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CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH

TECHNICAL ADVISORY COMMITTEE

11th Meeting
CIMMYT Headquarters
El Batan, Mexico

Report of the CGIAR/TAC Secretariat Mission to ICIPE, Nairobi

22 - 25 September, 1975

J. K. Coulter
B. N. Webster

Report of CGIAR/TAC Secretariat Mission to ICIPE, Nairobi, to discuss possible arrangements for collaborative work between ICIPE and the International Agricultural Research Centres

Introduction

1. Dr. Coulter and Mr. Webster visited ICIPE from 22-25 September in response to a decision taken at the 10th TAC Meeting that members of the Secretariats of TAC and CGIAR should discuss with representatives of ICIPE the feasibility of collaboration between the International Agricultural Research Centres and ICIPE. A paper entitled "Crop and Livestock Insect Problems Facing CGIAR Centres: A Strategy Towards Their Long-term Solution", had been prepared by ICIPE and submitted to the Centres for comment (Annex I). Written comments from IRRI, IITA and ILRAD, were made available to the discussion group, at which representatives of those Centres were also present.

2. Participants in the discussion, at which Dr. John Coulter, Scientific Adviser to the CGIAR, took the Chair, are listed in Annex II. The discussion took the form of an examination of ICIPE's proposals and budgets in the light of the comments made by the Centres representatives, and of compromise proposals put forward during the course of the meeting by various participants.

Scientific Management

3. In response to a request from the Chair, the Director of ICIPE outlined the Centres proposals for the scientific management of any collaborative work undertaken with the International Centres with possible CGIAR assistance. A Deputy-Director (Science) who would function as a Research Coordinator, had been appointed. This post might eventually be converted to Director of Research. A further post of Assistant Director was being kept open and resident programme leaders were being appointed to all current programmes presently supervised by non-resident research directors. A further two research directors would be appointed to Supporting Services and Training

and Communications. He admitted that these changes in management had not been contemplated and were not a natural evolution, but resulted from a response to comments from the TAC and the Centres. Concurrently with these changes, ICIPE was undertaking a major change of Constitution from a Limited Company, to an International Centre with a Board of Trustees, to be established under Kenya Law.

Installations

4. ICIPE had already outgrown its initial installations on a 4½ acre site at Chiloma provided by the University of Nairobi. Presently available space on this site permitted only limited expansion in the way of laboratories and office facilities, and no suitable area for extensive insectary and insect rearing facilities which might be shared with ILRAD. A chemistry laboratory had now been established, although not originally contemplated, and along with the Sensory Physiology and Fine Structures Unit made up the bulk of the research Supporting Services. Field stations, library and workshope were still lacking however and an electronics workshop was urgently needed to ensure continuous operation of the existing electronic equipment (including two electron microscopes, one a stereo-scanner). This facility could also be shared with ILRAD.

5. Opportunities to acquire land had been offered and a site at Langata (near Nairobi but not adjacent to either the existing ICIPE headquarters or ILRAD) had been surveyed. The current proposal was to abandon the present site (with possible reversion of all ICIPE financed installations to the University of Nairobi), and re-site the ICIPE on the new land. All capital proposals were based on this assumption and also assumed that three field stations would be established. It was readily agreed that before further meaningful discussion of capital requirements could be pursued some agreement should be reached on the research programmes which might prove acceptable for re-submission to the TAC/CGIAR.

Potential for collaborative research with IARC's

6. The original programmes of ICIPE were those on mosquitoes, ticks, tsetse fly, termites and armyworms. To these had been added, as a response to initial TAC reaction to the application, the programmes on cereal stem-borers, sorghum shoot-fly and sources of plant resistance to insect attack.

7. It was fully acknowledged that ICIPE's basic theme was to conduct fundamental research into the physiology and ecology of insects inimical to man, with the longer-term possibility that such studies would elucidate suitable points of attack, perhaps for more unconventional control measures.

8. The response of IRRI, ILRAD and IITA to the amended proposals had been quite positive, all seeing considerable value in the Sources of Resistance programme especially, and anticipating collaboration in an integrated chemical/biological approach to one or more of their outstanding research problems such as stem-borers of cereals, plant hoppers on rice, pod-borers of legumes as well as tick and tsetse physiology. ICRISAT also had already entered into discussions on sorghum shoot-fly.

9. Centre representatives also emphasized that individual Centres could not expect to develop independent capabilities for multi-disciplinary research on insects and that only ICIPE or comparable programmes elsewhere could provide such an approach. However, the Centres, whilst recognizing the advantages of such collaborative research, were not prepared to expand their budgets to pay for such activities outside their own Centres.

10. Neither foraging termites not armyworm (essentially a sporadic pest) posed a first priority problem for any of the Centres. Similarly work on mosquito vectors of human disease was not within the mandate of the CGIAR and this programme should therefore be continued by ICIPE, with its own resources. Should the range surveys to be conducted by ILCA produce conclusive evidence that the foraging termite was, in fact, a serious competitor with cattle for available foodstuffs, then future consideration

might be given to this programme as a suitable subject for international assistance in collaboration with ILCA. It was already being supported by the UNDP/ICIPE project and UNEP had also expressed interest.

11. With reference to the other programmes, however, there was general agreement that work on ticks and tsetse-fly as vectors of animal disease, and stem- and pod-borers of cereals and legumes, sorghum shoot-fly and Sources of Resistance, should be regarded as suitable projects for inclusion in a programme for consideration by the TAC/CGIAR.

12. In support of this proposal, the Centres' representatives stressed their need for basic information on pest/parasite relationships, the biochemical bases of insect resistance and the increasingly important process of development of insect biotypes capable of surviving on formerly resistant plant varieties. Although the development of insect resistant plant varieties through breeding had been pursued with a fair degree of success by the Centres, an enhanced availability of information on the chemicals responsible for plant resistance could feasibly permit the much more rapid screening of germplasm. Such a screening technique could also be of use in identifying alternate hosts and elucidating some of the anomalies currently being observed with respect to insect attack in mixed cropping.

13. Work on both hard and soft ticks had been started by ICIPE on a speculative basis; it had since been concentrated on the hard tick (vector of East Coast Fever), and important findings on the pheromones controlling sexual behaviour and aggregation, and on population dynamics had already been published. Not only was the hard tick important as a vector of East Coast Fever but it could also be a fatal pest of cattle *per se*. Joint projects with the East African Veterinary Research Organization (EAVRO) were already underway. The Project Manager of the FAO/UNDP/EAVRO Tick Control Project emphasized that great reliance was being placed on ICIPE for the basic biological and ecological information of vital importance to the project.

14. Likewise the Director of ILRAD indicated the importance of potential inputs by ICIPE to ILRAD's programme, which would be incomplete without basic work being done by both the tick vectors of East Coast Fever and the tsetse-fly vectors of trypanosomiasis. Whilst techniques for breeding Glossina morsitans in captivity were available, and could be put into routine use by ILRAD, no such techniques were available for Glossina pallidipes and ILRAD foresaw a role for ICIPE in the development of such techniques.

15. The meeting concluded therefore that there was a justification for establishing a mission-oriented programme at ICIPE which might be submitted to the TAC/CGIAR.

Proposed CGIAR Sponsored Programme

16. An arbitrary division was made of the ICIPE programme between the medically-oriented sector (Aedes species and other mosquito work); the exploratory sector (soft ticks, insect communication, termites, armyworm, etc.), and the food production oriented sector (Sources of Resistance, Cereal Stem-borers, Sorghum Shoot-Fly, Tsetse flies and Hard-ticks).

17. The Research Support Services, comprising Chemistry, Sensory Physiology, Fine Structure Research, Insect and Animal Breeding Unit, Field Stations, and the Workshop would supply inputs to all programmes and should therefore be considered as a shared service.

18. The food production oriented programme was accepted as that part of ICIPE's total programme which should form a "minimal package" for re-submission to the TAC. ICIPE accepted a division of this programme into two sub-programmes on (i) Crop Pests and (ii) Insect Pests. Sub-programme leaders would be appointed for each, and overall control of the Programme would be allocated to the Deputy-Director (Science) who would spend 75 per cent of his time on the programme; this would legitimately be a charge on the CGIAR sponsored programme.

19. The components of the two sub-programmes would be as follows:

i) <u>Crop pests sub-programme</u>:

a. Sources of Plant Resistance to inseot attack.

Target Insects:

b. Stem-borers of rice, maize, sorghum and millet and pod-borer (*Maruca* spp) of cow pea,

c. Sorghum shoot-fly.

(It was also agreed that if time and resources permitted sorghum gall-midge and rice plant hoppers could be added to this sub-programme.)

ii) <u>Animal pests sub-programme</u>:

Target insects:

d. The brown ear tick (hard tick) *R. Appendiculatus*, vector of East Coast Fever,

e. The two tsetse flies involved as vectors of cattle trypanosomiasis, *G. morsitans* and *G. pallidipes.*

<u>Resources Required</u>

20. Following agreement on the inclusion of the above five elements (a - e) in an internationally sponsored programme, a calculation was made of the minimum resources required in terms of scientist and supporting staff man-years, capital installations and equipment, to carry such a programme forward.

i. <u>Crop Pests Sub-programme</u>

21. It was agreed that not less than one senior scientist should be applied to each type of crop pest within the programme and that a Sub-programme leader be appointed from within the group of five scientists suggested as the minimal cadre necessary. Adequate support staff (calculated by ICIPE as averaging three technical or research assistant grades to each scientist) would also be included in the programme. Although no attempt was made to assign specific disciplines to the above scientists at this juncture it was agreed that at least one insect ecologist and one insect behaviourist should be included in the team.

ii. Animal Pests Sub-programme

22. Again a general Sub-programme leader and two Senior Scientists (Tsetse and Ticks) should be appointed together with a further three scientists. Out of this total of six scientists three should be physiologists and two ecologists. Supporting staff requirements would be concomittantly higher (24) as would be ancillary and daily rated workers.

iii. Research Support Services

23. At present these services made a contribution across the total programme of ICIPE. Clearly this support would need to be continued. ICIPE's own contribution to the proposed CGIAR sponsored programme could most effectively come from this sector of research support in the form of chemistry, electron microscopy, etc. It was therefore agreed that an annual contribution of 4 man-years from ICIPE's core programme would be made in this form.

iv. Additional manpower requirements

24. Minimal additional staff at a senior, if non-professional level, to secure proper support for the above teams were thought to consist of a farm manager, a professional administrator for the field station, an electronics engineer for the proposed workshop, an insectary manager and, eventually, a livestock manager. It was concluded that as the farm/field station operations would be mainly occupied with activities of the proposed CGIAR-sponsored programme it would be rational to charge the farm manager and field station administrator on a shared basis of 75 per cent to CGIAR and 25 per cent to ICIPE core programme. The remaining posts should be funded either by ICIPE, through additional bilateral funds, or on a shared basis with ILRAD in view of the latter's strong interest in the insect and animal rearing facility. Further discussion was desirable on these points.

25. Other posts, likely to be needed in the near future, were additional senior technicians for the proposed insectary, an equipment supervisor and, at the professional level, a statistician. The question of possible sharing of these posts would also need to be discussed further.

Field Stations

26. ICIPE's own proposals (see Annex I) were to develop three field stations, one in Western Kenya, one near the East Coast and another on the plateau 75 Km from Nairobi. Following discussion of priorities it was agreed that the W. Kenya field station was of highest priority, so as to provide a site for ecological and crop-oriented studies on the major target insects in the food production-oriented programme.

27. Examination of the site, at Mbita Point, Homa Bay, indicated its suitability for growing maize, sorghum, millets and beans, and some adjacent areas should prove suitable for rice.

28. Discussion of housing and laboratory requirements on the site led to the conclusion that, with the exception of the farm staff housing, no permanent residences should be provided. Adequate guest house accommodation should be provided for visiting scientists, it being anticipated that a maximum length of stay of three months should be sufficient.

29. Sophisticated laboratory facilities were also deemed to be unnecessary and it was recommended that a re-calculation be made of the needs at the Mbita Point field station, in order to bring these within the compass of a contribution anticipated from a bilateral donor.

30. ICIPE would continue to finance activities at the E. Coast station, at present concerned with work on the mosquito vector of yellow fever, from its core programme resources. Subsequently this work might be terminated and work started on the Anopheles mosquito at Mbita Point.

31. Further field work, in collaboration with ILRAD could possibly be contemplated at the Langata site near Nairobi but the mission urged the re-examination of the possibility of obtaining sufficient land for insectary and animal breeding facilities at Kabete, adjacent to both ILRAD and the Kenyan Department of Veterinary Research.

Programme and Budget

32. The meeting developed some preliminary ideas on the budget for the proposed CGIAR-sponsored programme, starting in 1977. As pointed out in paras. 21-22, eleven scientists plus support staff would be required for the cooperative programmes and, whilst facilities would be provided by the Centres for any staff out-posted to them, additional facilities would be needed at ICIPE headquarters.

33. The original ICIPE submission envisaged the development of a complete new site (at Langata) for the headquarters of the Centre but since the meeting had agreed not to pursue this proposal the modified capital budget proposals would include development of facilities on the present ICIPE site, sufficient only to cater for the additional programme, and of essential facilities still lacking at ICIPE but needed for its expanded role in international research. These would include:

(i) Additional laboratory facility of $1000m^2$. This would almost double the present laboratory space, as well as providing additional space for the existing staff who were at present somewhat cramped - accommodating the eleven scientists in the proposed CG programme. It would also provide additional service facilities.

(ii) An insectary of $700m^2$. This would accommodate a breeding and research programme on tsetse, ticks, stem borers, pod borers and shoot fly. If land at Kabete was definitely unavailable, it might need to be sited at Langata.

(iii) General purpose room of $200m^2$. This would be multi-purpose, and used as a reading room/library, seminar room and, with temporary sub-divisions, for visiting scientists. As part of its cooperative programme, ICIPE would expect to hold regular meetings of both its own and Centre scientists involved in cooperation projects. ICIPE is particularly short of such space at present.

(iv) Room for controlled environment chambers of $200m^2$. This would provide space for the installation of 10-12 such chambers for the growth of crops under controlled conditions. No such facilities existed at ICIPE at the moment.

34. Preliminary estimates for these facilities, based on information from an architectural firm in Nairobi approached by the mission, are given in Table I. These are lower than the unit costs given by ICIPE's architect, and the general feeling of the meeting was that the latter were too high.

TABLE I.

Capital Budget, ICIPE Headquarters

Space Allocation		Function	US $
$1000m^2$	(1)	Laboratory at $\$257/m^2$	257,000
	(2)	Special services, gas, electricity, plumbing at $\$42/m^2$	42,000
	(3)	Extract systems, fume cupboards, cold rooms etc. at $\$83/m^2$	83,000
		Total for Laboratory	382,000
$700m^2$		Insectary at $\$257/m^2$	180,000
$200m^2$		General purpose room at $\$257/m^2$	52,000
$200m^2$		Room for controlled environment chambers at $\$257/m^2$	52,000
		GRAND TOTAL	666,000
		Add 35% for circulation space (calculated on basic costs)	190,000
			856,000
		Plus escalation at 20% per annum (over two year period)	342,000
			$ 1,108,000

35. Operational Costs. ICIPE staff salaries are based on those paid at the University of Nairobi and are thus below those paid at the International Centres. The Director of ICIPE stated that these salaries will need to be increased but he did not

envisage that the increase would bring salaries up to international centre levels. Staff salary differentials for staff posted in collaborative programme to Centres would thus emerge but the meeting felt that this situation would have to be accepted. In fact some of the advantages of ICIPE would be the lower staff costs.

36. The meeting discussed two alternative ways of funding the CGIAR-sponsored programme; either by contracts funded by the Centres, or by direct funding of co-operative programmes developed conjointly by ICIPE and the Centres. The Centres representatives and ICIPE all favoured the latter method of funding, and the meeting agreed that this would be the preferred method. ICIPE's budget shows that its cost per scientist works out at $70,000 to $80,000 per annum; on this basis the proposed CGIAR-sponsored programme would cost under $1 million per annum

Follow-Up Action

37. There was insufficient time at the meeting in Nairobi to develop a detailed programme and budget for the proposed CGIAR-sponsored project. The figures given in Table I and para. 36 are, however, considered reasonable approximations. If the TAC agreed that the strategy outlined in this report was an acceptable one, and if the CGIAR agreed in principle, to the approach, then the CGIAR and TAC Secretariats would work with ICIPE's management in developing a detailed programme and budget for 1977, for discussion at the TAC meeting in May 1976, and presentation at the CGIAR meeting in July. ICIPE would be asked to develop an overall programme and budget for the Centre's activities as a whole. It would indicate those parts of its core programme for which funding was available, those parts for which funding was being sought, as well as the budget for the CGIAR-sponsored cooperative programmes and needs for bridging funds in 1976.

