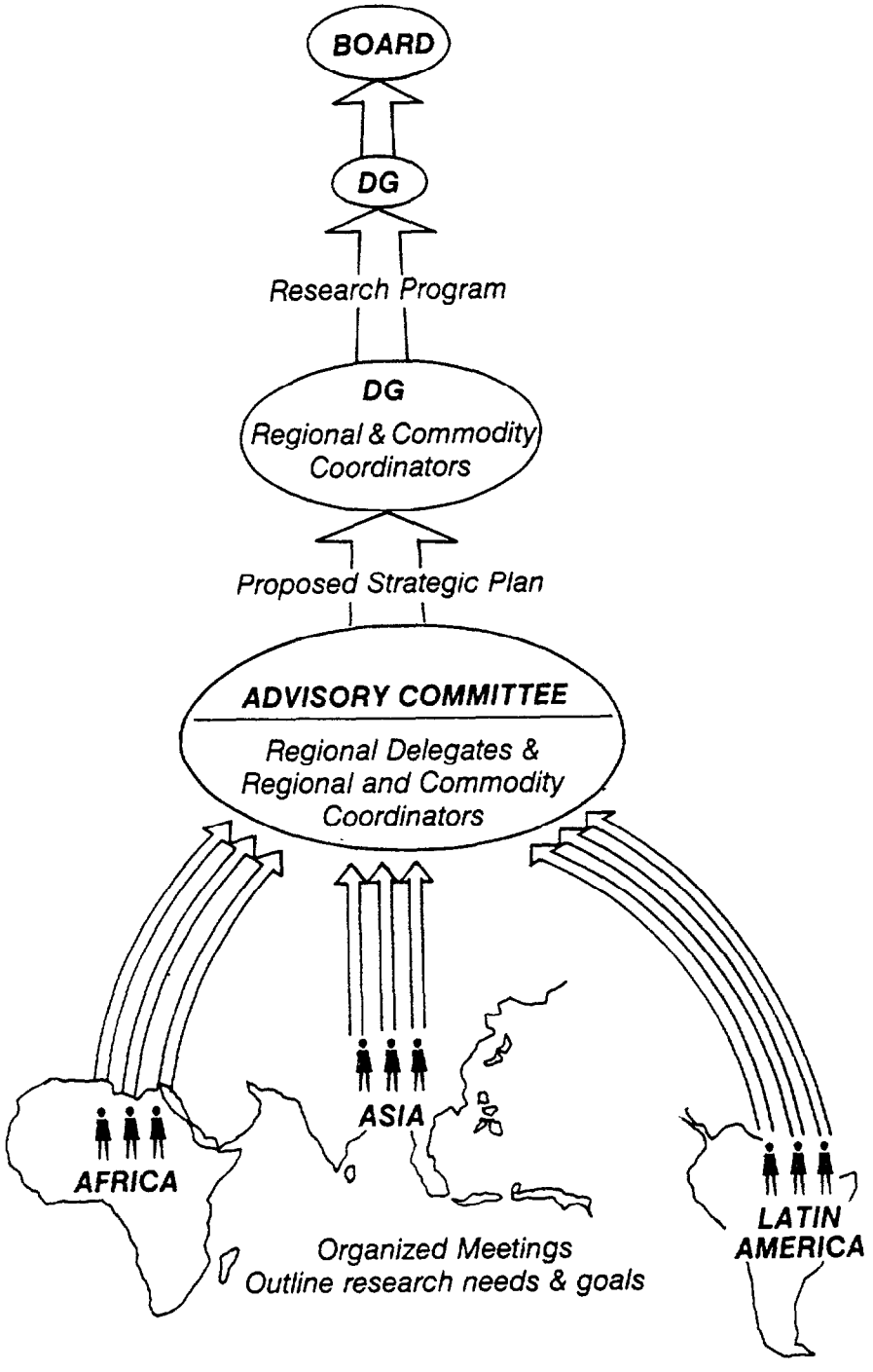

Fig. 1 ESTABLISHING A RESEARCH AGENDA FOR THE NETWORK

will have full authority to develop and negotiate the terms of reference, procedures to be followed, and the reporting and evaluating mechanisms to be used. The fact that the CGIAR may make funds available to support contracts in a given subject area does not imply an entitlement for any particular institution or potential contractor, and it in no way reduces the right of the Director General to control the funds nor the DG's responsibility to account for them. Establishing a proper stance in letting and managing contracts in an efficient and equitable manner will be key to the success of the new entity. Some of the relationships involved in the contract procedures are shown graphically in Figure 2.

152. The technical content of contracts would be the responsibility of the commodity coordinator, but it is recommended that the regional coordinators take a partnership role in shaping all contracts in the region for which they are responsible. A "contract officer" from the headquarters group should also participate to foster sound and equitable agreements from the business and financial accounting point of view. Contracts should be signed by the Director General and the head of the organization that undertakes the contract.

Contract management and review

153. The supervision and review of commodity research contracts will be the on-going responsibility of the commodity coordinator. For non-commodity research, it will be the job of the specialist in the particular field under study. In carrying out these responsibilities, they will visit the projects on a regular basis and they may also arrange for colleagues from the headquarters staff to schedule visits to discuss special aspects of the work. Simplified accounting procedures should make it possible to audit the contract research at reasonable cost, but for the long term viability of the system it is essential that financial management receive regular attention. It is expected that the regional coordinator and the commodity coordinator will often make joint visits. On a continuing basis, the coordinating officer for the region will be a communication link for the total network and will solve problems as necessary.

154. Another important mechanism in contract management will be periodic conferences and visits by members of the collaborating units themselves. The contract work will generally be fully integrated into other work being carried out by a cooperating unit and presumably it will not be singled out for separate attention. However, an aim of the periodic network conferences will be to review accomplishments and recommend changes.

155. Periodically the new coordinating body will wish to organize formal reviews of its contract research. The reviewers may look at several commodity programs and at work in several regions to ensure that comparable standards are being maintained. Finally it is expected that the coordinating unit itself will be reviewed periodically by the CGIAR system. Contract research, as the central research mechanism of the new entity, will receive attention.

Network alternatives over time

156. The network as conceived here will perform needed research by pooling existing facilities and personnel, and in the process, will strengthen existing entities so that they will be more effective in the

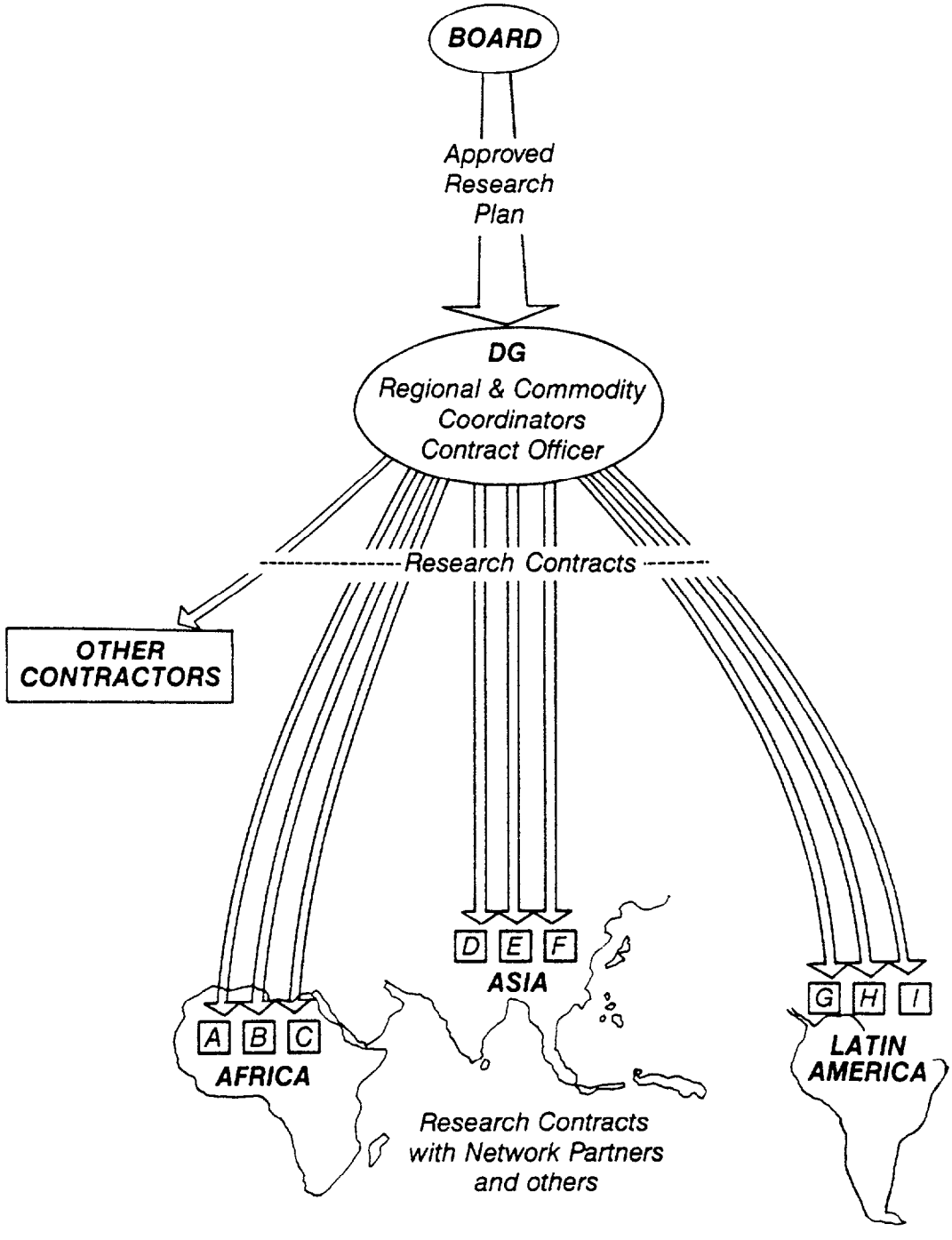

Fig. 2 MANAGEMENT OF CONTRACT RESEARCH

future. The desired outcome would be to have a series of national research systems that, to a large degree, took care of the research needs of their own farmers. Ideally, there would be an efficient exchange of information among the systems, with perhaps a continuing international undertaking to preserve germ plasm and to explore and develop new avenues of research. This is not significantly different from the view that prevailed in the early formative days of the present international centers. If this philosophy is followed here, the result might be that countries that have large staffs in vegetable research at the start would be the primary sources of network-generated technology during the early years. Network partners with small staffs at the outset would undertake human resource development programs and, in the meantime, draw on technology generated elsewhere in the network. Subsequently, these institutions could assume certain phases of the collaborative research, while the older systems would do more advanced research as their contribution.

VIII. ORGANIZATIONAL ASPECTS: SCHEDULING AND COSTS

157. What is envisioned in this presentation is a new kind of entity within the CGIAR family. It is not just a venture varied in content but not in form from earlier ones. It is a new structure. The networks developed and used effectively by a range of organizations, including the international centers themselves, are a helpful precedent. But using the mechanism as the basis for fostering the generation of new technology, rather than primarily testing and extending it, is to a fair degree experimental. Because of its innovative nature, the new organization management, its board of trustees, and the CGIAR itself will need to maintain an attitude of flexibility as the organization moves ahead and evolves operational techniques. A phasing procedure that permits the new entity to build on strength and experience to the extent possible is also recommended.

158. Not only because it is a new structure, but also because it is designed to facilitate the work of existing institutions, it is expected that the coordinating body will modify its procedures over time. As various national institutions gain greater strength and maturity, they will be expected to take a different role in collaborative undertakings and to have less need for an outside facilitator. Their funding base should increase, which would modify the role of the coordinating body and the need for external funds. In all probability, there will continue to be substantial differences between regions in the kinds of activities needed and the institutional arrangements to be made. The location of the headquarters might shift and some activities might be dropped as others are added. This suggests that the new entity should be organized to operate for a specific length of time with the horizon reviewed periodically. It could be extended for such period as results obtained and existing needs would indicate. It is recommended that the initial period of operation be 8 years, subject to renewal for another 5 years. The decision to extend would be made following a review in the sixth year of operations.

159. Employment contracts for senior staff would generally be for periods of 3 to 5 years with provisions for review and renewal. The Director General's appointment would be for not more than 5 years. Senior

staff would be sought worldwide in accordance with procedures of CGIAR centers. Contractual arrangements with other institutions would be for periods not longer than 5 years and would generally be for 2 years with provisions for renewal. There would be annual reviews, both technical and financial, of all contracts. The contracts would be structured to fit to the funding cycle of the coordinating body and would have durations that would permit orderly completion within the latter's own time frame.

Board of Trustees

160. The proposed new organization is seen as a full member of the CGIAR system. It would operate under a self-perpetuating board of trustees, which would be selected in accordance with CGIAR precedents. The dispersed nature of the proposed program and its close involvement with national research systems suggests that ample membership from the developing countries would be particularly important. To foster mutual understanding and to encourage good working relationships, the board of the new entity might consider inviting a member of the AVRDC board to serve. The board will act as trustee of funds of the organization and will be responsible for review and approval of the annual research program and budget. It will report to TAC and the CGIAR in accordance with standard practice. The board will select the Director General.

161. Although the research of the proposed organization will involve network partners and others on a contract basis, it is expected that the relationship of the program committee of the board to research activities will be comparable to the relationship at the international centers. The annual work plan and proposed budget will be prepared and presented by the organization's own staff, just as it is at other centers. Periodic reviews of research contracts would be analogous to the program review sessions held by the international centers. The presence of program committee members at these sessions will permit a regular monitoring of activities and progress. Holding these reviews in different locations from time to time would permit the committee to observe activities directly. To further increase their involvement, the trustees might wish to appoint program sub-committees for each region that could more closely monitor and evaluate research activities.