ANNEX I

THE INTERNATIONAL CENTRE OF
INSECT PHYSIOLOGY AND ECOLOGY
P.O. BOX 30772, NAIROBI, KENYA

CROP AND LIVESTOCK INSECT PROBLEMS FACING CGIAR CENTRES: A STRATEGY TOWARDS THEIR LONG-TERM SOLUTION

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ICIPE
Nairobi, Kenya

26th August 1975

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I. INTRODUCTION

Experience with the high-yielding varieties of cereal crops in the last few years has shown that there are serious impediments to the general adoption of green-revolution technology by the peasant farmers, who make the majority of the farming community in the less developed countries (LDCs). For instance, peasant farmers have adopted the new "miracle" seeds of rice for only one-quarter of the world's rice-lands; and, even in some countries where the new rice varieties are widely grown, rice production has increased far less than was anticipated. Yet, the present food production methods can only lead to a widening gap in the total world food production and food expectation. At the 1975 International Centres Week held in Washington, D. C., in July, the CGIAR Centres saw the challenge as that of harnessing their talent to develop improved crop varieties and the relevant technology geared towards the small farmer in the LDCs; of venturing on food production in regions having adverse ecological conditions to the particular crop; and in helping the small farmer to produce more food from limited land resources.

A study of cropping systems in the LDCs in tropical and subtropical regions has shown that crop monoculture is rare, and that more complex systems are normally put into practice: intercropping, mixed cropping, multi-cropping, or relay-cropping. Initial farming systems analysis by some of the CGIAR Centres now investigating these questions has indicated that these complex cropping systems have some considerable agronomic advantages: maximisation of water use, the utilization of residual soil moisture during periods of long dry seasons, the lessening of land preparation problems associated with second-season crops, the production of higher yields under these conditions than when single-cropping is practised, and the reduction of pest losses under mixed cropping. Consequently, there is a tremendous need to invest considerable research and development effort in fashioning new technology for the small farmer in the LDCs, while realising that he will want to continue using the more complex systems - albeit improved by innovative research.

A recent study by IRRI in the Laguna Province of the Philippines within the farmers' fields has demonstrated that, using IRRI technology, he can produce about 5.0 tons/hectare of rice during the wet season; but, if he uses his traditional agronomic practice, he can only produce 3.3 tons/hectare. The investigations showed that the most important constraint to high productivity at the farm level were insect pests and diseases (making up 70% of the total complement of avoidable constraints), while other avoidable constraints made up the rest (weeds 18%, nitrogen fertilizers 6%, and seedling management 6%). Although the figures were different under dry-season conditions, as similar picture regarding the constraints emerged. There is no question therefore that the control of insect pests is a major ingredient in the strived-for revolution for high productivity by the small farmer.

The problems of livestock production in tropical and sub-tropical Africa are just as difficult. Perhaps the most pervasive problem is that of livestock trypanosomiasis, transmitted by tsetse flies (Glossina spp.). It is a major limiting factor in livestock production, excluding 4 million square miles from animal production in Africa. It is estimated that this area alone would - if tsetse flies were eradicated from therein - support an additional population of 120 million head of cattle, producing about 1.5 million tons of meat every year, representing a value of at least U.S. $ 750 million a year.

Tick-borne diseases are equally important in Africa and other tropical countries. Theileriosis, anaplasmosis, and babeciosis are all major constraints to the attainment of full productive capacity in the LDCs. Although there are long-term possibilities for effective and cheap vaccines for prophyllaxis and drugs for the treatment of the overt disease condition, vector control is a principal avenue for the efficient control of these diseases. Since acaricide resistance by ticks is becoming a looming threat, other tick control strategies are needed.

The ICIPE has an important role to play in complimenting efforts to solve these problems.

The ICIPE recognizes that there are important applied problems in the pest management of food crops (including livestock production). But it also recognized that in several crucial cases these applied problems cannot be satisfactorily approached without further basic knowledge. The target pest species that the ICIPE has chosen for its first attack - tsetse flies, livestock ticks, sorghum shootfly, cereal stemborers, African armyworm, and foraging termites - are all pests that have already received considerable national, regional, and international attention. Many have been the subject of practical, eradication programmes on an extensive scale over the last 70 years or so. If there were simple, direct methods for the control of these important pests they would have been found in that time and put into operation. This vital fact has persuaded the ICIPE to approach these major pest problems with a more open strategy. Thus, the ICIPE will, in each case, explore several lines of study which hold promise as novel avenues for pest control, and which possibly, together with already-tried methods, may be fashioned into a pest management programme.

The present paper is an outline of the research programmes that the ICIPE believes, based on discussions during the recent International Centres Week and other contacts, are of special interest to certain CGIAR institutes - CIMMYT, ICRISAT, IITA, IRRI, and ILRAD:

1. Sources of plant resistance to insect attack: of interest to CIMMYT, ICRISAT, IITA, and IRRI.

2. Cereal stem-borers: of interest to CIMMYT (maize), ICRISAT (sorghum and millet), IITA (maize, sorghum, and rice), and IRRI (rice).

3. Sorghum shootfly: of interest to ICRISAT.

4. Tsetse flies: of interest to ILRAD.

5. Tick vectors of livestock diseases (mainly East Coast Fever): of interest to ILRAD.

6. Biology of foraging termites: some interest shown by IITA

7. African armyworm: some interest shown by CIMMYT.

It expected that important research results that can find application in the short-term may well be found in some cases, e.g. in the programme dealing with sources of plant resistance (where results could be incorporated quite quickly in the crop breeding programmes). But in most cases, it is realised that the research results of the ICIPE approach to pest management can have practical application only in the medium and long-term.

The research orientation of the ICIPE is one of problem-solving, much in the same way that ILRAD is oriented strategically in this fashion. The ICIPE must therefore complement and work closely with commodity institutes, with their overwhelming production orientation, in its search for new pest management strategies.

The ICIPE is well placed to undertake this kind of work, and to respond to the needs of the CGIAR institutes in the area of pest management research. Firstly, the ICIPE is strategically located in an equatorial tropical LDC at a confluence of a high-altitude tropical area, a range of savannah ecosystems, and with access to lowland tropical areas as well as semi-arid regions. Consequently, it can tackle a range of tropical pest problems, and be in intimate communication with national and regional efforts in solving applied insect problems. Secondly, the ICIPE has already chosen, as its first target insects, pest problems that are of more than national (e.g. tsetse and armyworm), regional (e.g. termites and ticks), or African continental interest (e.g. cereal stem-borers). Indeed, some of these problems are of international importance (e.g. sources of plant resistance and sorghum shootfly). Thirdly, the ICIPE has realised from the very beginning that training of young scientists and technologists from the LDCs is vital to the enhancement of the scientific capabilities of these countries, which is important to any long-term, science-based solutions to development problems. Fourthly, a special strength of the ICIPE lies in its ability, through its multi-disciplinary research teams and through a network of some of the best entomological research laboratories throughout the world, to bring the resources of modern biology to bear on major pest problems as they are identified, and thus facilitate the introduction of novel methods of pest control. And, finally, the ICIPE is already a tried and an on-going research centre of high quality and capability.

In the course of its short history so far, and in the light of the new challenges in pest management as it applies to increased food production, certain weaknesses in the ICIPE structure and management have appeared. The ICIPE Governing Board has recently taken major decisions to change these, and at the same time to consolidate the main strengths of the ICIPE approach to development problems. These will be outlined in subsequent sections.

The proposal as a whole should be regarded as a preliminary one. The ICIPE is ready to respond to suggestions from the CGIAR Centres, and to modify its programmes and activities accordingly.

II. RESEARCH PROGRAMME PROPOSALS

The research programmes outlined below are those that the ICIPE plans to undertake on behalf of and in collaboration with the CGIAR Centres. The first one is completely new, and was first suggested in a restricted sense in the original application to the TAC. The others are already being undertaken by the ICIPE, and are being sharply focussed to meet the special interests of the CGIAR Centres.

In all those cases involving crop pest programmes, ICIPE scientific staff will initiate its collaborative programmes with the CGIAR Centres by spending an entire crop season at the relevant Centres acquiring background knowledge of the vast crop germplasm, the particular pest problems involved, the interaction of the crop and the relevant pest, and the agronomic milieu in which the pest problem occurs. This initial orientation will ensure that ICIPE staff become familiar with the practical problems and objectives of the Centres at an early date. The special relations that the ICIPE enjoys with ILRAD has ensured that the two institutes, geographically close together, have already a close working relationship at the technical and scientific level.

It is proposed that the initial studies undertaken by the ICIPE at the CGIAR institutes be a regular feature of the ICIPE method of keeping in close contact with Centres' pest problems. It is suggested also that scientists from the CGIAR Centres, including their entomologists, make frequent working visits to the ICIPE to become fully acquainted with research results that could be incorporated in their various programmes related to pest management.

1. Sources of Plant Resistance to Insect Attack

The classical technique of producing new high-yielding varieties of crops is to make selections under an "insecticidal umbrella". The release of superior, but otherwise insect-susceptible, varieties in the tropics, especially under small-farmer conditions, has often lead to very disappointing levels of crop performance - largely due to pest attack. This classical technique is being progressively replaced by a new strategy of making selections of resistant plants from crops under a minimum insecticide application, plants which at the same time have the high-yielding and other requisite characteristics.

The first significant elite rice variety that was released for widespread distribution, and which possessed both the characteristics of high-yielding and pest-resistance, was IR20. It was released in 1969, and has since been quickly adopted by numerous farmers. This demonstrates that farmers will adopt such resistant varieties because of two special agronomic advantages at least: insect resistance stabilizes crop yields; and production costs are significantly lowered. Rice farmers prefer to use only small amounts of insecticides, and then only when pest damage is obvious - at which time corrective measures may be too late. As the energy crisis deepens and continues, so the price of traditional pesticides will continue to rise. Consequently, the CGIAR Centres have become to regard breeding for insect resistance as an essential part of their production - oriented breeding programme for crops.

However, the techniques presently available for selecting insect-resistant plants are highly pragmatic. Experimental cultivars are grown under more or less uniform environmental conditions and inter-planted with insect-susceptible cultivars, either in the field or in some type of glasshouse, screenhouse, or greenhouse; in either case, the plants are exposed to intense insect populations, either naturally occuring in the field or artificially released in the experimental arena from mass-bred insect populations; the damage to the plants are scored according to a predetermined rating, and the plants showing tolerance or resistance are thus identified, assembled, and processed for further breeding work. A first step in simplifying these selection procedures would be to identify the sources of plant resistance to each particular pest. Besides, such knowledge of the sources of plant resistance would provide a tool for the monitoring of each of the steps of a plant improvement programme, ensuring that insect-resistance is retained in the course of completing the "synthesis" of a new cultivar possessing desirable agronomic and other characteristics.

Two peculiar problems arise where a mixed cropping system is practised, as has been shown by recent experience in IITA. Firstly, the pest problem is much less intense than is prevalent under the separate cropping of single plant species. There is not much documentation of this phenomenon, nor are the factors that lead to this pest amelioration status known. Secondly, varieties of a crop that are insect-resistant while grown separately are not necessarily resistant in a mixed-cropping system. We are unaware of the missing element in this latter condition.

A closely related question is that of insect biotypes, some of which have evolved to attack crop varieties that were originally selected for their resistance to insect attack. A pertinent demonstrative example of this problem, which could have tremendous impact on pest management through the selection of insect-resistant crop varieties is that of brown rice planthopper, Nilaparvata lugens, which is rapidly becoming the most serious pest of rice in Asia. IRRI recently found that some of the rice varieties that they had developed in the Philippines and were resistant to the planthopper in that country - e.g. Mudgo and ASD 7 - were susceptible to the same species of planthopper when grown in Sri Lanka and in Kerala State (in southern India). An initial study has shown that the brown planthopper can rapidly develop a new biotype able to attack previously resistant rice varieties, if these possess monogenic resistance. For instance, biotype 1 is the brown planthopper naturally found at IRRI, lives well on the susceptible rice variety TNI, but cannot develop on resistant varieties Mudgo, ASD 7, and IR26 at IRRI. When, on the other hand, brown planthoppers were collected from fields intensively planted with resistant rice varieties and were then reared for several generations on resistant rice plants in a greenhouse, 3 new biotypes were found to have evolved, including one that could survive on 2 resistant varieties, Mudgo and ASD 7 (biotype 4). It may therefore be hypothesized that if only a few pest-resistant varieties of rice are intensively planted over a wide area, insect biotypes may develop, through natural selection, that can attack and thrive on formerly resistant crop varieties. Such an eventuality will probably develop very rapidly when crop resistance is governed by a single pair of genes ("monogenic resistance"). it may be slowed down considerably when the resistance is governed by two or more pairs of genes ("multigenic resistance").

The major question facing us is to identify the several genetic mechanisms that enable an insect pest to produce new biotypes, to identify the regulatory factors in the resistant plant variety that set off the biotypic micro-evolution, and to find ways in which this process can be combated.

Because of the widespread interest in breeding crops for insect resistance, the attendant pest problems outlined in the present ICIPE programme is likely to develop into a major activity. It will eventually cover the major crop insect pests whose control techniques encompass the production of pest-resistant crop varieties.

Initially, the ICIPE will tackle the following projects:

(a) Possible chemicals responsible for resistance to leafhoppers (Empoasca fascialis) and thrips (Sericothrips occipitalis) in the cowpea, which take a heavy toll of cowpeas in the pre-flowering stage. Several varieties of cowpea are now known to be resistant to these and other pests, e.g. VITA 9. Legumes are know to have a pronounced phenol defence mechanism to insect attack; and it is possible that phenols, or their precursors, may be a factor in cowpea resistance to attack by leaf-hoppers and thrips. The ICIPE will investigate this and other chemical avenues, in collaboration with IITA.

(b) The pod-borer, Maruca testulalis, is a pest of legumes all over the world, and is a principal pest of cowpea, feeding on flowers and newly developed cowpea pods. In this way, it causes an almost 100% damage. Recent observations at IITA have demonstrated that damage to maturing cowpea pods shows some varietal differences. The resistance mechanism appears to be complicated, as the varieties which are resistant at the earlier pod development stage were susceptible at later development stages, and vice versa. The ICIPE plan to establish the factors, including chemical ones, for pod-borer resistance at the various pod-development stages, in collaboration with IITA staff.

(c) The ICIPE will study, in collaboration with IRRI, the biotypic development of the brown rice planthopper under conditions of intense pressure from resistant rice varieties of different genotypic constitution, and under mixed-cropping conditions.

(d) The ICIPE will undertake, in collaboration with CIMMYT and IITA, the sources of resistance of tropical lowland maize to maize stem-borers. It will also study the mechanism of seeming breakdown of this resistance when maize is grown under mixed-cropping with legumes, sweet potato, and other crops.

This is a new programme altogether, of great interest to CGIAR Centres; and we plan to have two principal scientific staff make a start in 1976. The programme will be heavily supported by three research support units - those for Chemistry, Sensory-physiology, and Fine Structure. The full complement of the plant resistance programme will therefore not be large, and will consist of only 4 scientific staff, which will be reached in 1977. The staff complement will be: one insect population ecologist, one insect behaviourist, one insect geneticist, and one natural products chemist. This staff, together with the relevant staff from the research support units, will work as a multi-disciplinary team on this programme.

2. Cereal Stem-borers

Stem-borers are particularly serious pests of maize and rice in the African continent. In maize alone, stem-borers can cause 5-40% yield losses in Kenya. Stem-borers have become such a major pest of rice in Iran in recent years that IRRI was requested to make a special survey of the problem in 1974. Apart from the sorghum shootfly and the sorghum midge, stem-borers are the most important insect pests of sorghum in Africa and Asia. The loss in yield wrought by stem-borers is through loss of stand (by the death of the growing shoot, leading to "deadhearts"), extensive damage to the plant's vascular system (leading to "white heads" and unfilled or aborted grains).

Insecticidal control is not a great success, although newer techniques of application are now being tried, e. g. the placement of encapsulated systemic insecticides (carbofuran and others) near the root zone. Breeding for borer-resistant cereals is being investigated in several Centres, although so far only tolerance or moderate resistance is being turned up. A concerted effort for a systematic approach to resistance breeding is needed, and the ICIPE can contribute effectively to this effort.

It is planned that the ICIPE concentrate its major efforts on ecological and physiological studies of a few, key stem-borers that are principal pests of maize, sorghum, millet and rice. It is also proposed that the major theatre for this work should be East Africa, although there will be constant reference to other stem-borer/plant complexes in other situations in other regions. The key stem-borers will be the following:

Chilo partellus (=zonellus), the sorghum stem-borer : In maize, sorghum, millet, and rice

Busseola fusca, the maize stalk-borer : In maize and sorghum

Sesamia calamistis, the African pink borer : In sorghum and rice

Maliarpha separatella, the African white rice borer : In rice

The ICIPE has already made a start on this programme by initiating an investigation on seasonality and the occurrence of a larval diapause. Seasonal development of the sorghum stem-borer, C. partellus, is synchronized with the maturation of the maize crop, and the occurrence of dry and wet seasons. With the ripening of the crop, mostly coinciding with the dry season, pupation of the larvae is retarded and their further development is arrested when they attain the last larval instar. This diapause is only broken at the onset of rainfall in the succeeding wet season. Diapause is a crucial weak link in the seasonal cycle of this pest, and probably in most other stem-borers. Knowledge of the precise factors that initiate or break this diapause is lacking, although present preliminary studies indicate that the reduction in rainfall in the penultimate larval instar may well be the inducing factor for diapause in the last larval instar. Such knowledge may give us a better tool for prognosis of stem-borer outbreaks. It could also lead to the design of a novel pest control method for these important insects.