Management requirements and relationships

162. A strong management system is needed to coordinate worldwide attention to a range of commodities and at the same time to recognize and accommodate to regional differences. Three critical kinds of management roles are as follows:

a) Director General. It is expected that under the Board of Trustees and within the mandate of the coordinating body, the Director General's authority to develop the program of the organization will be comparable to that of other DG's in the CGIAR system. The fact that the new entity must develop much of its program by influencing the efforts of others differs only in degree from the situation facing other centers of the CG system. All of them must work closely and effectively with national research systems to accomplish their objectives, and their level of success in developing new technology and seeing it applied is closely tied to how well the

center's program meshes with that of national research agencies. The Director General of the coordinating body must be an experienced professional who is familiar with research methodology and management, has a proven record in administration in the international arena, and will be a good spokesman for the vegetable cause. While thorough knowledge of vegetable issues is important, the Director General's area of specialization might be plant pathology, genetics, or another field of importance in vegetable research and development.

b) Regional Coordinators. It is proposed that there be one regional coordinator for each continental area in which the network operates. Although further study might suggest otherwise, this probably means having three regional coordinators, one in Asia, one in Africa, and one in Latin America. Each will be identified as the coordinator for the network activities in the region of assignment. The objective of the regional networks will be to deal with issues that transcend commodity lines. Subjects such as training, marketing, seed production, and the social sciences in general fall in this category. As the ranking officer of the organization in the region, this person will be promote the orderly development of network research and training activities within the region. The regional director will be involved in, or aware, of all these activities, and it will be a specific responsibility to make sure that they are appropriate in respect to cultural or political relationships as well as technical ones. The regional coordinator will take part in all contract negotiations in the region including those that deal with strictly commodity-related matters. This practice will foster a close fit with local working relationships and traditions and ensure that contracts from different parts of the organization are similar in terms and fair in their benefits and requirements.

c) Commodity Coordinators. The strength of the CGIAR system has been based on the premise that international centers deal with constraints to production and consumption of a particular commodity on an integrated multidisciplinary basis. Location-specific problems are handled on a regional or sub-regional basis, but in the main, the international centers address problems on a global scale, including potential threats, such as plant diseases or insects that may not at present be globally distributed. The commodity coordinators of the coordinating body will take responsibility for establishing and implementing the research needed for the commodity(ies) assigned to them. The network mechanism for decision making will assist the coordinators in accomplishing this. The relationship of the community coordinator to the regional coordinator must be one of mutual cooperation. The commodity coordinator will have final say on technical matters related to the commodity(ies), while the voice of the regional coordinator will be stronger related to sensitivities and working procedures within the region.

Senior Staff: General Characteristics and Qualifications

163. The role of the center group in coordinating network activities will require individuals who are capable of making sound judgments over a broad range of subject matter, part of which may lie somewhat outside their

expertise or experience. Just as a research manager of a multi-disciplinary group has to select and direct staff outside his or her own field, the staff of the new organization will need to draw up contracts that embrace a range of disciplines. The new organization will of course aim to have staff expertise on key subject areas, but it will not attempt to have a specialist in each category. Judicious use of expert consultants from inside or outside the network can serve to extend the effectiveness of the coordinating staff in dealing with a broad range of subjects.

164. For certain fields, however, where it is apparent that in-house knowledge of a particular subject would be especially important, a person with that background should be added to the coordinating staff. To cite an example, it is noted that techniques have been developed in molecular biology that can be of great value in the identification of progeny carrying resistance to a particular disease or insect. The staff of the new organization should include a person who is competent in this field and can assure that the new entity will apply these techniques beneficially through contracts with appropriate centers. Virology is another area where in-house expertise is strongly indicated because of the large complex of viruses that attack the solanaceous plants proposed for study by the network.

165. The senior staff of the coordinating body should also include specialists who are employed to foster research that can only be done in the national research programs themselves but which at present is neglected in the developing countries. The areas of economics and sociology/anthropology fall in this category. Effective development of vegetable research that will result in the production and consumption of vegetables of high nutritional value will require study of many socio-economic questions. While the appropriate disciplines are represented by some outstanding individuals in the developing countries, they are in short supply and few of them are engaged in research related to vegetables. The presence of these specialists on the staff of the coordinating body will close critical research gaps.

166. Finally, there is need to improve links between the public and private sectors in seed production and vegetable production and marketing. There are too few qualified scientists in these areas in national systems. The inclusion of such specialists within the coordinating body would foster appropriate research and linkages in these subjects.

Program content staff, and schedule: A first approximation

167. The section of this report entitled "Priority Species and Research Objectives" outlines a program for the proposed new vegetable initiative during its first 6 to 8 years. In that section and elsewhere in the report, alternatives and priorities are suggested that could alter substantially the scope and shape of the organization and its staffing needs and costs. The range of alternatives presented was a natural outgrowth of the interviewing process, and it was preserved for the benefit of TAC decision makers. In order to define the research program more clearly and to estimate the probable costs, however, it seems appropriate to choose among some of the alternatives, to make some specific decisions on phasing, to assume certain capabilities and outputs from prospective network partners, and generally to choose among options. It is proposed herewith to depart from the more general and propose the more specific, and then in subsequent sections to suggest possible staffing and funding needs.

168. The proposed program is being called a "first approximation" to emphasize that it is preliminary and subject to change. Its presentation here will not deprive the coordinating body or the network partners of their opportunity to pass upon the same questions. In some features, it does reflect comments already received from TAC about choice of species, research areas, and phasing, but they should not be viewed as definitive.

a) Species and research areas. During the first 3 years, the program will be limited to tomatoes, peppers, onions, and leafy green vegetables. Provided further study justifies current ideas, okra and eggplant will be added in Year 4. The research areas for all commodities will be those outlined in this paper with such modifications and elaborations as may be developed during the organizational phase.

b) Non-commodity research. Socio-economic research and research on seed production problems will be included from the outset. Staff specialists in these areas will participate in the organizing and planning sessions leading to the development of the strategic plan for the network. Activities related to post-harvest problems will be initiated in Year 3.

c) Headquarters and sub-units. For the sake of this discussion, it will be assumed that arrangements can be made to place the headquarters of the coordinating body at the Kamphaengsaen campus of Kasetsart University. It is further projected that the necessary groundwork and negotiations can be completed during the first 12 months after the founding of the new entity and that the African Unit will be initiated at the start of the Year 2. Provisions will be be made to have a Latin America Unit in place at the beginning of Year 3. In Year 2, in anticipation of this action, a person with appropriate Latin American experience will be added to the headquarters staff. This officer will become familiar with network activities and resources in the Asian area and lay the groundwork for development of the Latin American Unit. At the start of Year 3 this officer will transfer to Latin America as Coordinator, Latin America Network. A second scientist will be added to the Latin American Unit at that time.

d) Training. During Year 1, arrangements will be made with AVRDC to handle all training activities either through its program in Taiwan or at the Thailand Outreach Project (TOP). In Year 2 the new entity will initiate training programs in Africa. This may result in some reduction in use of basic Asian facilities, but this change may be offset by special offerings in seed production and other subjects. In Year 3, training is projected to begin in Latin America.

e) Commodity research strategy. Two of the principal commodities, tomatoes and peppers, are on the research agenda of AVRDC. Contracts will be let with AVRDC for accelerated research on bacterial and fungus diseases of tomato and on varietal improvement and plant disease research with peppers. Because of the advanced stage of these projects, it appears reasonable to start contract research with AVRDC soon after founding the new entity. Also after

development of the strategic plan, contracts with appropriate laboratories in the network and elsewhere will be let on subjects such as interspecific hybridization for tomatoes, virus research etc. Arrangements will be made for advanced laboratories to conduct specialized research in molecular biology. Contracts related to field testing, integrated pest management, and production horticulture will be made with various network partners. Research on both tomatoes and peppers should move rapidly because of the strength of a number of national programs.

Efforts will be made to identify an institution within the network that has an onion varietal improvement program that, with support, could contract to provide improved lines and breeding materials to the network. As noted elsewhere in this report, scientists from Brazil, Senegal, and India expressed interest in similar programs aimed at developing onion varieties for use under short day, warm temperature conditions. It is hoped one of these programs could be brought to the desired capability through contract or the assignment of additional staff. If this approach is inadequate, the coordinating body might assemble the needed germ plasm and embark on an accelerated onion breeding program in cooperation with the host country in which its headquarters is located.

For leafy green vegetables, the Africa unit will take responsibility. During the initial years, emphasis will be on screening a wide range of species before selecting those for in-depth research. The African Unit will lead these activities, but will arrange for collaboration with local partners. It will very early enter into contracts with national partners for germ plasm collection and for testing materials under different environmental conditions. Such contracts may be undertaken in Asia and Latin America as well as in Africa.

In anticipation of establishing programs with okra and eggplant at the beginning of Year 4, studies will be undertaken to clarify the importance of these commodities and to verify the case for including them on the agenda. If the findings are positive, steps would be taken to assemble germ plasm from existing collections and to add to them by field collections in key areas around the world. Responsibility for these two commodities will be placed with the Africa Unit because of their importance in Africa. But it will also establish the principle that activities in Africa should be reinforced as rapidly as institutional arrangements will permit. In accordance with the global orientation of the commodity programs, it is understood that research contracts for these commodities may be placed in Asia and Latin America as well as in Africa.

169. The staffing pattern for this program is summarized in Table 1. Fig. 3 shows how the appointment of this staff and the development of these activities might be phased. The proposed phasing mentioned in the foregoing paragraphs refers to Year 1, Year 2, and so forth from the founding date of the new entity. It is not likely that this will coincide with the calendar financial year of the CG system. Since TAC is scheduled to forward a recommendation to the CG in May 1988, the earliest feasible date of founding seems to be July 1, 1989, and the phasing chart uses this date. Assuming this start-up, Year 1 would be July 1, 1989 to June 30, 1990.

Table 1. Projected staff levels for a "first approximation" program based on selected options and phasing. (See paragraph 168)

	Position	Specialty	Year 1	Year 2	Year 3	Year 4
HEADQUARTERS ASIA*						
1.	Director General	Production Horticulture**	1.0	1.0	1.0	1.0
2.	Coordinator, Asia	Genetics & Plant Breeding**	0.9	1.0	1.0	1.0
3.	Coordinator, Solanaceous crops	Virology**	0.8	1.0	1.0	1.0
4.	Coordinator, Onions	Plant Physiology**	0.8	1.0	1.0	1.0
5.	Contract and Financial Officer	Administration	0.9	1.0	1.0	1.0
6.	Network Specialist	Seed Production	0.8	1.0	1.0	1.0
7.	Network Specialist	Economics	0.8	1.0	1.0	1.0
8.	Network Specialist	Soc.Sci./Anthropology	0.8	1.0	1.0	1.0
9.	Network Specialist	Training & Information	0.8	1.0	1.0	1.0
10.	Network Specialist	Postharvest Technology		-	1.0	1.0
AFRICA UNIT*						
11.	Coordinator, Africa	Plant Pathology**	-	1.0	1.0	1.0
12.	Network Specialist	Plant Breeding	-	1.0	1.0	1.0
13.	Network Specialist	Production Horticulture	-	1.0	1.0	1.0
14.	Network Specialist	Soc.Sci./Anthropology	-	1.0	1.0	1.0
15.	Network Specialist	Training	-	1.0	1.0	1.0
16.	Commodity Coord.	Plant Breeding**	-	-	-	1.0
17.	Commodity Coord.	Entomology**	-	-	-	1.0
LATIN AMERICA UNIT*						
18.	Coordinator Latin America	Plant Pathology**	-	1.0	1.0	1.0
19.	Network Specialist	Production Horticulture	-	-	1.0	1.0
			7.6	15.0	17.0	19.0

* Persons shown as members of a particular geographic unit may have duties in other regions as well.

** These specialties are indicative only, Coordination/management staff may come from various disciplines.

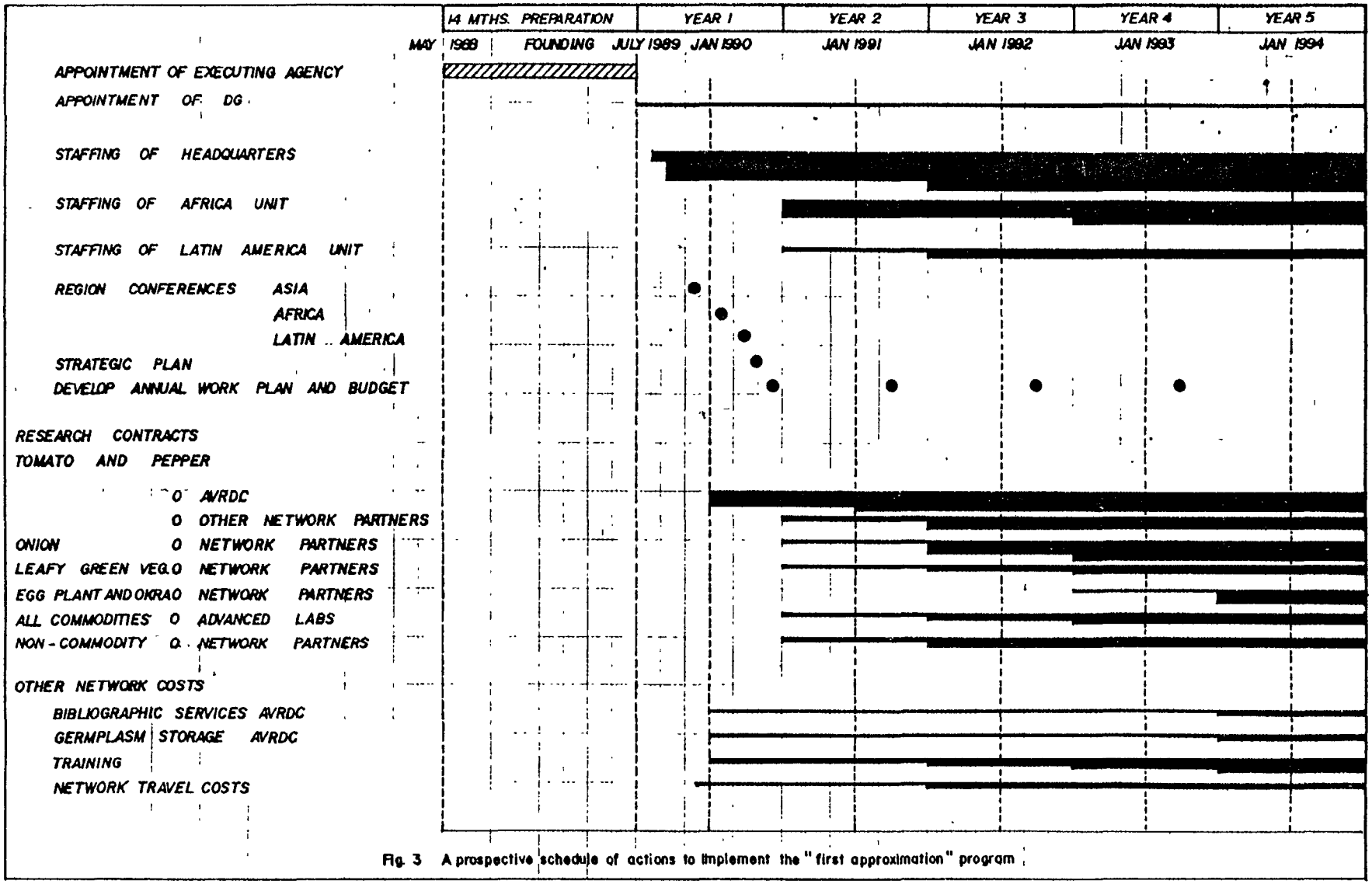

Fig. 3 A prospective schedule of actions to implement the "first approximation" program

170. The staffing levels proposed here are seen as necessary to provide for the network coordinating function and also to allow participation in cooperative research. The level of effort for the coordination function is estimated at about 8 person-years per year. This is based on experience acquired by Winrock International in coordinating a regional farm forestry network based in Asia. Additional staff may be needed in both the headquarters and elsewhere to participate in research activities. Hopefully such staff might be employed with special project funds or by selective posting of scientists available for secondment from donor agencies. While the research systems are engaged in staff development, such input can ensure that an on-going research program is maintained and expanded.