The ICIPE now intends to develop this project into a more comprehensive programme on stem-borers of maize, sorghum, millet, and rice as indicated previously. The programme will initially focus on the following problems:

(a) Seasonal life cycle and the periodicity of infestation of stem-borers in all four cereals. The project will include the study of aestivation diapause in Chilo and other stem-borers.

(b) Ecological impact of seasonality on the development and reproduction of the various stem-borers.

(c) Host-plant relations, especially in regard to oviposition, larval feeding, and larval development. The problem of host selection (including the question of wild hostplants) will also be investigated.

(d) Factors determining resistance : the dynamic state of susceptibility under different agronomic practices, the chemical basis of acceptance or rejection of plants, and the physical or biophysical properties conferring tolerance or resistance, will form part of these investigations. The programme staff will necessarily work closely with staff involved in questions of plant resistance; they will also need to work closely with plant breeders and entomologists in CGIAR Centres.

The Cereal Stem-borer programme has only one principal scientist at the moment. But the research needs are great and diverse, and it is intended to build the scientific staff to 6 by 1980. The staff will then cover the following specialisations: ecology and host-plant relations (3), insect endocrinology (1), insect behaviour and pheromonal behaviour (1), and biochemistry (1). The group will work in a multi-disciplinary fashion in tackling these cereal stem-borer problems.

3. Sorghum Shootfly

This research programme is close to that on stem-borers, and the two teams will work closely together.

The most important pest of sorghum in the Old World (Mediterranean in Europe, Asia, and Africa) is apparently the sorghum shootfly, Antherigona varia soccata and it causes serious damage to the crop arising from the habit of the shootfly larvae in penetrating the growing point. This causes deadhearts in the young shoots. Although the plants generally react by producing tillers, which in turn may also be killed by larvae, the number of grain-producing panicles are reduced. Much of the base-line data on this fly is not known, thus limiting choices on control techniques.

The seriousness of the shootfly as a major pest of sorghum has been exacerbated by the recent attempts at introducing new high-yielding varieties. For instance, the traditional sorghum varieties in East Africa are tolerant to the shootfly, and the latter was therefore not such a major pest until the introduction and widespread cultivation of new high-yielding varieties (such as Serena), which also happen to be susceptible to the shootfly.

This research programme was only initiated towards the end of last year, as a result of recommendations made by ICRISAT to the UNDP/ICIPE Policy Advisory Committee. Investigations have been focussed on field studies of the shootfly in a region of major sorghum production, Western Kenya near Lake Victoria. It is already clear from these preliminary studies that we may be dealing with a complex of 3 closely related species (or other taxa), that there are important wild graminaceous hosts, and that the latter may well play a vital role in the seasonal outbreaks of the insect.

Working closely with ICRISAT and IITA, it is proposed to undertake the following projects on the sorghum shootfly:

(a) Factors controlling the development of the fly larvae, the chief pest stage. The manner in which the host physiology, host specificity, and the plant micro-environment regulate larval development will be a major part of these studies.

(b) Control of reproduction in the shootfly and a study of the fly's reproductive potential in the field. Such studies will naturally lead to the consideration of seasonality of shootfly occurrence and outbreaks.

(c) Responses of larvae to plant hosts (for feeding) and of adults (for oviposition), and the sensory mechanisms (including the active principles involved) underlying these behaviour patterns. These facets are a key to the problem of host specificity: they may also lead to the chemical (or other) sources of plant resistance to this pest. Reports mentioned at the Hyderabad Symposium on "Sorghum in Seventies", held in October 1971, show that tolerant varieties selected in India over several years from a large germplasm bank, all of the India rabi type, is primarily due to non-preference for oviposition. There is therefore some hope that truly shootfly-resistant sorghum varieties may well be developed in the future, with the cooperation of ICRISAT sorghum breeders.

The ICIPE has already appointed one principal scientist for this programme. The staff complement will develop to 4 in 1978, and it is planned that it forms a multi-disciplinary team with 2 ecologists (population ecology: seasonality and host-plant relations), and 2 physiologists (insect physiology, and sensory-physiology). It is hoped that plant physiologist from ICRISAT and IITA will collaborate closely with the ICIPE team.

4. Tsetse Flies

Measures aimed at eradicating livestock trypanosomiasis have usually taken three principal forms:

- Eradication of the tsetse vector by several means, or their combinations: bush clearing, elimination of game thought to be preferred hosts of tsetse flies, and the use of insecticides. Many control programmes have used this approach over the last 60 years or so

- The use of trypano-tolerant cattle breeds, such as Ndama in West Africa

- The use of drugs to treat the disease. However, the problem of drug-resistance by trypanosomes is becoming a serious threat

- The development of immunization systems. ILRAD has been established primarily to undertake the immunological approach to this disease (as well as East Coast Fever).

Apart from the last approach, which has still to be fully exploited, a general conclusion from past efforts in livestock trypanosomiasis control is that the problem is very far from having been contained, let alone eliminated.

The ICIPE strategy is to work closely with ILRAD and other agencies working towards the elimination of this major animal disease problems, (e.g. EATRO, at Tororo, Uganda; the Nigerian Institute for Trypanosomiasis Research: and the FAO-supported project on Animal Trypanosomiasis Control in Dry Savannah Zone, which is to be launched in 1976), but concentrate on research effort on the vector itself.

The ICIPE initiated research on tsetse biology more than two years ago, and has already made some notable achievements in elucidating the reproductive biology of tsetse flies, and in opening up new questions regarding the development of infective trypanosomes within the fly. This research is to be continued with the express purposes of opening up new avenues for vector control through the exploitation of the weak links in the biology of tsetse flies - e.g. its low reproductive potential and its complex uterine reproductive biology, which often lead to abortion; of elaborating a technique for the mass-rearing of one of the most important vector of this livestock disease, Glossina pallidipes, which has so far not been bred continuously bred in the laboratory - a process important for continued laboratory research on tsetse physiology and trypanosome development in the fly; and of complementing the work of ILRAD by elucidating the biochemical and physiological factors within the tsetse fly that are essential for the development of Trypanosoma brucei to the infective state.

The ICIPE plan to continue working on the following three large projects:

(a) Development and reproductive physiology of tsetse flies, particularly the important vectors G. pallidipes and G. morsitans. The type of questions that will be asked include: What factors lead to abortion? What are the critical factors that correlate intra-uterine larval feeding to lactation, and vice versa ? How is lactation geared to the mother's food intake ? In what way is intra-uterine larval growth and development geared to lactation ? Which are the cruical factors in information exchange between mother and larva ? What is the nature of the pacemaker mechanism that maintains cycles of pregnancy, parturition, and the subsequent events?

(b) Breeding biology of and mass-rearing technology for G. pallidipes. The first major step, now being studied, is the process of naturalisation to laboratory conditions of wild-caught tsetse flies, leading to successful feeding, mating, and breeding. This is a major initial barrier. The next step will be to establish a self-sustaining colony of G. pallidipes, which does not need to be replenished from time to time with new flies or pupae from the field. Insects from this colony will be used by experimentalists in the ICIPE and ILRAD. A final step (tried by others before but without apparent success) will be the establishment of a resident tsetse colony in a large field cage, in one of the traditional tsetse habitats using one of the naturally favoured hosts (viz. wild pigs and cattle), for comparative behaviour, ecology, and physiological studies.

(c) Factors controlling infectivity of trypanosomes within the tsetse fly. Efforts will continue on the re-examination of the whole developmental life-cycle of the polymorphic trypanosomes - in the gut, in the haemocoele, and in the salivary glands - and to relate these cycles with the physiological and biochemical events in the fly, and further to correlate these with the immunological loss of infectivity (in the gut) and its eventual re-acquirement (in the salivary glands). A chief question in regard to the latter is whether the antigens acquired by the trypanosomes while residing in the insect salivary glands are immunochemically the same antigens that the parasites previously acquired in the vertebrate host and subsequently lost in the first few hours of its sojourn in the insect. The answer to this question will form an important cornerstone to the whole problem of producing a practical vaccine against trypanosomiasis. While ILRAD and EATRO are concentrating on immunological studies of the parasite in the vertebrate host, the ICIPE is undertaking complementary studies on the parasite during its insect phase. In this respect, the ICIPE will be establishing a laboratory for the culture of tsetse salivary glands and other tsetse tissues for the experimental study of the biochemical environment vital for the infective development of the trypanosomes.

(d) The nature of and factors that regulate vectorial capacity in the tsetse fly. These capacities are linked with endogenous factors of the tsetse fly itself (e.g. species, sex, age, physiological condition, and host preference), the trypanosome itself (e.g. the infective capacity of the parasite, the various strains and developmental forms, and the parasite population taken into the insect), and ecological factors (micro-climate, presence of appropriate host, etc.). This project will be started in 1976. Much of this study will require a great deal of field work, including new methods of sampling. For instance, how best can we sample the epidemiologically significant tsetse population, as opposed to the whole tsetse population ?

The full complement of principal scientific staff for this programme will be reached in 1979, when it will be 9, members of which will bring in the following specializations:

- *Female reproductive physiology
- Male reproductive physiology, especially in regard to sperm biology and mating behaviour
- Insect endocrinology
- *Parasitology
- Immunochemistry
- *Insect biochemistry
- Tsetse behaviour and vectorial capacity
- Population ecology (A senior position needed in 1976)
- Insect pathology (the staff member here will actually be in-charge of the tsetse breeding programme, since we now suspect that much of past failure was due to the considerable pathological condition attained by laboratory colonies of tsetse flies. He will assist other personnel on insect breeding problems also).

(* These positions are already filled).

5. Tick Vectors of Livestock Diseases

East Coast Fever (ECF) is a major disease of cattle, endemic in eastern Africa, from the southern border of the Sudan to Swaziland and from Zanzibar to Zaire. The parasitic agent concerned is Theileria parva, one of a group of related protozoal species affecting cattle as far afield as North Africa and the Middle East, which is transmitted by the brown ear-tick, Rhipicephalus appendiculatus, the most important field vector of this disease. Losses due to ECF are extremely serious: and it is estimated that in East Africa alone up to 500,000 calves are killed each year in the enzootic areas.

No specific treatment for the disease is presently tested and available, but the administration of broad-spectrum antibiotics during the incubation period can greatly reduce the severity of the infection, though risky in enzootic situations. It may also be noted that the UNDP/FAO Research on Tick-borne Diseases and Tick Control, based at EAVRO Muguga (Kenya) has shown significant progress in developing immunization against T. parva by, for example, the inoculation of schizont-infected bovine lymphocyte cells grown in tissue culture; but these methods still need a great deal of further development since cattle immunized in this way can withstand homologous challenge in a paddock artificially infested with the brown ear-tick infected with T. parva, but cannot apparently withstand uncontrolled natural challenge in field trials.

ILRAD will be pursuing these immunological studies, and will be collaborating with EAVRO team in this aspect of the ECF problem.

The ICIPE will be concentrating its efforts on elucidating the ecology and physiology of the tick vector, as it relates to the epidemiology of the disease and in order to open up new avenues for ECF elimination by vector control. So far, present vector control measures (such as tick control by acaricides, the cleansing of pastures with regularly dipped sheep or immune indigenous cattle, or control of stock movements) can work (as they have done in southern Africa), but they are not succeeding on a long-term basis under small-farmer conditions and because of the considerable danger arising from the appearance and spread of acaricide-resistant ticks in recent years.

The ICIPE initiated the tick research programme more than two years ago. These initial studies have already shown that adult females of R. appendiculatus that had been feeding for several days secrete a volatile substance that induced fed, sexually-active males to move towards them and mate: chemical studies are now proceeding to identify the principles concerned. It has also been shown that full engorgement is only triggered off by the mating process; and that the factors are involved are partly mechanical ones (agitation during copulation) and partly chemical (an active principle included in the spermatophore transferred by the male during copulation); the significance of this finding is that it is during feeding that T. parva is transmitted: if the female tick is not mated, she will remain attached by her mouth for several weeks, salivating all the while, and thus facilitating the massive transfer of T. parva. On the ecological front, a long-term study of the changes in number of an experimental population of R. appendiculatus has been in progress for more than a year. Large numbers of juvenile ticks were placed on cattle that had been innoculated with ECF; the ticks engorged, detached and moulted; and the cattle died. When susceptible cattle were subsequently introduced into the experimental plot, they picked up many ticks, became infected and died. The tick population has become established in the field, and is now being used as a challenge for cattle immunised against ECF at EAVRO, and the ICIPE is continuing the study of the population dynamics of this infected tick population. A control field, with no seeded ticks, and with cattle introduced only at intervals, is also being studied.

The ICIPE, closely integrating their work with that of ILRAD [illegible] EAVRO, plan to continue their investigations along the following [illegible]:

(a) Ecology and population dynamics of the ECF vector species, R. appendiculatus, closely integrated with the epizootiological studies on ECF, both in experimental paddocks and free grazing land. These studies will be extended to the habitats of reservoir animals, e.g. the African buffalo (Syncerus caffer). The development of rational tick and disease control programmes demands the use of sophisticated studies on the population dynamics of the vector species and the infection rates of disease organisms within the vector populations. These studies are long-term, demanding at least 7 years for providing a reasonably comprehensive base-line data, with some idea of seasonal variations under a range of grazing ecosystems.

(b) The importance of the different species of Theileria in the ECF syndrome and the different tick vectors of these parasite species. It is known, for example, that T. mutans, which is transmitted by the tick Amblyomma cohaerens, is pathogenic to cattle and is involved in the ECF syndrome; but whereas this tick is very common on cattle in Ethiopia, it is rare on cattle in East Africa: the reason for this difference in ecology is not known. There is also need to investigate other Amblyomma species in East Africa as vectors of T. mutans and the ICIPE has already started on this.

(c) [illegible] of the associated tick behaviour.

(d) The chemical characterization of the various pheromones and other active principles involved in aggregation, engorgement, mating, and other aspects of tick biology.

(e) The hormonal factors responsible for tick development, and how these and other analogues might unbalance the normal sequence of development.

Two principal scientific staff are already working at the ICIPE: a behavioural physiologist and an ecologist. The full staff complement will be reached in 19[illegible], by which time there will have been appointed 3 additional scientists with the following specializations: population ecologist (1976), a tick reproductive physiologist (1977), and an insect biochemist with strong endocrinological training. Chemical analysis and characterization is being undertaken in collaboration with the Chemistry Research Unit.

6. Biology of Foraging Termites

Termites have an enormous impact on the African economy - an impact which is only just beginning to be documented by ecological work being done at the ICIPE (started this year in a dry savannah area of Kenya) and in Nigeria by a termite team from the Centre for Overseas Pest Research, London (COPR). These insects are abundant, and they eat all kinds of cellulose-containing plant materials. Thus, not only do they damage buildings, but also trees and crops, as well as probably competing with cattle and game for pasture grasses, particularly in marginal lands. The objectives of the research already underway at the ICIPE are to find weak points in the behaviour and life cycles of the termites that will allow us to repel their attack or reduce their numbers without damage to the environment or to other species.

The entire programme is focussed on the foraging termites, which feed on pasture grasses and cereal crops, and which are thought to be of immense economic importance in the tropics. The investigations have therefore been confined to Macrotermes subhyalinus, a mainly grass-feeding species common throughout equatorial Africa and a pest of grain crops. Three other species will be brought into the programme in 1976: Hodotermes mossambicus, a true harvester in the arid and semi-arid zones: Trinervitermes bettonianus, an important consumer in the open savannah areas; and Odontotermes, a litter -, timber-, and grass-feeding group.

This is the most established programme at the ICIPE at [illegible], with considerable research over the last three years [illegible] development of castes within an incipient termite colony, [illegible] juvenile hormone (JH) on the course of caste differentiation, the [illegible] mechanisms of chemical communication (using, as a model, the [illegible] recruitment to a food source and the laying down and maintenance of a pheromonal trail), the chemical characterization of the various pheromones involved in trail-laying behaviour, and initial studies on mound building and colony development. There is now a substantial base for concentrated research on the ecology and physiology of these highly complex tropical termites.

The following lines of research will be continued.

(a) A study of the state of the termite colony by sampling mounds on a monthly basis and taking a census of all castes and development stages, recording the state of the fungus gardens, and recording the microclimatic conditions of the mounds.

(b) An investigation of colony development.

(c) A study of foraging and food consumption: establishment of foraging territory; estimation of the caste composition of foraging parties: identification of food preferenda; determination of timing, extent, and quantity of material foraged, etc.

(d) Continued studies on factors controlling caste differentiation: seasonal cycles, effect of hormones and pheromones (including JH), etc.