Funding needs

171. Capital costs. If the coordinating unit is based at Kasetsart University, it is likely that considerable office space could be leased. Almost certainly, a sharing arrangement could be developed. It also seems likely that no additional facilities for training programs would be needed at least during the initial years. To be conservative, however, it seems prudent to have $200,000 designated for modifying staff offices and space to service field experiments. Experimental farm development costs, including irrigation drainage and additional roadways, are estimated at $150,000. For the Africa Unit, the experience of CIAT in Tanzania provides some guidance. CIAT has four scientists located there and encountered capital costs of about $250,000 for offices and field laboratory facilities. Field-plot experimental equipment, microcomputers, farm machinery, and vehicles including two minibuses, are proposed to be budgeted at $380,000 for the headquarters and $120,000 for the Africa Unit. There will be start-up capital costs for the network partners, particularly for microcomputers for database use. It is proposed that $200,000 be budgeted in this category. Additional sums for equipment for network partners could be supplied as part of a research contract as needed and agreed upon. It should also be noted that the experimental fields and much of the equipment would be shared between scientists of the coordinating body and those of the national program where they are posted. Thus it is not possible to make a sharp distinction between the capital costs of the coordination unit and those for network partners. These cost estimates are summarized in Table 2.

172. A rough estimate of the recurring costs of the first approximation program over the first 5 years is given in Table 3. A prospective schedule of actions related to these expenses appears in Figure 3. The numbers shown here are based generally on the costs of some international centers and on operating experience of bilateral programs in developing countries. Despite the uncertainties, they may serve a useful purpose for estimating what the new initiative might cost.

173. Some of the assumptions behind the estimates presented in Table 3 are as follows:

a) Staff costs. Costs are estimated from the experience of existing CGIAR centers. Current data on senior staff costs indicate that managerial positions require funding at the level of about $150,000 per person per year including support staff and all other expenses. For this budget, that figure is used for all positions. The

Table 2. Estimated Capital Costs

	Purpose	Approximate Timing	Amount (U.S. dollars)
1.	Modifications of headquarters facilities	Year 1	200.000
2.	Offices and field lab, Africa Unit	Year 2	250.000
3.	Exp. farm development, Headquarters	Year 1	150.000
4.	Equipment and vehicles, Headquarters	Year 1-2	275.000
5.	Equipment and vehicles, Africa Unit	Year 2-4	175.000
6.	Equipment and vehicles, Lat. Amer. Unit	Year 2-3	50.000
7.	Equipment for Network Partners	Year 1-5	200.000
			1,300.000

Table 3. Projected recurring costs for the "first approximation program (Para. 168).*

Cost Center	1988-89 Preparation (12 mos)	1989 Start up (6 mos)	1990	1991	1992	1993
1. EXECUTING AGENCY	(To be added)	-	-	-	-	-
COORDINATION STAFF**						
2. Headquarters & Asia		465,000	1,350,000	1,425,000	1,500,000	1,500,000
3. Africa Unit		-	375,000	750,000	750,000	1,050,000
4. Latin America Units		-	75,000	225,000	300,000	300,000
TOTAL COST OF COORDINATING UNITS		465,000	1,800,000	2,400,000	2,550,000	2,850,000
NETWORK ACTIVITIES						
5. Research Contracts						
Tomato and Peppers						
o AVRDC		-	600,000	800,000	800,000	800,000
o Other Network Partners		-	150,000	550,000	550,000	550,000
Onion						
o Network Partners		-	150,000	675,000	8900,000	800,000
Leafy Green Vegetables						
o Network Partners		-	75,000	250,000	300,000	300,000
Egg Plant and Okra						
o Network Partners		-	-	-	150,000	600,000
All Commodities						
o Advanced Labs		-	100,000	300,000	400,000	400,000
Non-Commodity Research		-	200,000	400,000	450,000	550,000
6. Bibliographic Services		-	100,000	100,000	100,000	200,000
7. Germplasm Storage		-	125,000	125,000	125,000	250,000
8. Training		-	190,000	380,000	430,000	480,000
9. Network Conferences		30,000	120,000	120,000	120,000	120,000
TOTAL NETWORK COSTS		30,000	1,810,000	3,700,000	4,225,000	5,050,000
TOTAL	(To be added)	495,000	3,610,000	6,100,000	6,775,000	7,900,000

* In U S dollars, without adjustment for inflation

** It is estimated that about 40% of the time of the coordinating body will be spent in managerial type activities. The balance will be spent in research in collaboration with national systems.

additional cost for research activities by these staff members are considered to be part of the network costs and are so shown in Table 3, which presents cost estimates from July 1989 through 1993.

c) Contract research. The level of funding that will be needed and that can be efficiently managed through contracts is difficult to estimate. Much will depend upon how effective the new coordinating body proves to be in developing contract relationships. To provide some guidance in this area, the following suggestions are made. (1) For the start-up year, allow a sum that is well within the capacity of the new entity to supervise. The experience of existing CGIAR centers provides an indication of how much this might be. (2) For subsequent years, provide for substantial growth in contracts, but leave the actual amount to be allocated to decisions made each year at annual budget review. (3) Take a special look at AVRDC and the potential it has to contribute immediately to the new initiative and to give it a fast start. Informal discussions indicate AVRDC could effectively use several additional scientists in both the tomato and pepper programs. As an estimate, provide for two scientists and their full support in each of two programs and use CGIAR experience to estimate costs. The basis for the CGIAR figure is such that it covers indirect costs as well as direct ones. The figure for an equal level of effort in a national system will vary from place to place, but is deemed to be substantially lower than that of international bodies especially when stripped of indirect costs. Rather than attempting to define or defend the figures in Table 2 in detail, it is suggested that the start-up levels of contract funding shown here are well within the demonstrated ability of other CGIAR centers to manage. The new entity should be able to use these levels effectively. As it gains experience, the projected fund increases would permit a substantial expansion.

d) Bibliographic services and germ plasm preservation. AVRDC has a computerized bibliographic service which deals with several commodities, including tomato and pepper. Adding two new commodities, onion and leafy green vegetables, to this service, would cost about $100,000 per year according to AVRDC. To add eggplant and okra in Year 4 would cost an additional $100,000.

e) AVRDC estimates that to add two more commodities to their germ plasm storage activities would involve about $125,000 per year. This sum is shown for two commodities for the first 3 years, rising to four crops and double this amount when eggplant and okra are projected to be added in Year 4.

f) Training costs. For a program to be located in Bangkok, the estimate is based on AVRDC's current experience, which indicates a cost of $1000 per month per participant. If 40 participants are included in each of two 4-month courses per year, the budget would be $320,000. To this, add an estimated $60,000 for participant travel, which gives a total training figure of $380,000 per year.

g) Network conferences and related expenses. To estimate certain of these costs, the experience of the farm forestry network being coordinated by Winrock International offers some insights. This

network is based in Bangkok and includes most of the Asian countries. Its program of planning conferences, reviews, and seminars is similar to that envisioned for the vegetable network. Total costs for the travel and per diem for network members amount to about $35,000 per year for the Asian region. Assuming similar costs for Africa and Latin America, and to allow for some inter-continental travel of participants, a budget of $120,000 is suggested.