(e) Continued studies on trail pheromones as model substances for the interrelated studies on chemical communication in termites. Such substances are candidate materials for use in termite control.

(f) An analysis of building behaviour which preliminary results indicate may be based on communication by olfactory and tactile stimuli. This behaviour pattern underlies much of the ecology and bionomics of these tropical termites.

(g) Research on the reproductive physiology of the termite queen.

The termite group is the best established programme at the ICIPE so far, having already in its team 6 principal scientific staff - covering the areas of mound ecology, foraging ecology, insect behaviour, pheromonal biology, caste differentiation, and insect biochemistry. A seventh, and last, scientist will be appointed in 1976 to initiate research on the reproductive physiology of the termite queen. Close collaboration will be maintained with the COPR team at Mokwa, Nigeria, and with IITA (who are interested in the question of termites as pests of cereal crops and cassava cuttings, and as a possible increasingly important factor where minimum tillage systems require the deposition of litter on the top soil).

7. <u>African Armyworm</u>

The African armyworm <u>Spodoptera exempta</u>, has long been known as a major pest of graminaceous crops and pasture grasses in eastern Africa. During its migratory flights, it ranges from South Africa to northern Ethiopia and even, in some years, into the Yemen. It has also been recorded from other parts of Africa, and from Australia and Hawaii. The African armyworm is truly an international pest: and with the reasonable control of the desert locust in recent years, and to a lesser extent other locust species, the armyworm has become the most important migratory pest in Mid-Africa.

Research on this pest at the ICIPE started in 1973 with the dual objective of obtaining further information which would assist and improve the accuracy of the warning service operated by EAAFRO, at Muguga (Kenya) for the whole of eastern Africa, and of elucidating in more detail the behaviour of this insect in order to identify features of its life history and behaviour which might be susceptible to forms of control other than chemical spraying. CIMMYT has indicated interest in this pest, as it attacks maize. Close collaboration will therefore be maintained with CIMMYT, EAAFRO, COPR, and other institutions with applied ends as a goal.

The ICIPE scientist have made some significant research progress in recent months: they have discovered several very effective armyworm anti-feedents (effective at 0.1 ppm); they have discovered and characterised biting and swallowing stimulant compounds; they have described in great detail the structure of the chemoreceptors in the larval mouthparts having preferential sensitivity to certain of the important constituents of the hostplants; they have studied thoroughly the behavioural response of the male moth to the point where it can be used as a bioassay for the chemical studies of the nature of the pheromone; and accumulating field data give a strong impression that armyworm outbreaks are not solely due to migration but may well arise from resident population - contrary to the prevailing theory.

Future work will be continued along the following lines:

(a) Selectivity of larval feeding. Armyworm larvae have a strong preference for graminaceous plants.

(b) Intensified search for methods of reducing the acceptability of graminaceous plants to the larva, by continuing research on the characterization and functional behaviour of naturally occurring anti-feedants.

(c) Chemical characterization of the female pheromone(s) and the determination of the role, if any, of male pheromones in assembly and mating.

(d) Investigation of the genetics of S. exempta to determine the extent of structural and behavioural polymorphism in the resident and migratory populations.

(e) The occurrence of migratory and non-migratory races: this is being done by carrying out an extended study of outbreaks, and by sampling armyworms from a wide geographical range, to elucidate the importance of resident and migratory populations and the influence of environmental conditions on this polymorphism.

(f) Investigation of improved methods for the early detection of larval outbreaks. Aerial infra-red photography is a possibility being considered.

(g) Investigation of improved methods for determining the migratory range of the adult moth.

(h) Moth behaviour studies during migratory flights. Field observations will be carried out using a mobile radar to discover whether the adult moth orients during migratory flight, since such a capability would double the potential migratory range.

Of the four principal scientific staff that are expected to form the full armyworm team by 1978, two are already at the ICIPE - a behavioural ecologist, and a population geneticist. It is planned to recruit a third scientist in 1976 (a population ecologist), and in 1977 a behavioural physiologist. The armyworm group is getting a great deal of assistance from the research support units.

III. RESEARCH SUPPORT SERVICES

In addition to the normal support services of a biological research centre (e.g. library, insectaries, workshops, technical services, communication, and information), the ICIPE has from the start established three highly specialized laboratories (for chemical analysis and characterization, for fine structural studies of insect tissue, and for electrophysiological studies). These are staffed with highly qualified staff, at postdoctoral and graduate level, and equipped with sophisticated and relevant equipment. These laboratories provide specialized service to the core and special research programmes; but they also conduct some research of their own which underpin the investigations of the target-insect oriented programmes.

The research support services are briefly summarized below:-

1. Chemistry Research Unit (CRU)

The chief mandate of the CRU is to collaborate with the biologically-oriented research groups at the ICIPE in solving chemical problems, by bringing to bear advanced physico-chemical methods, isolation techniques, purification methods, techniques for chemical structural elucidation, and biosynthetic studies to characterize the natural regulators of insect life, active principles, and other natural products.

The unit is presently conducting research on the following problems:

(a) Female sex pheromones of the cattle tick, R. appendiculatus.

(b) Trail pheromones of foraging termites.

(c) Defensive secretions of soldiers of foraging termites.

(d) Feeding attractants, inhibitors, and anti-feedants of the armyworm extracted from African plants.

The CRU already has a staff of 3 principal scientists - all organic chemists. It is planned that, with the great increase already of demands of support services from biologists, two scientists be added to the unit in 1976. They should be natural products chemists.

2. Sensory-Physiology Research Unit (SPRU)

The analysis of the structure and function of chemoreceptors - whether for olfaction or taste - constitutes one of the most urgent tasks of the SPRU in relation to the several studies already being undertaken at the ICIPE on insect chemical communication - in relation, for instance, to plant resistance studies, termite recruitment, and pheromonal biology. Secondly, in combination with clear-cut behavioural tests, electrophysiological bioassays can greatly help to a more rapid identification of biologically active substances employed in mating, food-plant selection, oviposition-site identification, host detection, and host finding. Finally, there are other sensory systems in the target insects which can be enalysed profitable : for instance, the auditory system in tsetse flies and armyworm moths. Consequently, the SPRU must always remain highly flexible, so that it can adjust to new experimental demands.

The SPRU has three electrophysiological recording units that are already operational: a taste cell recording unit, a micro-recording system from single olfactory cells, and an electroantennongram bioassay unit.

The SPRU work in close collaboration with the fine-structure research group, since research on sensory receptors requires a detailed morphological knowledge of the latter. The unit also works closely with other biological research programmes. The following projects are presently under study:

(a) Location and function of the various chemoreceptors involved in armyworm feeding and discriminatory host selection.

(b) Detailed study of the receptors responsible for the trail-laying behaviour in foraging termites.

(c) Survey of the antennal sense organs of tsetse flies responsible for host finding.

(d) Detailed analysis of the structure and function of the chemoreceptors that recognize. tick pheromones.

(e) An analysis of the plant-resistant factors in the various crops mentioned in the plant-resistance programme will be initiated when detailed behaviour studies have been completed in each case.

The team in this unit consists of 3 principal staff, who have all been appointed.

3. Fine Structure Research Unit (FSRU)

The FSRU is staffed by experienced staff in histological, histochemical, autoradiographic, and electron-microscopic techniques whose chief mandate is to give assistance to the core programmes on questions demanding fine-structural information, at a resolution approaching the molecular level.

The unit is presently involved in investigations along the following lines, apart from giving short-term assistance to the various research teams:

(a) Histochemistry and fine structure of the tsetse salivary glands and the gut, both in the infected and healthy state.

(b) Morphological aspects of the development of trypanosomes while sojourning within the tsetse fly.

(c) A detailed fine-structural survey of the female reproductive system of the tsetse fly, correlated with the ovulation and pregnancy cycles.

(d) A detailed analysis of the reproductive accessory glands of tsetse flies involved in sperm transfer, sperm storage, and lactation.

(e) Morphological study of the chemoreceptors of ticks, tsetse flies, termites, and armyworm caterpillar.

There is an enormous demand on the services of the FSRU; and the one principal scientist presently in post, supported as it is with highly trained technical staff, will shortly not be able to cope with the volume of work. It is proposed therefore to appoint a second scientist in 1977, and a third in 1978. This complement of staff will make an effective supportive team.

4. Insect and Animal Breeding Unit

The task of this unit is to establish and maintain a large, self-reproducing colony of each of the target insect species for experimental purposes, and of other insect species needed for bioassays and similar work. For blood-sucking arthropods, this requires that the unit also maintains colonies of the appropriate host animals. For plant-feeding insects, it may require the provision of standardized plant material grown in greenhouses, etc. Experimental, as opposed to routine, breeding of insects is the responsibility of the individual projects.

The following colonies of insects are being routinely mass-reared by the unit:

(a) Tsetse flies: G. morsitans and G. austeni

(b) The brown ear-tick, R. appendiculatus (in collaboration with EAVRO)

(c) The soft tick, Ornithodoros moubata

(d) The sorghum stem-borer, C. partellus

(e) The wax-moth, Galleria mellonella

(f) The locusts, Schistocerca gregaria and Locusta migratoria

(g) The African armyworm, Spodoptera exempta.

It is anticipated that the sorghum shootfly, on which experimental breeding work is now being conducted, and other major target insects named in the newer programmes on plant resistance and stem-borers will be mass-reared by the unit in the near future. Radically new and properly designed facilities are urgently needed for this critical support service.

5. Field Stations

Ecological work at the ICIPE is the main anchor of much of the other multidisciplinary research being conducted on the target insects. Although the ICIPE already has a number of mobile laboratories for some of its field work, the longer term field ecological investigations does require more or less permanent residence in the field. Another consideration is the selection of appropriate sites which will give ICIPE's core programme a variety of ecological conditions for the detailed investigations that are needed for a balanced pest management programme. Finally, decisions to establish particular field stations has only been reached when it is abundantly clear that existing facilities in the region (e. g. those owned by the Ministry of Agriculture) cannot meet the special research needs of the ICIPE.

Following these guide-lines, the Board has agreed to the establishment of the following field stations, all located in Kenya:

(a) Mbita Field Station, near Homa Bay, on the shores of Lake Victoria. The station will be vital for ecological studies on the sorghum shootfly, the stem-borers of sorghum and maize, the armyworm, ticks, and tsetse flies (particularly G. pallidipes). While this station is being planned and eventually built up during 1976-1977, field work is being carried out from field accommodation provided by the Ministry of Agriculture, some 100 km away, but still near Lake Victoria.

(b) Coastal Field Station, near Mombasa. This will provide an equatorial, lowland tropical area needed for field work - especially on stem-borers and plant resistance studies - on maize and rice pests. It will also be important for tick ecological work. It will have a large number of experimental plots, maintained on contract for the ICIPE by the Ministry of Agriculture. Survey of the area and site is underway. In the meantime, field studies are being carried out from the Ministry's main research station at Kikambala, 20 km from Mombasa.

(c) Kajiado Field Station, near Kajiado town, 75 km from Nairobi, located within a large area of dry savannah grading into almost the semi-arid zone. A small temporary building has recently been erected on the 10-acre site, and it is planned to have other facilites built by early 1977. The station is particularly important for field research on termites, and in a more limited way for ticks.

Each of the stations will have a mini-administrative staff, but otherwise the staff manning the field stations will be programme staff.

6. Workshops

The ICIPE vitally needs to maintain a first-class electronic workshop for servicing the many electronic and other sophisticated equipment and to assist in the design and fabrication of new equipment, which is a constant need for electrophysiological, fine-structural, and chemical research going on at the Centre. The latter also needs mechanical and wood-working workshops. All these facilities already exist at the ICIPE, although in miniature form only. It is essential that these facilities be expanded to meet the expanded needs of the research programmes and support services, the maintenance of the physical plant of the ICIPE, and the routine servicing of vehicles.

IV. COOPERATIVE PROGRAMMES WITH CGIAR CENTRES AND APPLIED INSTITUTES

1. Cooperative Programmes with CGIAR

The ICIPE proposes that collaboration between it and the CGIAR Centres be considerably strengthened, and that its pest research programmes interdigitate with the Centres' own concerns in this area, as indicated in Section II above. In the first instance, this close relationship will involve CIMMYT, ICRISAT, IITA, IRRI, and ILRAD; but it is hoped that it will encompass the other Centres as new needs arise and new opportunities for collaboration appear.

It has already been suggested that ICIPE scientists spend a considerable period of time at the beginning of this collaborative period to have first-hand experience with the crop material (and its germplasm) and the important pest problems. It is envisaged that the ICIPE scientists will return to the Centres from time to time to review their research orientation with the changing agronomic situation.

It is suggested that the Centres' own entomologists may find ICIPE an excellent reference point for obtaining new ideas for testing in their own institutions. Such a feedback mechanism will form an organic linkage between the ICIPE and the CGIAR Centres; and it is proposed that the Centres' entomologists be appointed to research associateship status at the ICIPE to enable them to undertake working visits at the ICIPE for short or long periods.

2. Cooperative Programmes at National and Regional Levels

The ICIPE already maintains an extensive network of liaison with applied research institutes in Africa and elsewhere for work on ICIPE target insects. These linkages need to be strengthened, as the ICIPE's own foundation becomes firmed up. Such institutes include the following, and many others:

EAAFRO, Muguga, Kenya
EAVRO, Muguga, Kenya
EATRO, Tororo, Uganda
Tropical Pesticides Research Institute, Arusha, Tanzania
Ministry of Agriculture, Kenya
University of Nairobi, Kenya
National Council for Scientific Research, Lusaka, Zambia
University of Ibadan, Nigeria
Institute of Pathobiology, Addis Ababa, Ethiopia
Tsetse Research Laboratory, Bristol, England
Centre for Overseas Pest Research, London, England
CSIRO, Canberra, Australia.

New linkages now need to be developed to reflect the needs of the new research programmes recently approved (sorghum shootfly, stem-borers, and plant resistance). The Tanzania Food Crops Research Project, recently initiated jointly by IITA and CIMMYT, is such a new important linkage.

The linkages are essential if the ICIPE is to ensure that its findings find practical application at the farmer's level.

3. Training Programmes

The ICIPE puts very high premium on the training of its technical staff, on the training of young graduate scientists from Africa and other LDCs, the training of young postdoctoral scientists, and the provision of opportunities of young African scientists already serving in other institutions coming to the ICIPE over a three-year period for a total time of 12 months to conduct important research on an insect problem relevant to the ICIPE core programmes and then returning to their own institutions to continue their professional. All these various devices are to permit the rapid build up of a scientific and technical capability in LDCs in pest research oriented to important development problems.

The ICIPE has made a start in this direction. The establishment of adequate physical facilites at the ICIPE will enable it to intensify this commitment.

4. Study Workshops and Seminars

The most important conference of the ICIPE has become the Annual Research Conference, at which the whole ICIPE scientific community reviews the research progress of the year and establish new lines of concentrated research. These conferences have become seminal, and will be retained as an institutional mechanism for monitoring ICIPE research and training activities.

Weekly seminars on specialized topics have also become a feature of ICIPE scientific life from the very beginning, and has formed one of the linkages with the scientific community in East Africa.

The ICIPE has now organized or sponsored two study workshops - on the armyworms (January 1975) and on tsetse breeding as related to the sterile-male control technique (March 1975). In these small workshops, a small group of actively involved field and laboratory workers, come together to discuss the state of the particular problem and plan future cooperative work. They have been enormously successful and the ICIPE is now planning one each year on a special problem related to ICIPE's core activities.

V. INSECT RESEARCH NETWORK

1. Collaboration with Other Insect Research Laboratories

One of the major intellectual resources of the ICIPE are the Directors of Research, who are world authorities in their own area of insect science, and who have therefore an excellent research laboratory in their home base, of which they are the recognized leader. These research laboratories, which collaborate with the ICIPE in research and training, therefore form - together with the ICIPE - a formidable network of research laboratories which has become pre-eminent in the insect research world. The network is not a fixed entity: it changes with the changes in the persons appointed as Directors of Research, and is therefore responsive to new ideas in the ICIPE. Above all, it ensures that the ICIPE scientific staff is constantly in communication with the latest developments in their own specialized and related areas. This is an unusual circumstance in a research laboratory in most LDCs, and gives the ICIPE great strength.

2. Sharing of Facilities

The ICIPE and ILRAD, because of their close geographical proximity, their common orientation to problem-solving rather than crop-production, and their interdigitating interest in livestock trypanosomiasis and ECF, are likely to have common interest. The management of the institutions have recognized this factor, and have started exploring facilities that the two institutions could, with profit, share. These include the following items:

- The sharing of a radiation unit, to be established by ILRAD in the next two years
- The sharing of the FSRU, established and already operational at the ICIPE, until such time that ILRAD find its work volume such as to need their own facility
- The organization of joint study workshops, such as the one being planned for October 1976 on tick-borne diseases of cattle and their vectors
- The enlargement of the tsetse and tick colonies at the ICIPE so as to meet the experimental needs of ILRAD. This is a matter of first priority for both ILRAD and ICIPE.

It is possible other joint interests will surface at a later date. The two managements will certainly want to consider them carefully, and recommend appropriate action.

VI. ORGANIZATION AND RECRUITMENT

Criticism has been made on the present management and staffing of the ICIPE along the following major lines:

- The organizational structure is too complex, and it is not obvious that the institution derives significant value from these encumbrances

- The need to strengthen the management of the ICIPE by the appointment of a full-time Director. So far, he holds a faculty position in the University of Nairobi, as Head of the Department of Entomology

- It is unrealistic to expect Directors of Research, who usually visit Nairobi only once or twice a year, to provide the necessary continuity in the leadership of the research programmes

- The present policy of appointing principal scientific staff for only 2-4 years makes for too rapid a turnover, and may lead to the unnecessary interruption of important work (especially in the field of ecology) or the loss of research support service staff (who require long technical training and experience).

As indicated to the Technical Advisory Committee of the CGIAR during their meeting in Rome in January 1975, the ICIPE Board was willing to make some changes in its organization, management, and recruitment policies to meet some of these vital matters of policy. In this task, the ICIPE was considerably assisted by the recommendations of a Visiting Group (headed by Professor Harvey Brooks of Harvard), appointed by the Board in September 1974, which reported in May 1975 on the progress of the scientific research and training activities of the ICIPE.

The Board has now taken important decisions in these matters, which can be summarized as follows:

(a) The ICIPE company will be abolished within the next few months (in 1976), and its place taken by a Board of Trustees, who will be the ultimate authority on policy decisions affecting the ICIPE. The composition of the Board will continue to have an international character; and include representatives of donors, the LDCs, the host country, the scientific community, and men of public affairs.

(b) Professor Thomas R. Odhiambo will become the full-time Director of the ICIPE from the beginning of 1976.

(c) The Board has taken the decision to appoint a few very senior scientists, who will be resident at the ICIPE, and give coordination to the research programmes and research support units. A number of the Directors of Research will continue to give scientific guidance to the resident scientific staff, particularly in relation to specialized disciplines, while a number of others will now act more in the manner of research consultants. These changes are likely to give firmer research leadership and continuity at the ICIPE, while still retaining the essential elements of a worldwide research network conferred by the Directorship of Research system of appointments.

(d) Recruitment tenures will now be more flexible, permitting longer and renewable contracts according to the project needs and the continued excellence of the research worker concerned.

VII. CONTRACTUAL ARRANGEMENTS

The associated membership status being considered for the ICIPE vis-a-vis the CGIAR is a novel one, and needs some close examination.

1. Funding and Accountability

The ICIPE is now an on-going vigorous institution. But it is clear also that it cannot reach its optimum potential nor perform the contractual work it is proposed it will do on behalf of the CGIAR Centres, unless it is given considerable physical facilities (in terms of laboratory buildings, administration accommodation, training facilities, field stations, etc.) to match these research objectives. Furthermore, it would seem that the best method of channelling grants for this capital development would be through the CGIAR itself - rather than via contractual arrangements separately with the individual CGIAR Centres collaborating with the ICIPE.

An equally difficult question concerns the manner of reaching contractual arrangements in regard to the proposed research programmes and the support services that underpin these research activities (research support services, training and communication, and management). It would pose an almost insurmountable problem if each of the research programmes were to be divided into individual projects for subsequent individual negotiations for contract agreements with the appropriate Centres. Rather, a system should be developed for having the Centres agree to each of the programmes as a whole and have this research programme package negotiated by the CGIAR on behalf of the Centres. A contract agreement between the CGIAR and the ICIPE would then be the result.

We believe these contractual arrangements would give to the ICIPE both the stability and simplicity of operation that it needs in order to carry out its mandate in the area of pest management.

The ICIPE will, of course, raise from other sources funds that it may require for its special programmes - mainly the more speculative research projects on insects (e.g. population diversity in G. pallidipes), research projects specifically contracted by other agencies (e.g. the role of termites in the savannah ecosystem), and research on tropical pests of medical importance (e.g. ecogenetic studies on the yellow fever mosquito, Aedes aegypti). In these cases, the ICIPE will levy an appropriate level of overhead charges to finance management and similar costs.

A crucial question arises as to the accountability of the ICIPE to the

- The ICIPE should report its research progress and its research needs at the International Centres Week, as the CGIAR Centres and other associated institutions do each year
- The Technical Advisory Committee of the CGIAR should be able to conduct reviews of the research and training activities of the ICIPE, as it does from time to time those of the other Centres
- The ICIPE should submit to the audit requirements laid down by the CGIAR
- The CGIAR should, if it so desires; appoint its representatives on the ICIPE Board, either as full members or observers.

2. Basic Financial Support

A Table summarising the financial needs of the ICIPE for capital development (U.S. $3,417,000) and research and support activities ($587,800) for the year 1976 is attached (Table 7). The ICIPE already has some funds (see Table 8); but it needs bridging funds to enable it to start some of the new research projects or intensify existing ones, and to start on the planning and development of new physical facilities.

Table 6 gives the total picture of the capital development estimates over a three-year period, 1976 - 1978. The overall estimated expenditure is $9,785,000.

Tables 1-4 (summarised in Table 5) give the budget for the research and related activities in 1977, and forecastes for 1978 - 1981. It will be noted that the recurrent budget for the CGIAR-sponsored programmes will be about $4.1 million in 1977, rising to approximately $7.1 million in 1980, when the financial requirements of the ICIPE would be levelling off, at the time the ICIPE will be expected to have reached its threshold.

LIST OF PARTICIPANTS

Dr. P. Haskell, Director, Centre for Overseas Pest Research, Board Member, ICIPE

Dr. T. Odhiambo, Director, ICIPE

Dr. J. Strangways-Dixon, Deputy Director (Science), ICIPE

Mr. J. M. Ojal, Deputy Director (Special Duties), ICIPE

Mr. J. H. Jivanjee, Deputy Director (Finance), ICIPE

Mr. A. Mando, Controller, Technical Services, ICIPE

Dr. S. Singh, Entomologist, Grain Legume Programme, IITA

Dr. M. D. Pathak, Assistant Director, Research, IRRI

Dr. J. B. Henson, Director, ILRAD

Dr. K. Banks, Immologist, ILRAD

Dr. J. K. Coulter, Scientific Adviser, CGIAR

Mr. B. N. Webster, Deputy Executive Secretary, TAC.

CORE RESEARCH PROGRAMMES - BUDGET 1977 AND PROJECTIONS 1978 TO 1981 TABLE 1

(in thousands of U.S. Dollars)

	SOURCES OF SORGHUM Plant Resistance		Stem-Borers		Shoot-Fly		Tsetse		Ticks		Termites		Armyworm		TOTAL	
	No	Cost	No	Cost	No	Cost	No	Cost	No	Cost	No	Cost	No	Cost	No	Cost
1977																
Personnel Costs																
Scientific	2	52.1	2	52.1	2	52.1	6	146.8	3	77.3	7	159.9	4	96.4	26	636.7
Technical Support	3	39.3	4	49.2	3	36.1	8	95.2	5	59.1	2	26.2	6	72.2	31	377.3
Ancillary & Daily Rated	-	10.4	-	26.8	-	27.3	-	23.0	-	56.1	-	67.2	-	29.0	-	239.8
Total Staff	5	101.8	6	128.1	5	115.5	14	265.0	8	192.5	9	253.3	10	197.6	57	1253.8
Consultations	-	6.8	-	6.8	-	3.4	-	3.4	-	6.8	-	6.9	-	3.4	-	37.5
Travel	-	7.4	-	7.4	-	7.4	-	22.3	-	14.9	-	15.4	-	7.4	-	82.2
Supplies & Expenses	-	14.0	-	9.5	-	10.0	-	26.6	-	17.5	-	26.3	-	49.3	-	153.2
Equipment	-	24.0	-	31.0	-	20.0	-	93.0	-	16.0	-	24.3	-	71.0	-	279.3
Total 1977	5	154.0	6	182.8	5	156.3	14	410.3	8	247.7	9	326.2	10	328.7	57	1806.0
PROJECTION																
1978	11	260.6	10	281.4	10	289.7	20	546.3	13	339.6	11	410.4	11	357.8	86	2485.8
1979	11	290.7	13	402.0	10	295.5	31	830.5	13	407.0	11	458.4	11	346.1	100	3030.2
1980	11	323.7	14	475.6	10	333.8	33	928.4	14	463.2	11	501.1	11	377.0	104	3402.8
1981	11	344.3	14	508.5	10	366.2	33	1021.3	14	496.8	11	551.3	11	400.2	104	3688.6

22nd August, 1975

[illegible] PHYSIOLOGY AND ECOLOGY

SUMMARY OF ICIPE BUDGETS FOR THE PERIOD 1970 - 1976

EXPENDITURE

TABLE 8B

SI - K. Shs. 7/-

	ACTUAL						TOTAL	BUDGETTED		TOTAL	GRAND
	7.4.70 to 30.6.70	1.7.70 to 30.6.71	1.7.71 to 30.6.72	1.7.72 to 30.6.73	1.7.73 to 30.6.74	1.7.74 to 30.6.75	7.4.70 to 30.6.75	1.7.75 to 30.6.76	1.7.76 to 31.12.76	BUDGETS	TOTAL
	$	$	$	$	$	$	$	$	$	$	$
Incorporation and Prospectus	5,313	-	-	-	-	-	5,313				5,313
Personnel Costs	1,097	30,451	82,391	188,060	373,919	569,038	1,224,956	803,284	408,039	1,211,323	2,436,279
Travel	1,355	4,068	7,251	13,584	31,627	33,482	91,307	55,272	31,986	87,258	178,655
Materials, Services & Expences	1,982	13,345	36,332	90,162	173,124	200,560	515,505	269,071	148,315	417,386	932,891
Research Collaboration & Training	-	5,973	29,003	19,258	97,533	79,155	230,922	121,929	65,714	187,643	418,565
Sub-Total	9,777	53,837	154,977	311,064	676,203	862,235	2,068,093	1,249,556	654,054	1,903,610	3,971,703
Buildings	-	39,668	39,468	2,915	124,221	150,036	356,308	18,429	-	18,429	374,737
Office Furniture & Equipment	2,350	8,810	10,916	3,282	34,736	12,347	72,441	11,071	2,357	13,428	85,869
Scientific Equipment	-	2,409	2,041	68,800	279,712	215,229	568,200	82,214	-	82,214	650,414
Vehicles	99	-	9,562	30,315	38,919	13,095	91,990	19,572	-	19,572	111,562
Equipment to be allocated	-	-	-	-	-	-	-	19,290	-	19,290	19,290
Sub-Total	2,449	56,887	61,987	105,321	477,588	390,707	1,088,939	150,576	2,357	152,933	1,241,872
Provision for Price changes	-	-	-	-	-	-	-	22,120	11,055	33,175	33,175
TOTAL EXPENDITURE $	12,226	104,724	216,964	416,385	1,153,791	1,252,942		1,422,252	667,466		
							3,157,032			2,089,718	5,246,750

21st August, 1975

RESEARCH SUPPORT - BUDGET 1977 AND PROJECTIONS 1978 to 1981
(in thousands of US Dollars)

	Chemistry		Fine Structure		Electro Physiology		Breeding		Field Stations		Workshops		Statistical		Lab Services		Total	
	No	Cost	No	Cost	No	Cost	No	Cost	No	Cost	No	Cost	No	Cost	No	Cost	No	Cost
Personnel Costs																		
Scientific	4	102.5	2	44.3	3	57.5	1	19.1	-	-	-	-	-	-	-	-	10	223.4
Technical/Admin	2	26.2	6	78.6	3	36.1	14	167.1	3	69.0	5	77.6	-	-	4	65.1	37	519.7
Ancillary & Daily Rated		6.4		6.3				23.1		50.8		25.4	-	-	-	35.6	-	147.6
Total Staff	6	135.1	8	129.2	6	93.6	15	209.3	3	119.8	5	103.0	-	-	4	100.7	47	890.7
Consultations		-		6.9				10.3		10.3		10.3						37.8
Travel		12.3		7.4		11.1		-		-		-	-	-	-	-		30.8
Supplies & Expenses		32.1		16.5		13.1		30.4		23.0		9.0				22.0		146.1
Equipment		50.0		15.0		8.9		20.0		1.0		25.0				11.0		130.9
Total 1977	6	229.5	8	175.0	6	126.7	15	270.0	3	154.1	5	147.3			4	133.7	47	1236.3
Projections																		
1978	9	264.2	10	221.6	6	146.3	19	414.0	3	169.7	5	158.7	1	62.5	4	193.1	57	1630.1
1979	10	289.3	10	247.0	6	165.5	19	390.3	3	194.7	5	154.9	1	59.4	4	179.8	58	1680.9
1980	10	312.9	10	280.4	6	179.0	19	421.8	3	213.5	5	165.0	1	55.0	4	195.8	58	1823.4
1981	10	328.9	10	304.2	6	208.0	19	462.7	3	230.3	5	177.6	1	56.9	4	207.9	58	1976.5

TABLE 3

BUDGET 1977 AND PROJECTIONS 1978 to 1981

	TRAINING & LIAISON				LIBRARY AND COMMUNICATION					
	TRAINING & LIAISON		ANNUAL RES.CONF.		LIBRARY & DOCUMENTATION		COMM. & INFO		TOTAL	
	No	Cost	No	Cost	No	Cost	No	Cost	No	Cost
1977										
Personnel Costs										
Scientific	½	12.1					2	44.4	2½	56.5
Technical/Admin					1	16.3			1	16.3
Ancillary & Daily Rated						2.1				2.1
Total Staff	½	12.1			1	18.4	2	44.4	3½	74.9
Consultations						3.4		10.3		13.7
Travel						2.5		2.5		5.0
Supplies & Expenses		58.8		12.3		9.0		16.0		96.1
Equipment		2.0		5.0		1.5				8.5
TOTAL 1977	½	72.9		17.3	1	34.8	2	73.2	3½	198.2
Projections										
1978	2	162.1		17.4	2	115.1	6	254.0	10	548:60
1979	2	179.0		17.4	2	106.1	7	235.9	11	538.4
1980	2	185.0		17.4	2	100.8	7	254.3	11	558.5
1981	2	193.8		17.4	2	109.8	7	283.9	11	604.9

TABLE 4

MANAGEMENT & ADMINISTRATION - BUDGET 1977 AND PROJECTIONS 1978 to 1981

	GOVNG.BD & COMMITTEES		ADMINISTRATION		GENERAL OPERATIONS		TOTAL	
	No.	Cost	No.	Cost	No.	Cost	No.	Cost
Personnel								
Administrators			6	184.9			6	184.9
Admin/Technical			14	164.3	1	16.3	15	180.6
Ancillary & Daily Rated				84.6		70.6		155.2
Total Staff			20	433.8	1	86.9	21	520.7
Consultations				17.1				17.1
Travel		122.6		2.2				124.8
Supplies & Expenses		36.4		43.9		47.0		127.3
Equipment				64.0		5.0		69.0
TOTAL 1977		159.0	20	561.0	1	138.9	21	858.9
Projections								
1978		159.0	24	630.4	3	301.8	27	1,091.2
1979		163.9	25	711.6	3	315.6	28	1,191.1
1980		159.0	25	742.7	3	336.0	28	1,237.7
1981		159.0	25	794.9	3	358.2	28	1,312.1

TABLE 5 (NOTES)

NOTES ON 1977 EXPENDITURE BUDGETS AND 1978-81 PROJECTIONS

1. Ancillary and Daily-Rated Staff

This staff, whereas large in number, represents a proportinally smaller cost, and has been excluded from the staff numbers so as not to distort the figures. The rate for Daily-Rated Staff is laid down by Government Order and is expected to rise to about K.Shs. 15/- per day by 1st January 1977. In 1977 the number of Ancillary and Daily Rated Staff would be 102.

2. Salary Scale

The Scales are worked out to include basic salary, subsidized housing or housing allowance in lieu, 20% gratuity or retirement benefit scheme, a small travel allowance for annual leave taken in Kenya, medical insurance, workmen compensation insurance, and/or personal accident insurance, and in the case of staff expected to be recruited internationally the cost of passages from/to home.

A 10% increase per year is built in the Scales.

3. Consultations

A consultation is expected to cost US $ 3,430 and would include consultants' travel hotel accommodation, and a small supplement for incidental expenses.

No emoluments to the consultant for his time is included.

In the Administration budget, consultations are provided for to enable a review of the accounting systems and establish a case for and feasibility of the computerization of the accounting and budgetary programmes.

4. Travel

The Travel Budget is comparatively large and is based on the travel costs of

(a) Ten Governors and 2 Advisors to at least two Board meetings per year.
(b) 17 Directors of Research to the ICIPE Research Centre for supervisory scientific visits for 1 - 3 times a year depending on the circumstances of individual programmes.
(c) Each principal scientist to a Conference/Seminar/Study Workshop at least once in eighteen months.
(d) African Committee meetings.
(e) Five members of the International Committee who might not be able to meet the costs of attendance at the annual committee meetings.
(f) Ten members of the Policy Advisory Committee to attend their annual meeting.
(g) The Executive Committee which is expected to consider ICIPE policy and management matters in between Board meetings.
(h) The Directors and the Deputy Directors' travel to various international centres, meetings, and conferences.