IX. CONCLUDING COMMENTS

An executing agency

174. The impression gained by the Consultant throughout the study is that the time is ripe for an international effort with vegetables. The developing countries are particularly receptive and the donor organizations seem favorable. The collaborative approach is appealing to both groups and should speed the creation of the new organization. If the CGIAR decides to proceed, the task of the executing agency may prove easier than launching a conventional international center.

175. The matter that will require most careful attention from the executing agency will be the preparation of the charter and by-laws under which the new body will operate. The spirit of partnership and joint setting of goals must be maintained for the collaborative mode to genuinely exist. But at the same time, safeguards must be put in place to ensure that the program maintains the sharp focus that characterizes the CGIAR system. In order to arrive at a satisfactory document, it will be necessary to work closely with developing country scientists and administrators and with donor agency officials.

176. The experience gained from the establishment and operation of other CGIAR activities combined with current enthusiasm for work on vegetables should facilitate making suitable arrangements for the headquarters location. The executing agency may also lay some of the groundwork for locating the Africa Unit and the Latin America Unit, but the current recommendation calls for these to be in operation within 2 years after the new body is founded.

177. To ensure a good understanding and to foster good working relationships, the executing agency should confer closely with AVRDC and its clients and supporters. It will also be desirable for the agency to meet with potential network partners and others in parts of the tropics that were not visited in this study. At some point, it might be desirable to prepare a prospectus for the new organization that would concisely describe the goals and procedures of the new organization.

The revised report

178. When this assignment was undertaken, it was agreed that the Consultant would have an opportunity to review the report with the TAC before submitting it in final form. There was no requirement that the report be modified. Rather there would simply be an opportunity to discuss

complex issues with the body for whom the study was undertaken and possibly to clarify or elaborate on issues of concern. This review took place at TAC-44 in Washington D.C. in October 1987.

179. Since TAC had already placed vegetables high on its list of priorities, it is not surprising that there was little question about the central case that was made for an international effort with vegetables. The earlier studies commissioned by TAC provided a substantial base for dealing with certain important aspects. The revised version of the report attempts to clarify the reasoning behind the selection of the vegetable species recommended for the initial research program and to respond to similar questions of TAC. Aside from these and editorial modifications, there are few changes in Sections I through V.

180. In its review, the main concerns of TAC were with organizational aspects of the new undertaking; how it would be structured, how decisions would be made, how different units and individuals would interact and so forth. The report of TAC-44 summarized this concern by stating, "Even if the evolution of the effo[illegible] could not be clearly envisioned in all aspects, it was necessary to prov[illegible]n its proposal to the Group indicative details of structure and operat[illegible]n the understanding that these would be reviewed by the executing agency [illegible]h would presumably be entrusted with the task to bring the entity into existence." In the spirit of this statement, numerous additions were made in Sections VI through VIII. These sections deal with the proposed new organization, the network that it would undertake to develop, and the interactions between the two. Hopefully the added detail will not obscure the statement of principles that should guide the new undertaking; one being that many issues should be decided by the network partners themselves in concert with the coordinating body.

181. In the preparation of this report, one of the most difficult tasks was to strike a balance between the intent to build on and to strengthen existing national research systems and the need, on the other hand, to fill gaps in the capacity of the national systems to generate immediately needed technology. The proposed solution, derived from the TAC-44 discussions, essentially does away with the concept of research that would be done independently by the coordinating body. Instead the staff of the coordinating body will engage in research jointly with national programs where the headquarters and branch units are located and with others.

182. This proposal bears little resemblance to the one considered by TAC in 1979. It is also substantially different from the outline produced by the Winrock conference. It does, however, maintain the vision of two senior horticulturalists who wrote to Winrock in 1985 and suggested a study of the subject of vegetable research. They said, "We do not envisage capital outlay for buildings, land, and equipment, or long-term commitments to personnel. But rather a flexible, dynamic arrangement to identify problem areas, to assign them to those willing and able to deal with them, and to evaluate progress on the basis of documentable proof of productive effort."

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ANNEXES

TECHNICAL ADVISORY COMMITTEE

Forty-Second Meeting, Rome (Italy), 16-24 March 1987

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

VEGETABLE RESEARCH FOR DEVELOPING COUNTRIES[1]

1. From the early 1970s, TAC had recognized the importance of research to improve vegetable production indeveloping countries particularly on tropical vegetables. Among the earlier efforts outside the CGIAR to close the gap in research on tropical vegetables was the establishment in 1971 of AVRDC. The center has done commendable work on a limited number of vegetables for countries in Asia and the Pacific and it has undertaken various training activities.

2. Despite the high quality of its programs, it became apparent by the mid-70s that AVRDC could not alone meet the full global needs for research and training on vegetables for the developing world. The Committee commissioned a Vegetable Research Appraisal Mission and, following discussion of its report at TAC 12 in February 1976, a Vegetable Research Project Formulation Mission was organized. The report of the latter was discussed at TAC 15 in February 1977.

3. The Committee then affirmed (TAC 17) and re-affirmed (TAC 21; 1979 TAC Priorities Paper) its position that research on vegetables should have high priority among activities that deserve support from the CGIAR. A TAC subcommittee set up in 1979 examined alternative ways of addressing this research need and proposed the creation of a small (16 senior staff) international center at a low-altitude site in Asia.

4. The proposal to establish an International Vegetable Research Institute for the Tropics (IVRIT) was discussed by the Group in May 1979. The TAC Chairman's covering letter stated: "TAC is unanimous in according high priority to tropical vegetable research. It was not completely unanimous with respect to the form of implementation but a strong majority endorsed the attached proposal as a worthy one and as representing its best collective judgement."

5. In examining TAC's proposal, Group members raised questions and expressed reservations regarding the form of implementation. This reaction was noted by the Committee and its Chairman reported to the Group in November 1979 that "in view of the lack of consensus and of financial constraints, TAC was not ready to bring further recommendations at present."

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[1]Extracted from: AGR/TAC:IAR/87/4 dated January 1987 and used as background for Forty-second Meeting, Rome 16-24 March, 1987.

6. Priority for research on vegetables was again re-affirmed by TAC in a major output of its "Strategic Consideration" over the years up to the mid-1980's, namely the "TAC Review of CGIAR Priorities and Future Strategies" (AGR/TAC:IAR/85/18). An extract of the relevant paragraphs from the text and from part 3 of the Technical Annex is attached as Annex I. TAC argued that food crops should remain the top priority for the CG System, and it assigned highest priority for any new ventures for which resources could become available to research on vegetables.

7. The CGIAR first examined the TAC priorities document in November 1985. The System's future strategies were debated by an AD HOC working group of the CGIAR at Bellagio in January 1986, and TAC was requested to elaborate on its various recommendations. The Committee's elaboration (AGR/TAC:IAR/85/18) was presented to the Group at its May 1986 meeting in Ottawa.