5. Equipment

In the core Programmes and Support Services "equipment" is comprised of vehicles and scientific equipment. In the Library/Communication Services it consists of library shelving, printing machine, collator, binder, etc.

The ICIPE provides office furniture and equipment as a central service. The budget for these requirements are therefore included in the equipment budget of Management and Administration.

Computer cost has not been budgetted for at this stage.

6. Provision for Price Change

The provision is calculated on a 15% flat rate per year on costs other than personnel. Personnel costs have a 10% annual increase already built into the salary scales.

7. Proportionate Division of Costs

The percentages are shown on Table 5, and are repeated here

By Activity

	%
Core Research Programmes	44.1
Research Support	30.1
Conference, Training, Library	4.8
Management & Administration	21.0
	100.0

By Object of Expenditure

	%
Personnel Costs	66.8
Consultations	2.6
Travel	5.9
Supplies and Expenses	12.8
Equipment	11.9
	100.0

As a percentage, the Management and Administration Budget appears very high. But it should be noted that this budget includes the following items:

(a) Office Furniture/Equipment for all programmes and services (The purely Management and Administration portion = US $ 25,500)
(b) Computer consultancy (US $ 10,290)
(c) Travel and meeting costs of the Governing Board and Committees. These could have been allocated alternatively to the Conferences vote (US $ 159,000).

If these costs are excluded from the Management and Administration budget, the balance would represent 15.8% of the total.

The travel budget also appears high as a percentage and can be explained at (4) above.

CAPITAL DEVELOPMENT BUDGET (in thousand US $)

	1976	1977	1978	TOTAL 000, US $
Headquarters - Administration & Laboratories				
Master Planning, Site Preparation etc	96	-	-	96
Laboratories and Offices	2000	3050	265	5315
Hostel and Housing		700	40	740
Water Supply Generator, PABX etc		168		168
Animal Stables and Breeding Units		60		60
	2096	3978	305	6379
Field Stations				
Kajiado				
Site Preparation etc	25			25
Laboratories and Housing	370	100	29	499
Water Supply, Generator, Radio-telephone	185			185
	580	100	29	709
Homa Bay				
Site Preparation, Access Roads etc	86			86
Laboratories and Housing	100	400	38	538
Water Supply, Generators, etc		235	-	235
	186	635	38	859
Coast				
Site Preparation, Access Roads, etc.	157			157
Laboratories and Housing		200	18	218
Water Supply, Generator etc.		168		168
	157	368	18	543
Clerk of Works	20	20	20	60
Rotating Loan Fund	140			140
	3179	5101	410	8690
Provision for Price Change	238	765	92	1095
	3417	5866	502	9785

18.8.75

TABLE 6 (NOTES)

NOTES TO CAPITAL DEVELOPMENT BUDGET - Page 1

Headquarters - Administration and Laboratories Complex

	Sq m
Research Laboratories (All Programmes and Support Units = 10 x 200)	2000
Training Laboratories (including Common Room, Seminar Room, etc.)	400
Library to accommodate upto 50 readers at a time plus 4 staff. - Shelving area for 30,000 volumes and storage area	500
Conference Room to accommodate 150 participants, projection room and translation booth	300
Workshops (Carpentry, Metal and Electronics)	450
Stores (Chemicals Lab. Supplies, Equipment and Consumables)	650
Insectary (including Experimental breeding and pathology)	2200
Printing Machine Room Photography Room, (including storage space for printing materials, offices for Communication/Information offices etc.)	350
Administration (including Finance Department, Canteen/kitchen Board Room, etc.)	900
	7750
Add 60% Circulating area, Services, Corridors, Staircases, etc.	4650
Total Sq meters	12400

	US $
12,400 Sq m @ 160 K£ (inclusive of Fees and fixed fixtures)	5,315,000
Master Planning, Site Preparation, fencing Landscaping, Roads, Sewers etc.	96,000
Large Animals - Stables etc.	45,000
Small Animals Breeding Unit	15,000
Hostel for Trainees	160,000
Housing:(a) 5 Senior Staff @ 30,000	150,000
(b) Apartments for Graduate trainees 20 x 10,000	200,000
(c) Technical/Ancillary Staff	210,000
Water Tank: 6 days Water Supply to over-come shortages and pressure fluctuations	90,000
Stand by Generators to meet emergency power requirements during interruptions of power supply	48,000
Telephone PABX	50,000
	6,379,000

Field Stations

Kajiado

10 Scientists - 3 Experimental Officers, - 6 Technicians, 1 Admin Staff
1 Clerk/Typist and 1 Visitor

	US $
Fencing and Site Preparation	25,000
Laboratory, Office, Storage 800 Sq m @ K£ 100 (Inclusive of fess)	229,000
Two Generators to provide 24 hour electric supply	85,000
Water tank and Borehole and piping	90,000
Radio telephone	10,000
Housing - 14 Senior @ K£5,000 7 Junior @ K£3,500	270,000
	709,000 =======

<u>Homa-Bay</u>

8 Scientists, 6 Experimental Officers, 1 Visitor - 8 Technicians, 1 Admin. Staff and 1 Clerk/Typist

Site preparation and fencing (50 Acres)	50,000
Laboratory, Office, Storage etc. 800 Sq. m @ K£100 (Inclusive of fees)	229,000
Two Generators	85,000
Water-tank, Borehole and piping	90,000
Radio-telephone	10,000
Housing 16 Senior @ K£5,000 8 Junior @ K£3,500	309,000
Reservior and Irrigation System	50,000
Acess Roads etc. (10 km @ 25,000/-)	36,000
	859,000 =========

Coast	US $
4 Senior Staff, 1 Visitor, 4 Technicians 1 Admin. Staff and 1 Clerk/typist	
Site preparation and fencing (100 Acres)	100,000
Laboratory Office, Storage etc. 500 sq m @ K£100 (including fees)	86,000
Standby Generator	18,000
Watertank, Borehole and piping	90,000
Radio telephone	10,000
Housing 5 Senior @ K£5,000 6 Junior @ K£3,500	132,000
Reservior and Irrigation System	50,000
Acess Roads etc. (16 km @ 25,000/-)	57,000
	543,000

Clerk of Works

A professional Clerk of Works is required to Supervise the Building and development plans 3 years @ 20,000 US $ — 60,000

Rotating Loan Fund

ICIPE does not provide vehicles to Scientists. On appointment, Scientists and Senior Administrators need loans to enable them purchase vehicles for Social and other activies.

20 loans of $7,000 per year — 140,000

(in thousands of U.S. Dollars)

	Required	Available	Net Needed	REMARKS
I CORE RESEARCH PROGRAMMES				
1. Sources of Plant Resistance	82.6	-	82.6	Start-up of Programme
2. Stem-Borer	33.7	33.7	-	-
3. Sorghum Shootfly	45.6	43.2	2.4	Research Visits
4. Tsetse	227.8	197.9	29.9	Senior Scientist
5. Ticks	136.1	102.8	33.3	Snr.Scientist & Consultation
6. Termites	256.2	226.3	29.9	Seniro Scientist
7. Armyworm	165.7	135.8	29.9	Senior Scientist
	947.7	739.7	208.0	
II RESEARCH SUPPORT				
1. Chemistry	124.6	94.7	29.9	Senior Scientist
2. Fine Structure	103.6	93.6	10.0	Equipment
3. Electrophysiology	66.8	66.8	-	
4. Breeding	111.4	86.6	24.8	Scientific Staff to supervise Programme
5. Field Station	23.0	23.0	-	
6. Workshops	89.9	67.0	22.9	Engineer-in-charge
7. Laboratory Services	70.2	70.2	-	
	589.5	501.9	87.6	
III TRAINING, COMMUNICATIONS, ETC.				
1. Training	39.0	39.0	-	
2. Annual Res.Conferences	18.6	18.6	-	
3. Library	33.7	26.6	7.1	Books and periodicals
4. Communication and Information	24.0	-	24.0	Communications Officer and Expenses
	115.3	84.2	31.1	
IV MANAGEMENT & ADMIN.				
1. Governing Board and Committees	100.0	70.0	30.0	Meetings and planning
2. Administration	324.9	308.6	16.3	Full-time Director appointment: additional funds needed
3. General Operations	66.9	52.1	14.8	Physical Plant Manager
V FUNDS REQUIRED FROM CGIAR	491.8	430.7	61.1	
1. Additional funds required for Recurrent Expenditure			387.8	
2. Funds required for Cap. Development			3417.0	
TOTAL FOR 1976			3804.8	

22nd August, 1975

$1 = K.Shs. 7/-

THE INTERNATIONAL CENTRE OF INSECT PHYSIOLOGY AND ECOLOGY

SUMMARY OF SOURCES OF FUNDS FOR ICIPE ACTIVITIES, 1970-1975

TABLE 8A

G R A N T S

	R E C E I V E D						TOTAL	P L E D G E D		TOTAL	GRAND:
	7.4.70 to 30.6.70	1.7.70 to 30.6.71	1.7.71 to 30.6.72	1.7.72 to 30.6.73	1.7.73 to 30.6.74	1.7.74 to 30.6.75	7.4.70 to 30.6.75	1.7.75 to 30.6.76	1.7.76 to 31.12.76	PLEDGES	TOTAL
	$	$	$	$	$	$	$	$	$	$	$
American Academy of Arts & Sciences (acting as Agents)	11,550	39,685	37,892	11,705	-	-	100,832	-	-	-	100,832
Max-Planck-Society	-	20,448	-	-	844	20,751	42,043	-	-	-	42,043
Universities of Amsterdam & Wageningen	-	28,161	-	-	-	-	28,161	-	-	-	28,161
Netherlands Govt. /NOVIB	-	-	38,996	7,041	3,448	2,530	52,015	-	-	-	52,015
Royal Swedish Academy of Sciences	-	9,817	9,735	10,905	-	-	30,457	-	-	-	30,457
Swedish International Dev. Agency (SIDA)	-	-	24,843	52,103	207,544	144,923	429,413	154,286	47,679	201,965	631,378
Volkswagen Foundation	-	-	46,042	635	-	-	46,677	-	-	-	46,677
University of Notre Dame /USAID	-	-	40,343	42,216	39,905	45,701	168,165	-	-	-	168,165
Swiss National Science Foundation	-	-	3,500	7,000	4,000	4,000	18,500	4,000	-	4,000	22,500
Swiss Technical Coop. Agency	-	-	-	-	29,266	54,669	83,935	40,284	20,142	60,426	144,361
UN Development Programme - PPA	-	-	128,490	76,838	-	-	205,328	-	-	-	205,328
UN Development Programme	-	-	-	412,299	655,075	858,639	1,926,013	788,845	394,423	1,183,268	3,109,281
Rockefeller Foundation	-	-	-	65,711	62,934	3,763	132,408	17,300	-	17,300	149,708
Overseas Development Ministry (UK)	-	-	-	5,758	61,813	34,772	102,343	60,060	30,031	90,091	192,434
Overseas Development Library	-	-	-	-	-	26,142	26,142	-	-	-	26,142
Danish Int. Dev. Agency (DANIDA)	-	-	-	84,937	-	-	84,937	-	-	-	84,937
Norwegian Foreign Aid Agency (NORAD)	-	-	-	-	98,214	-	98,214	-	-	-	98,214
Nuffield Foundation	-	-	-	13,651	-	-	13,651	-	-	-	13,651
Israel Academy	-	-	-	6,016	-	-	6,016	-	-	-	6,016
Japan Society for The Prom. of Arts & Sciences	-	-	-	-	9,522	13,351	22,873	-	-	-	22,873
International Atomic Energy Agency	-	-	-	-	2,540	-	2,540	2,500	-	2,500	5,040
Leverhulme Trust	-	-	-	-	356	1,239	1,595	-	-	-	1,595
Commonwealth Fund	-	-	-	-	-	120	120	-	-	-	120
S[illegible] & I.C.I.	-	-	-	-	-	1,227	1,227	-	-	-	1,227
[illegible], 70 & Jeol	-	-	-	-	-	40,054	40,054	-	-	-	40,054
Sundries	188	76	637	515	566	21,550	23,532	-	-	-	23,532
TOTAL GRANTS $	11,738	95,187	330,478	797,330	1,176,037	1,873,440	3,687,200	1,067,275	492,275	1,559,550	5,246,750
TOTAL EXPENDITURE	12,226	104,724	216,964	416,385	1,153,791	1,252,942	3,157,032	1,422,252	667,466	2,089,718	5,246,750
Surplus/(Deficit) - Year	(488)	(6,537)	113,514	380,945	22,236	20,498	-	(354,977)	(175,191)	-	-
" " - Cumulative	-	(7,025)	106,489	487,434	509,670	530,168	530,168	175,191	0	(530,168)	0

[illegible] August, 1975

F-1

Pertinent Information
on
Cooperative CRIA-IRRI Program
in
Indonesia

Prepared for TAC Review, November 26-29, 1975

Beechel Hemk /
Rus Freed
Gary ... Lubwst

Pertinent Information

On

Cooperative CRIA-IRRI Program

In

INDONESIA

Prepared for TAC Review, November 26-29, 1975

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INTRODUCTION

Indonesia is an archipelago nation consisting of nearly 3000 islands strategically located between Malaysia and Singapore to the north and Australia to the south, thereby dividing the Pacific Ocean to the east from the Indian Ocean to the west. The major islands in the group are Sumatra, Kalimantan (Indonesian Borneo), Java, Sulawesi and Irian Jaya (Indonesian New Guinea). The distance between extreme points in the archipelago exceeds 3000 miles. Because of the number of islands and distances involved, travel, transportation and communications present difficulties not common to nations located on continents. Language differences compound communication problems, especially in remote rural areas. The official language is Bahasa Indonesia, but over 200 local languages and dialects are spoken. About 20 distinct ethnic groups give the Indonesian nation a very heterogenous nature.

Independence was declared in 1945 after 300 years of various forms of colonial rule. As with other emerging nations, progress has not always been smoothly achieved. However, during the last 10 years, the political and economic climate has been relatively stable and effective development programs are being implemented. With a large land and sea resource base, the national leadership is striving to improve the welfare of the people and strengthen the country economically.

Population-wise, Indonesia ranks fifth among nations. In land area it ranks thirteenth. The population is very heavily concentrated on the "inner islands" of Java and Bali.

However, Java and Bali occupy only 7.2% of the total land area and yet 65% of the population live on these "inner islands". The average population density is almost 600 people/Km^2 on the "inner islands" while average density on the outer islands is only 25 people/Km^2. The overall national average is 60 people/Km^2.

To put Indonesian research activities in their proper prospectives, several important facts about Indonesian agriculture are presented below.

Indonesia is predominantly rural. Of the total population of 125 million, about 100 million reside in rural areas and of this, about 85 million are members of families engaged in agriculture. Of these 85 million people, families of about 50 million are engaged in food crop production. Only a small portion of this latter group would not produce at least a small amount of rice during the year. On a national basis, the average farm size in the food crop sector is about 1.0 ha. By agricultural census figures, the average farm size on Java is 0.7 ha. However, agricultural census figures do not show farms with holdings less than 0.1 ha in size. Nevertheless, a house-listing shows that there are over 2 million farmers operating areas of less than 0.1 ha. In total then there are about 10 million farms on Java, with an average holding size of somewhat less than 0.6 ha. By contrast the average holding size on the outer islands is 1.7 ha.

Harvested areas for the years 1971 to 1974 give some idea of the relative importances placed on food crops by the farmers (Table 1). A per hectare yield trend shows an average annual increase for rice of almost 4% starting with 1968. As a contribution to this trend, the FAO Agricultural Planning Team has estimated that 600 kg/ha has been derived from genetic improvement where improved varieties have been grown. Most of this improvement has come from increased yield potential, i.e., nitrogen responsiveness. However, this increased potential needs to be protected through incorporation of disease and insect resistances into the high yielding varieties. Future increases must also come from tolerance or resistances needed to cope with production hazards such as flooding, drought, adverse soil conditions and extreme temperatures.

Table 1. Area and yield for rice, corn, cassava, soybean, and peanut from 1971 to 1974.

	Rice				Corn		Cassava		Soybean		Peanut	
	Lowland		Upland									
	Area*	Yld**	Area	Yld	Area	Yld	Area	Yld	Area	Yld	Area	Yld
1971	6783	1860	1439	750	2616	1000	1382	7740	666	770	375	760
1972	6691	1820	1296	780	2252	1000	1418	7320	685	760	356	790
1973	7152	1880	1231	920	3261	1130	1438	7780	719	750	394	740
1974	7376	1960	1161	830	2648	1220	1513	9100	753	730	408	780

* in thousand hectares of harvested area

** in kg/ha

From a 1974 Gross Domestic Product of $8,455 million derived from agricultural activities, roughly 60% or $5,080 million can be attributed to food crop production. Breaking it down further, 65% or $3,302 million can be attributed to rice alone and smaller amounts to cassava, corn, soybeans, peanuts and sweet potatoes, in roughly that order.

The per capita GDP in the agricultural sector was $97/year versus $190/year for an overall national average in 1974. However, the average GDP for the 30% non-agriculture population was $408/year. It is expected that per capita increases in the agricultural sector GDP will lag behind increases in the non-agricultural sector. General expectations are for GDP increases of 6-9%/year during the next five years. Taking population growth into consideration, per capita increases should range between 2.4 and 3.8%/year. With general increases in the economy and in the population, continued firm domestic demand can be expected for rice.

A price elasticity of demand for rice has been estimated at -0.5 and this figure has been commonly used in various demand analyses. Estimates of expenditure elasticities of demand have been in the range of 0.4 to 0.9 depending on rice grade, income group and region. By comparison, expenditure elasticities for the other major food products, i.e., corn and cassava, have been estimated to be much lower than the elasticity for rice and frequently negative.

Table 2 shows production figures for rice, corn cassava, soybeans and peanuts, rice imports for the years 1971-74 and estimated demand at constant prices for 1975 and 1980.

Table 2. Production figures for rice, corn, cassava, soybeans and peanuts from 1971 to 1974 with estimates of the 1975 and 1980 domestic demand as well as the amount of rice imported from 1971-1974.

	Production, 1000 tons					Imports 1000 tons
Year	Rice	Corn	Cassava	Soybeans	Peanuts	Rice
1971	13,724	2,606	10,690	516	284	120
1972	13,183	2,254	10,385	518	282	335
1973	14,607	3,690	11,185	541	290	1,863
1974	15,452	3,240	13,775	550	315	1,132
	Estimated Domestic Demand					
1975	16,600	2,770	10,310	575	320	
1980	19,850	3,210	11,640	690	380	

Currently some corn and cassava is being exported and further market expansion will have to look in this direction. Peanut and soybean production comes close to meeting domestic demand and further expansion will have also to look for world markets to maintain prices. Rice production capability, even though expanding, is still behind domestic demand although carryovers of large rice stocks will reduce the need for rice imports in 1975. Most likely no new import contracts will be required. However, by 1980, a growing demand will require an additional availability of 4,000,000 tons of milled rice over current production level. In addition to new high yielding varieties, low input varieties adapted to less than optimal environmental conditions will be required to fill this demand. Both the high yielding and low input varieties must possess resistances to diseases and insects and tolerances to environmental stresses (drought, low temperature, deep water, soil problems). Moreover, plans for intensification requires studies on crop management methods to most effectively use short maturity varieties in partially irrigated or rainfed systems so two rice crops and another food crop can be grown every year with little likelihood of failure. The insertion of another food crop may be essential to break build-ups of important rice insects. Also, crop extensification on the outer islands particularly in tidal swamp areas and in areas suitable for upland or rainfed rice and other crops should play a role in expanding rice production to meet domestic food needs. Expansion of cropping areas can lead to significant increases in employment opportunities if appropriate technology is employed.

The Rice Research Setting

In May 1968 a Workshop on Food held in Jakarta to develop strategies for coping with Indonesia's food shortage problem, recommended the establishment of a team to survey the agricultural research programs and institutions in Indonesia. The team, consisting of eleven Indonesian and seven foreign scientists, made several observations and recommendations, six of which are given below:

a. To rebuild the badly fragmented central research institutes into a strong National Agricultural Research Center and provide it with sufficient budget and facilities to achieve excellence in performance.

b. To establish strong, effective, cooperative links with agricultural faculties of the universities for upgrading the quality of both research and higher education in agriculture.

c. To improve the working conditions at the National Agricultural Research Center by providing adequate facilities, land, laboratory and residential buildings, ancillary physical facilities, and modern laboratory and field station equipment.

d. To establish strong research centers in the provinces in order to develop a research and testing program to suit the varying agro-ecological regions of the country.

e. To launch aggressive, production-oriented research programs in selected fields on a national basis to continue providing new agricultural technology for improving agricultural production.

f. To improve the compensation to, and working conditions of agricultural scientists to a level that will enable them to give full time and wholehearted attention to their primary task.

The team was also conscious of the need for continued foreign assistance for agricultural research and recommended that the various sources of assistance be coordinated so that it can be most effectively used.

Through a general reorganization of the Department of Agriculture, the government created a national agricultural research agency which has started to strengthen itself, define research priorities and develop research programs. However, even before reorganization, CRIA administrators and scientists had moved in the directions of the recommendations. Figure 1 shows the several fold increase in both operational and development budgets since 1971. These increases have been used to improve laboratory, office and field facilities and to increase the compensation to research staff. Moreover, many new junior staff have been recruited from among recent university graduates (See Table 3). CRIA has also been strengthened by the educational achievements of numerous staff members who have continued their

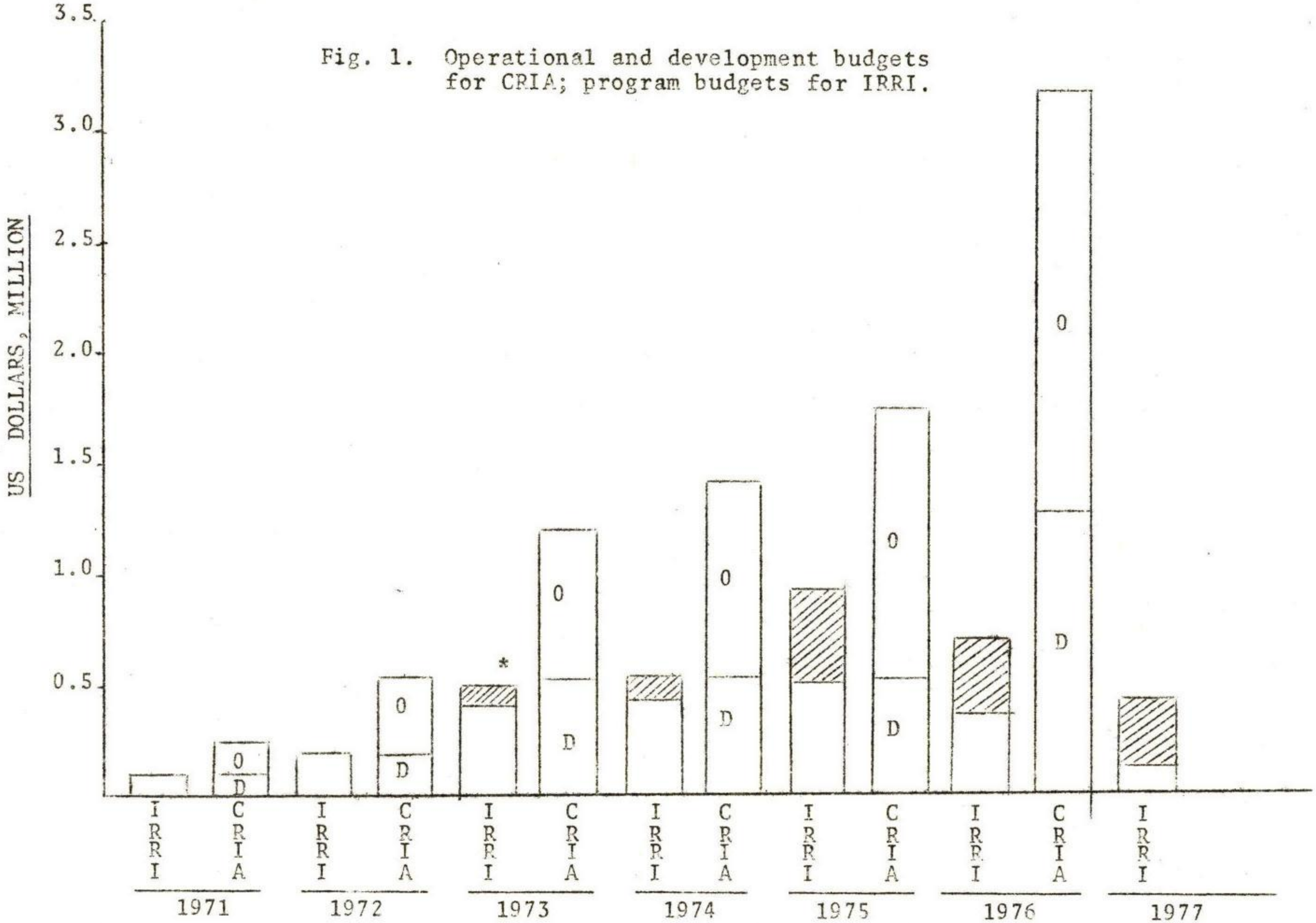

Fig. 1. Operational and development budgets for CRIA; program budgets for IRRI.

* Crosshatching represents funds from credit IDA 246-IND for Sukamandi development.
0 = Operational; D = Development.

Table 3. CRIA staff numbers by academic achievement, 1972 and 1975.

Year	Department or Branch	CRIA Staff by Academic Achievement				
		PhD	MS	Ir/Drs.	BS	High School
1972	Agronomy	2	4	13	15	27
	Physiology	-	2	9	3	11
	Pest & Diseases	1	-	20	5	11
	Secretariat	-	2	1	1	2
	Sukamandi	-	1	6	2	13
	Maros	-	1	4	15	24
	Other locations	-	-	3	8	60
		3	10	56	49	148
1975	Agronomy	4	3	17	11	38
	Physiology	-	2	12	4	17
	Pest & Diseases	2	1	16	-	12
	Secretariat	1	-	5	6	1
	Sukamandi	-	1	18	6	37
	Maros	1	1	8	13	35
	Other locations	-	-	6	9	56
		8	8	82	49	196

studies at several Indonesian agricultural faculties. Plans have been implemented at two CRIA regional branch stations to increase regional participation in research and master plans for the possible development of three more regional stations have been formulated. Recently, CRIA senior scientists organized a meeting to present overviews of their research programs on food crops. Scientists from universities and other research institutions were invited and given the opportunity to present their programs as well. During this meeting the way was tactfully paved to develop small, cooperative research projects between CRIA and other institutions.

In mid-1970, as a follow-up to the recommendations of the agricultural research survey team, IRRI arranged a two month consultancy through the Ford Foundation for Dr. S.V.S. Shastry. The recommendations of Dr. Shastry led to the creation of the National Rice Research Program, embracing a program coordinator, joint coordinator and an advisory board. The program lacked funding authority and full time, motivated leadership. Because the coordinator could not effectively control research and training activities, the program met with only a minimum of success. Of the several organizations engaged in rice research, it was apparent that CRIA with its network of field stations (See Appendix Table 1) on the four major islands, the past accomplishments of its staff, and its potential budget from the Department of Agriculture, should receive major technical, educational and commodity assistance. Therefore the bulk of assistance to rice research todate has gone to Central Research Institute for Agriculture (CRIA) headquarters in Bogor. Assistance has come through cooperation with Dutch and Japanese bilateral programs and with IRRI. IRRI's activities have been supported by various fund sources.

The Japan-Indonesia Joint Food Crop Research Program has provided six scientists to jointly conduct investigations on the ecology and the control of major diseases of food crops and mineral nutrition disorders. Methods to forecast the occurrence of major virus diseases and their importance were to be developed. The Indonesian-Netherlands Agricultural Cooperation Project has provided four scientists to carry out cooperative entomological and crop ecology investigations with CRIA scientists. Entomological studies have focused on the identification of new genetic sources of insect resistances, development of integrated insect control programs and the biology and epidemiology of the rice gall midge. Agro-climatic zones have been delineated for Java by crop physiologists and studies are being conducted to identify varieties adapted to these zones. Other studies are being undertaken to recommend cultivation methods and systems for the maximum use of solar energy and water and to identify varieties and breeding lines showing differential reactions to light, temperature and available soil water. In addition to the technical cooperation components, both the Japanese and Dutch projects have provided scientific equipment and specialized training opportunities.

IRRI's projects and programs with CRIA and other institutions are outlined on the following pages.

IRRI ACTIVITIES

IRRI has maintained two types of programs in Indonesia: 1) cooperative programs to increase research capabilities, 2) international network programs to assist national scientists in focusing on high priority problem areas. Both types of programs have been designed to be integrated with current Indonesian research programs and provide general program assistance. Programs at Bogor, Maros and Sukamandi fall in the first category while the farm mechanization network, cropping systems network, international rice testing, germ plasm collection and international agro-economic network activities fall in the latter.

In terms of IRRI scientists committed to research programs in Indonesia, the maximum number were present in 1975. (See Figure 2). As programs are terminated, the numbers will decrease. Total IRRI program budget allocations have parallelled staff changes (See Figure 1, Page 9). Over the same period CRIA administrators have been able to increase their budget considerably.

Table 4 shows the number of individuals who have received either academic or specialized training under these programs. Most of these individuals had made substantial research contributions both as administrators and scientists. But it was recognized that to intensify research programs, to sharpen the focus of the programs, to utilize new research equipment

Fig. 2. IRRI scientists committed to programs in Indonesia, 1971-1980.

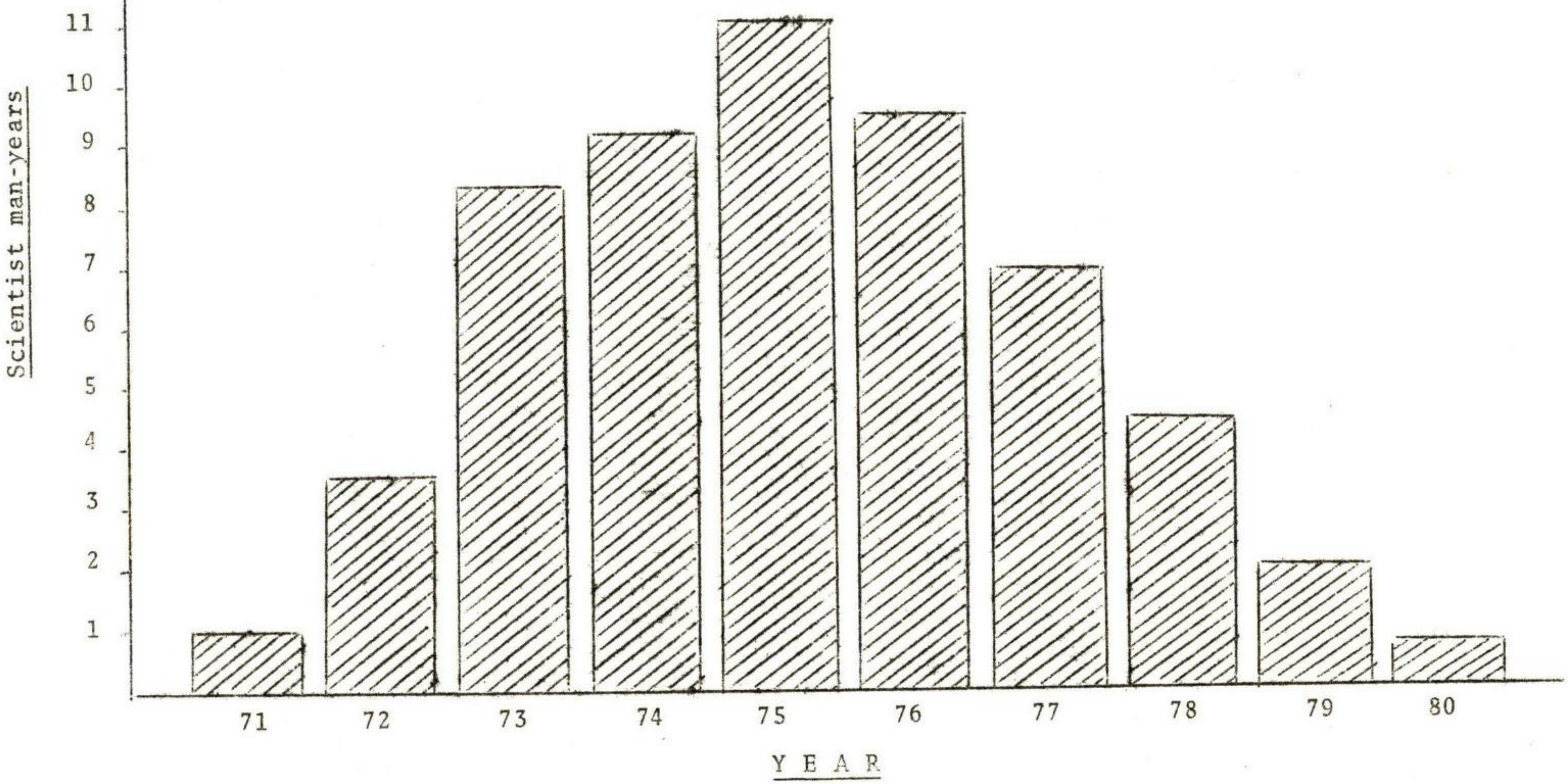

Table 4. Training activities under IRRI programs.