ALTERNATIVE ARRANGEMENTS FOR INTERNATIONAL SUPPORT TO RESEARCH ON VEGETABLES

16. Proposals and discussion by TAC during the 1970s on institutional alternatives for international research on tropical vegetables were summarized in a Secretariat Note prepared for TAC 23 (AGD/TAC:IAR/80/1). These alternatives were:

(a) International Vegetable Research Institute - an IARC with a Board of Trustees, a core program for research and training, cooperative programs and outreach programs for off-station research and for technology transfer and testing, conceived as a sister center to AVRDC. Stimulated TAC to mount two missions (see para. 2 above).

(b) International Vegetable Research Pilot Project - a CG-funded project of max. 5 years duration, operated at existing institutions (in Sri Lanka for Asia, at IITA for Africa with relay in Senegal for francophone areas) under the guidance of a Project Steering Committee, with tasks of germplasm collection and evaluation, some training and some documentation activities. This Proposal by expert mission (see para. 2 above) was not endorsed by TAC, in part in order to avoid ex ante commitment to support follow-up.

(c) International Council for Tropical Vegetable Research - essentially alternative (b) above, but with replacement of the Project Steering Committee by a Council which would approve programs for implementation by a program coordinator with a small secretariat (considered to act similar to IBPGR's secretariat); initial program at the two bases in Asia and Africa with a future base foreseen in Latin America. This proposal by TAC subcommittee was withdrawn in light of information that IITA could not host a project and that AVRDC faced several difficulties.

(e) Other approaches - discussion in TAC examined the following:

(i) strengthening individual national programs
(ii) establishing a network among national programs
(iii) use of existing IARCs
(iv) establishing an International Board similar to IBPGR.

In the climate of financial stringency developing in the early 1980's, TAC did not follow up these efforts to define suitable and acceptable arrangements for international support to research on vegetables.

Table 1. Mineral and vitamin content of some vegetables, compared with pulses and starchy foods. Extracted from PLATT (1975). Requirements for an adult man (55 kg) from FAO/WHO standards for East Asia: protein biol. val. 60%

product	per 100 g of edible portion							
	dry matter,g	calcium mg	iron mg	carotene mg	thiamine mg	Ribo-flavin mg	niacin mg	vitamin C mg
starchy basic food								
maize	88	12	2.5	0	0.35	0.13	2.0	0
rice	88	10	2.0	0	0.25	0.05	2.0	0
cassava	40	25	1.0	0	0.07	0.03	0.7	30
sweet potato	30	25	1.0	0.06	0.10	0.04	0.7	30
pulses								
groundnut	55	30	1.5	0	0.50	0.10	10.0	10
cowpea	90	90	5.0	0.01	0.90	0.15	2.0	9
vegetables								
dark-green leaves	15	250	4.0	1.80	0.10	0.30	1.5	100
tomato	6	5	0.4	0.15	0.06	0.04	0.7	25
okra	10	70	1.0	0.09	0.10	0.10	1.0	25
green beans in pod	10	50	1.4	0.12	0.08	0.12	0.5	20
Daily requirements		500	9	1.5	1.0	1.5	17	30

Table 2. Estimated daily vegetable consumption (g per head, net intake, raw edible product) and annual production in developed, centrally planned and developing countries

type of vegetable	developed countries			c. planned countries	developing countries							world production x 10^6 t
					consumption g/caput/day					production x 10^6 t	for sale %	
	cons. g/caput/day	production x 10^6 t	for sale %	production x 10^6 t	Africa	America	SW/ C. Asia	Other areas	mean			
1. tomato	34	11.6	85	14.3	9	11	41	12	14	12.5	80	38.4
2. peppers	3	1.0	90	1.3	6	7	6	2	4	3.4	40	5.7
3. eggplant	2	0.7	90	0.8	2	2	7	15	10	8.9	30	10.4
4. fleshy cucurbits	16	5.5	85	6.7	3	8	9	19	14	12.1	30	24.3
5. melon, watermelon	18	6.2	85	7.6	3	5	19	4	6	4.8	50	18.6
6. heading cabbage	19	6.5	85	8.0	2	6	12	7	7	5.7	40	20.2
7. cauliflower, broccoli	14	4.8	85	5.9	0	1	4	1	1	1.0	90	11.7
8. leaf cabbage	3	1.0	80	1.3	1	1	2	4	3	2.5	50	4.8
9. onions and shallots (dry)	15	5.1	90	6.3	4	2	14	4	5	4.1	80	15.5
10. green onions, leek, bunching onion	3	1.0	85	1.3	0	0	5	2	2	1.5	40	3.8
11. garlic	1	0.3	95	0.4	0	1	2	1	1	0.7	70	1.4
12. leguminous pods	9	3.1	75	3.8	0	1	2	6	4	3.4	50	10.3
13. green beans	3	1.0	85	1.3	2	1	2	2	2	1.7	40	4.0
14. green peas	9	3.1	85	3.8	1	1	5	1	1	1.2	40	8.1
15. dry beans (for sprouting)	0	0	-	0.1	0	0	0	2	1	1.0	40	1.1
16. lettuce	15	5.1	85	6.3	1	1	3	1	1	1.1	80	12.5
17. green leaf veg.(excl. 8, 10, 16)	20	6.8	75	8.4	21	5	11	15	13	11.7	30	26.9
18. carrot	11	3.8	85	4.6	1	1	6	1	2	1.3	80	9.7
19. roots, tubers (excl. 18)	7	2.4	75	2.9	2	2	4	2	2	1.9	40	7.2
20. shoots, sprouts, flowers, stalks	6	2.1	80	2.5	1	2	2	3	2	2.1	50	6.7
21. sweet corn	11	3.8	80	0.1	0	0	0	0	0	0	-	3.9
22. okra	1	0.3	65	0.4	6	2	3	4	4	3.4	40	4.1
23. various seeds (excl. 13,14, 15)	0	0	-	0.1	3	0	2	1	1	1.2	30	1.3
24. mushrooms	1	0.3	95	0.4	1	0	1	1	1	0.7	30	1.4
T O T A L :	221	75.5	87	88 6	69	60	162	110	101	87.9	47	252.0

Source: G J H Grubben, The Topical Vegetables and their Genetic Resources. IBPGR Doc 77/23

ANNEX B
Table 5

Table 3. Average nutritive value of vegetables. Data from: Food composition Table for use in East Asia (FAO, 1972).

type of produce	waste %	per 100g edible portion: DM g	energy Kcal	protein g	fibre g	ca mg	iron mg	carotene mg	thiamine mg	riboflavin mg	niacin mg	vit.C mg	ANV	ANV per 100 g dry matter
fruit-vegetables														
tomato	6	6.2	20	1.2	0.7	7	0.6	0.5	0.06	0.04	0.6	23	2.39	38.5
eggplant	4	8.0	26	1.6	1.0	22	0.9	0	0.08	0.07	0.7	6	2.14	26.8
sweet peppers	13	8.0	26	1.3	1.4	12	0.9	1.8	0.07	0.08	0.8	103	6.61	82.6
pepper, hot	13	34.6	116	6.3	15.0	86	3.6	6.6	0.37	0.51	2.5	96	27.92	80.7
okra	10	10.4	31	1.8	0.9	90	1.0	0.1	0.07	0.08	0.8	18	3.21	30.9
cucumber	20	3.8	12	0.6	0.5	21	0.4	0.1	0.03	0.04	0.2	11	1.69	44.5
pumpkin	17	8.1	27	0.7	0.8	24	0.7	0.8	0.03	0.04	0.5	14	2.68	33.1
watermelon	37	6.8	21	0.6	0.2	8	0.2	0.1	0.03	0.03	0.2	6	0.90	13.2
melon (white-green)	22	7.6	26	1.0	0.5	18	0.5	0	0.05	0.02	0.4	25	2.33	30.7
bitter gourd	20	6.0	19	0.8	1.0	26	2.3	0.1	0.06	0.04	0.3	57	4.10	68.3
leafy vegetables														
amaranth	40	10.7	26	3.6	1.3	154	2.9	6.5	0.04	0.22	0.7	23	11.32	105.8
kangkong	28	10.0	30	2.7	1.1	60	2.5	2.9	0.09	0.16	1.1	47	7.57	75.7
Chinese cabbage, leaf type	14	5.8	17	1.7	0.7	102	2.6	2.3	0.097	0.13	0.8	53	6.99	120.5
lettuce	26	6.4	20	1.4	0.6	56	2.1	2.0	0.06	0.12	0.5	17	5.35	83.6
white cabbage	15	7.0	22	1.6	0.8	55	0.8	0.3	0.06	0.06	0.3	46	3.52	50.3
cassava leaves	13	19.0	60	6.9	2.1	144	2.8	8.3	0.16	0.32	1.8	82	16.67	87.7
leguminous vegetables														
hyacinth bean (dry)	0	87.9	334	21.5	6.8	98	3.9	0	0.40	0.12	1.8	0	14.03	16.0
Lima bean (fresh)	43	31.5	119	8.4	1.0	25	2.2	0.1	0.16	0.16	1.5	30	4.88	17.9
mung bean (sprouted)	7	9.9	30	4.2	0.9	15	1.2	0	0.11	0.10	0.8	18	2.94	34.2
sprouts, bulbs, tubers, etc.														
onion (dry)	6	11.4	38	1.6	0.7	30	1 0	0	0.06	0.04	0.2	9	2.05	20.0
carrot	17	10.4	37	1.1	0.9	36	1.2	4.2	0.06	0.05	0.7	8	6.48	64.2
bamboo shoots	44	9.0	28	2 5	1.2	17	0.9	0	0.11	0.09	0.6	9	2.55	30.9
mushroom	9	11 3	37	2.7	0 9	8	1.0	0	0.10	0.42	4.8	3	2.10	19.3
taro (as vegetable)	16	24.6	94	2 2	0.8	34	1 2	0	0 12	0.04	1.0	8	2.38	9.7

Source: G J H Grubben, The Topical Vegetables and their Genetic Resources IBPGR Doc 77/23

Table 4. Annual production and consumption of vegetables (excluding roots and tubers) in the major regions of the world, 1984

	(1) Production $x10^6$ t	(2) Population $x10^6$	(3) Consumption kg/head
World	344.1	4,026	68
Developed market economies	94.7	762	99
North America	27.9	238	93
Western Europe	48.6	365	106
Oceania	1.6	16	80
Other	16.5	141	93
Developing market economies	122.5	1,975	49
Africa	14.5	328	35
Latin America	15.4	328	37
Near East	25.9	190	109
Far East	66.4	1,123	47
Other	0.3	4	60
Centrally planned	134.9	1,289	83
Asia	88.5	923	76
Europe & USSR	46.6	366	101

Column (1) and (2): FAO Production Yearbook 1984
(3) estimated (1)/(2) x 0.80. About 20% is lost as waste or used for sale.

Vegetables included are cabbages, artichokes, tomatoes, cauliflowers, pumpkins, squashes, gourds, cucumbers, gherkins, eggplants, chilies, peppers, onions, garlics, beans, peas, and carrots.

Source: Dr. Chamnien Boonma, Dept. of Economics, Kasetsart University, Bangkok, Thailand.

Table 5. First Priority Vegetables Suggested for International Research
(Ranking: 5=very high, 4=high, 3=medium, 2=low, 1=very low)

Vegetable type	Gen. economic value	Geographic distribution	Content			Potential for improvement	Present value of research
			Proteins	Minerals	Vitamins		
Green leaf vegetables							
Amaranthus spp. (amaranth or Chinese spinach)	3	4	5	5	4	3-4	1-2
Celosia spp. (cock's comb)	2	3	5	4	4	3-4	1
Ipomoea aquatica (kangkong)	3	1	4	3	4	3	1
Bassella alba (Ceylon or Indian spinach)	2	3	3	4	4	2	1
Corchorus olitorius (jute mallow)	3	3	5	5	5	4	1
Leguminous vegetables							
Dolichos lablab (hyachinth bean)	1	3	5	2	2-3	3	2
Psophocarpus tetragonolobus (winged bean)	1	2	5	4	3-4	4	2
Vignana unguiculata (yardlong bean)	3	4	4-5	4	3	4	4
Solanaceous vegetables							
Lycopersicon esculentum (tomato)	5	5	1	2-3	2	2	5
Capsicum spp. (sweet and hot peppers)	4	4	2-3	3	4	4	2
Solanum melongena (eggplant)	4	5	1	3	1	2	4
Other vegetables							
Abelmoschus esculentus (okra)	4	5	2-3	4	3	4	1
Brassica spp (cabbages)	3	5	3	2	2-3	2	4
Cucurbita spp (pumpkins and squashes)	3	4	1	3	2	3	2
Allium spp (onions)	2	5	2	3	1	2	4

Table 6. Nutrient production calculated for 1978-80 average yields as reported in 1980 FAO Production Yearbook. Rank in parentheses.

Crop	Thousand cal/a/day		kg protein/ha/day	
	World	USA	World	USA
Carrot	82 (1)	11 (4)	1.53 (9)	2.08 (11)
Maize	81 (2)	161 (1)	2.16 (5)	4.28 (4)
Potato	77 (3)	160 (2)	1.49 (10)	3.12 (8)
Sweet potato	70 (4)	76 (9)	0.70 (14)	0.80 (14)
Sugarcane	61 (5)	88 (6)	0	0
Soybeans	58 (6)	70 (11)	4.69 (1)	5.65 (1)
Wheat	55 (7)	64 (12)	1.87 (6)	2.18 (10)
Cabbage	52 (8)	53 (13)	3.49 (2)	3.50 (5)
Onion	45 (9)	125 (3)	1.36 (12)	3.75 (6)
Rice	44 (10)	81 (7)	0.86 (13)	1.60 (13)
Garlic	40 (11)	94 (5)	2.16 (4)	5.07 (2)
Tomato	38 (12)	76 (8)	1.63 (8)	3.25 (7)

Source: Henry M. Munger, Adaptation of Breeding of Vegetable Crops for Improved Human Nutrition, paper presented at the First International Symposium on Horticultural and Human Health, Arlington, VA, April 12-15, 1987.

Table 7. Top ranking food crops in developing market economies. From Horton, Douglas E. 1985. Potato Atlas. CIP.

Energy		Protein	
Crop	MJ/ha/day	Crop	kg/ha/day
Potatoes	216	Cabbages	2.0
Yams	182	Dry broad beans	1.6
Carrots	162	Potatoes	1.4
Maize	159	Dry peas	1.4
Cabbages	156	Eggplants	1.4
Sweet potatoes	152	Wheat	1.3
Rice	151	Lentils	1.3
Wheat	135	Tomatoes	1.2
Cassava	121	Chickpeas	1.1
Eggplants	120	Carrots	1.0

Source: Henry M. Munger, Adaptation of Breeding of Vegetable Crops for Improved Human Nutrition, paper presented at the First International Symposium on Horticultural and Human Health, Arlington, VA, April 12-15, 1987.