	PhD	MS	Specialized			
			Rice Production*	C.S.Production*	GEU	Others*
Completed	4	3	6	31	5	20
In progress	7	8	0	0	0	0
Planned	1	4	11	8	8	As needed
Total	12	15	17	39	13	20

* Many trainees in these categories have come from extension and other government agencies.

and materials and to employ the latest advances in research methods, these senior scientists needed further academic training. Yet if all were to go abroad at the same time, the programs in progress would at best remain static and most likely would regress. Such regression would occur at the time when the national government, in its attempt to stimulate rural development, would be calling on agricultural research institutions to provide solutions to the technical problems encountered in increasing food crop production. IRRI and other foreign scientists have helped to fill these temporary vacancies, while simultaneously expanding programs in progress and assisting in the implementation of critical new programs.

In addition to the academic training, specialized training in production and research methods, have been offered through IRRI's programs. Most of the trainees in the production programs have come from extension and production agencies outside CRIA.

In brief, the goals of IRRI's activities, regardless of station, program or source of funds, have been to increase rice research capability 1) by using IRRI scientists to assist in the continuation, development and implementation of research programs, 2) by academic and specialized overseas training programs at IRRI and elsewhere and 3) by purchasing a selected few pieces of equipment to support priority research programs*.

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*On this issue, IRRI has agreed to purchase some items for Sukamandi beyond those needed directly in research programs. By using IRRI's purchasing procedures, the cumbersome time consuming procedures required in the GOI-IDA loan agreement can be avoided and yet IDA regulations can be fulfilled.

Cooperative Programs

The following sections provide additional information on the three locations in which IRRI is participating. The activities described are those being conducted jointly by the CRIA research staff and IRRI team members.

Bogor. As a follow-up to Dr. Shastry's recommendations, the Ford Foundation supported a joint coordinator for the National Rice Research Program starting in 1971. In addition to support for the joint coordinator who also acted as IRRI representative, funds were provided for research equipment and for travel and subsistence allowances for families of trainees supported by other funds. Money was also provided to bring scientists from several IRRI departments to Indonesia to assist in defining breeding and research priorities. During the five years of support from the Ford Foundation, the joint coordinator was involved in planning and administrative activities for the cooperative programs at Bogor, Maros and Sukamandi as well as in the network programs. In addition, the joint coordinator was the team leader for the IRRI-USAID contract team located in Bogor.

The IRRI-USAID contract was entered into in 1972 as one of the elements in an aid project between USAID and the Department of Agriculture of the Republic of Indonesia. The thrust of the project was towards increased research capabilities at CRIA headquarters. The scope has been national even though the project is located in Bogor.

The project had three components: training, technical assistance and supplies and equipment purchases. Until recently, the bulk of the training funds for all locations have come from the USAID training program. Table 3, Page 10, shows the CRIA staff changes between 1972 and 1975. Table 4, Page 16 summarizes the training activities under IRRI. Significant increases have been made in the numbers holding Ph.D and MS degrees. Although CRIA staff increases have been sizeable, the number of scientists trained has fallen below that permitted by resources available.

The contract provided for five positions: two breeders, two agronomists, and a statistician-economist. One breeder was to assist his counterparts to develop and conduct rice breeding programs and to design and conduct on-the-job and in-service training for CRIA staff, while the second breeder was to carry out similar activities for high-priority non-rice crops. One rice agronomist was to develop and conduct production technique research for rice and to design and conduct on-the-job and in-service training for CRIA staff. The second agronomist was to assist his counterparts to develop and conduct research on systems of cropping which involves rice as the principal crop but includes other food crops to make better use of land and water resources. The statistician-economist, with his counterparts, were to train and assist research workers in (a) research design, (b) statistical techniques and significance analysis and (c) economic interpretation of results. With approximately nine months remaining of the total four years of the contract, the following paragraphs summarize what is believed to be the contribution to research program improvement. The direction in which research should continue over the next five years if not explicitly mentioned, is implicit from the past activities.

During the first three years, three of the senior Indonesian rice breeders were abroad for advanced degree training. To carry on the program and to incorporate many of the latest breeding procedures into the program as well as introducing new gene sources, the IRRI rice breeder became intimately involved with many aspects of the program. The IRRI breeder brought to Indonesia seeds of a group of compound crosses involving Pelita (an Indonesian variety) as one of the parents. These crosses had been made to combine resistances to several diseases and insects in a Pelita-type plant. The crosses have served as a nucleus for starting an integrated breeding program. Choice of parents for the crosses were made through discussions with senior Indonesian breeders. With the junior breeders who remained in Bogor and in close cooperation with CRIA pathologists and entomologists, new nurseries were established in various locations to screen for different characteristics, mainly disease and insect resistances. As the program expanded, it became obvious that the junior staff members, who must be heavily relied upon to organize materials, to plant nurseries, to assist in making selections and to maintain records, needed specialized training. Several have been sent to IRRI for GEU training. Concurrently, the GEU concept was adopted by the Indonesian Rice Project Leader and the varietal improvement program moved towards a more fully integrated unit involving pathologists, entomologists, agronomists and physiologists, as well as breeders. With assistance from the IRRI breeder, specific program objectives have been established for upland and lowland variety development. As capability expands and as environmental factors are more fully understood, programs for tidal swamp varieties and low input varieties will be developed. In this regard, the Indonesian GEU program now has the capability to screen for the following characteristics: Resistance to brown planthopper, green leafhopper, gall midge, grassy stunt virus, tungro virus, bacterial leaf blight and blast; tolerance to low temperatures, drought, and deep water; and grain quality evaluation. There are now several promising breeding lines which may be candidates for varietal release within the next year or so. In the future, more complete information regarding disease and insect reactions and environmental tolerances will be known when new strains are put before the varietal release committee as candidates for new varieties.

The legume breeding program has historically had much less direction, had less experienced and technically trained staff and less genetic material with which to work. Traditional agronomic practices and poor seed germination have always hampered field evaluation. The legume breeder has used various informal methods to impart knowledge of breeding techniques and basic genetics to his co-workers as well as encourage improved cultivation practices and post-harvesting seed storage. Many new varieties have been introduced for adaptive screening and to serve as materials for future crosses. Sources of resistance to cercospora leafspot and leaf rust, two common yield-limiting peanut diseases have been introduced in the breeding program. Promising lines carrying both resistances should be available within two or three seasons. Cooperative screening tests for Agromyza resistance in soybean and mungbean has been initiated with the entomology department. Efforts have also been made to improve stand establishment and reduce variability in the nurseries and yield trials. Equipment to improve seed drying and cleaning as well as storage conditions has been secured. These items are of critical importance in maintaining seed viability in the tropics. Without reliable means of storing seed beyond three months, even a moderate size breeding program cannot progress rapidly.

The rice agronomist was employed between 1972 and 1974. In the projects in which he was involved, fertilizer efficiency studies, mainly involving SCU, and water use efficiency were emphasized. Research on herbicides and upland varieties were also conducted.

In addition to carrying out field investigations at the experimental stations, the cropping systems program has been primarily engaged in field studies in two areas, one in Lampung, Sumatra and one in Indramayu, West Java. The study in Lampung has been directed toward evaluation of management techniques for upland rice based cropping systems suitable for transmigation areas on red-yellow podzolic soils very common to the area.

These soils require rather exacting management techniques to maintain productivity over time. Preliminary studies show that crop production can be maintained and soil fertility improved by the use of fertilizers, crop residues and intensive cropping patterns. In the Indramayu area cropping patterns are being studied which employ early maturing varieties and direct seeding methods of rice production as well as the normal transplanted lowland method. Because of its climate and physiographic position, cropping patterns for Indramayu area stress strategies to reduce flood hazards during the wet season and drought hazards during the dry season. Studies include the use of residual moisture by secondary crops during the dry season, direct seeding of rice early in the rainy season (gogo and gogo rancah) and reduced tillage for a second rice crop (walik jerami). The study sites at Lampung and Indramayu have been included in the International Cropping Systems Network.

The statistician-economist has been engaged in consulting and service work in experimental design, survey design and statistical analysis. After procuring programmable calculators through the program, efforts have been directed towards programming various common analysis of variance routines. Time is also being given to evaluating discontinuous and grafted polynomial production function models in an effort to obtain more appropriate data fits for economic analysis. For assessing the suitability of varieties and agronomic practices from multi-locational and/or multiperiod data, stability indexes, game procedures and stochastic dominance methods have been examined. These procedures consider the risk factor in the analysis of research data for recommendation purposes much more so than is done by budgeting or marginal analysis methods.

All scientists, through general seminars or lectures and informal discussions with their counterparts or colleagues have attempted to improve technical understanding and to stimulate planning and coordination of research activities. Also, all scientists have been instrumental in identifying promising candidates for academic and specialized training.

While Bogor has been the historical agricultural research center for over a century, it is typical of only 5% of the rice growing area of Java. Therefore, in keeping with the agricultural research survey team's recommendation to decentralize research, IRRI has assisted station and research programs at two other locations: viz. Sukamandi, West Java and Maros, South Sulawesi. Both stations are in regions which are significant rice producers. Activities at these two stations are briefly described below.

Sukamandi. The contract for cooperative development of the CRIA Sukamandi Branch Station was finalized and signed in December 1972. It was originally planned to cover 5 years. However, implementation delays early in the project necessitated an amendment of the contract to extend the period up to 1980. To the present, only 5 man-years have been provided of the total of 25 man-years called for in the amended contract. The contract amendment also deleted 5 man-years of assistance in corn breeding and seed certification but added two man-years for a station development engineer.

The Sukamandi Station is located on the north coastal plain of West Java, about mid-way between Jakarta and Cirebon. It occupies a 420 hectare area which is situated within the Jatiluhur irrigation system, a major rice producing area. The station is developing into an important breeding and applied research station for the national rice program as well as the national palawija crops program. It should also serve as a regional station for the immense hectarage of rice grown on the coastal plain in which it has been located.

The results of Sukamandi's breeding programs will be channeled into Perum Sang Hyang Seri, a national seed farm consisting of 2,500 hectares which lies adjacent to the research station. As a regional station, Sukamandi can service the approximately 470,000 hectares classified as sawah and another 33,000 ha classified as non-irrigated upland crop land located between Jakarta and Cirebon and the mountains to the south.

Soil capability maps show much of the sawah land could also be devoted to upland crops during the off-season. On the other hand the area is covered by extensive irrigation systems with design service areas of about 330,000 hectares in total or 70% of the crop area. Assuming one and a half rice crops are grown in the area each year, and upland rice is grown in pure stands or in mixed culture in unbunded areas during the rainy season, about one-tenth of all Indonesian's rice production takes place within three hours driving time from the Sukamandi Station.

Rice yields in the area are about average for Indonesia as a whole. The main hazards to production in the vicinity of Sukamandi include gallmidge, stemborers, rats, bacterial leaf blight, sheath blight, flooding and drought. Localized brown planthopper outbreaks have recently appeared in the area and this insect along with the grassy stunt virus it transmits, may become of extreme importance within the next few seasons.

Most rice is produced using traditional sawah methods, but gogo rancah, walik jerami, and upland cultivation is practiced in some areas. Large expansions of corn, sorghum, soybean and peanut hectarages are possible, provided certain constraints can be overcome.

In the early stages of research program development, heavy reliance has been placed on assistance from CRIA Bogor for program direction, especially within the context of the National Genetic Evaluation and Utilization Program. With time, the hub of GEU activities should shift to Sukamandi while CRIA Bogor puts more emphasis on basic agricultural and biological research programs. In view of the importance of the area it was deemed wise to develop a strong national rice research program at this strategic location. IRRI scientists through the IRRI contract with the Republic of Indonesia are assisting in the development of production oriented research programs. As outlined in the contract the Sukamandi research program is to emphasize the following:

(a) Plant Breeding

- Development of improved varieties with such desirable characteristics as high yield, response to fertilizer, photo-insentivity, good grain quality, and resistance to major diseases and insects.
- Collection and evaluation of local and exotic germ plasm.
- Yield trials with promising selections and introductions.
- Production of breeder and foundation seed.

(b) Entomology

- Survey of important insect pests in the area
- Evaluation of damage caused by individual pests.
- Study the biology and ecology of important pests and possible means of their control.
- Screening insecticides and developing insecticidal application schedules.
- Testing varieties for insect resistance and assisting plant breeders in the development of insect resistant varieties.

(c) Plant Pathology

- Survey of major diseases affecting rice and other crops.
- Study the ecological factors and cultural practices affecting disease development.
- Screening fungicides for disease control.
- Testing varieties for disease resistance and assisting plant breeders in the development of disease-resistant varieties.

Field investigations on insecticide applications and cropping dates, insect occurrences, chemical method of control and losses due to brown planthoppers are being conducted on rice. Other field studies have been started on soybeans and corn. In the laboratory and greenhouse, investigations of brown planthopper bionomics, biotypes and population development on resistant and susceptible varieties are underway.

Blast, sheath blight and bacterial leaf blight screening nurseries are being conducted by pathologists. Fungicide experiments to determine chemical control effectiveness for cercospora and sheath blight on rice and several leaf diseases on legumes have either been planned or implemented. Epidemiology studies of sheath blight and other diseases of rice are being undertaken, along with general surveys of rice diseases.

A collection consisting of 1000 local and 400 introduced varieties and lines is being evaluated for adaptability and also as germplasm for the rice breeding program. Bulk hybrid populations and pedigree nurseries are being grown under lowland and upland conditions. Observational and replicated yield trials for both lowland and upland rice are being conducted by breeders and agronomists. These activities are being coordinated with the Bogor program.

A station development engineer has been employed at the station since March 1974. Since then he has assisted the head of the station with planning and design of civil works, construction cost estimations, tendering and bid evaluations and supervision of construction works.

Maros. The CRIA Maros Branch Station is located 32 km north of Ujung Pandang, South Sulawesi. Situated on the coastal strip of the southwestern part of the province, the station is in an important rice producing area. The soils in the area are of alluvial development; annual precipitation approaches 3200 mm and falls on approximately 175 days per year, mostly between November and May. Stemborers, tungro virus, bacterial leaf blight, rice seed bug, and rats are the major factors limiting yields. Recently there have been localized outbreaks of brown planthoppers in the province. Sheath blight has a potential to become serious as intensification occurs. Saline and water-logged soils occur in some areas. In rainfed areas and irrigation systems where water supplies are not reliable, droughty conditions are frequently expected. Although yields are slightly below the national average, the province is a surplus rice producer. The provincial yield average is 1.5 mt/ha of milled rice and total production is 730,000 mt/year. The population density is only 85/km^2. Average farm size is 1.3 ha and considerably more animal power is used in working the land than is common on Java.

In addition to the main station at Maros, there are two substations used by the research staff. One station, Bontobili is used for upland crops including rice. It is 30 km east of Ujung Pandang. A second station, Lanrang, is located 180 km north of Ujung Pandang. Because Lanrang is located on the other side of a small mountain range, its rainfall pattern is almost the reverse of the Maros pattern. This affords the research staff with the capability to undertake wet and dry season studies throughout the year. Moreover, the Lanrang station is in an area which has been plagued by tungro virus and considerable field screening has been undertaken there to determine the reaction of lines to the virus. Data generated from the screenings have been of international as well as national significance.

Prior to transferring to the Maros station, the CRIA branch staff was located in Ujung Pandang proper and used a small field facility on the edge of the city. With the recommendation to decentralize agricultural research, IRRI was requested to assist in developing a master plan for a station in Sulawesi to serve as a center for food crop research for the Sulawesi - Moluccas - Nusatenggara region. The plan for Maros was submitted in late 1971. Land for the station was purchased by the provincial government. Funds for building construction, land development, equipment procurement and staff expansion have come through the CRIA-Maros budget. The Maros facility was officially dedicated in 1973, shortly after completion of the first building. Land procurement is still in process and field development will begin shortly. In the meantime, the Maros staff has been using the field layouts left by farmers.

As part of a five year program, the Netherlands government granted IRRI funds to provide the services of two staff members, for a training program and for additional equipment. The initial proposal called for a station development engineer and an agronomist with experience in research administration for two years each. In addition, through its bi-lateral program, the Netherlands stationed an entomologist in Ujung Pandang to cooperate in research with the Maros entomology staff.

The station development engineer arrived in February 1972 to assist in the design of civil works, in contract tendering and in construction supervision. The entomologist arrived in July 1972 and over the next two years participated in entomological research including insecticide application rate and method studies, testing of new insecticides and field screening of varieties and lines for resistance to the tungro virus and green leafhopper. The agronomist arrived in August 1972. He has assisted in expansion of the research program and the development of an improved organizational structure. In addition he has determined field and laboratory equipment needs in light of program goals. Special attention has been given to laboratories for the Agronomy/Crop Physiology and Soils Departments. Moreover, part of his time was taken by participation in soils and fertilizer studies.

After the initial two years, the Netherlands was asked to increase the grant above that already planned in order to continue IRRI's assistance to station and research program development for the remaining three years. The grant was approved and became effective in August 1974. The grant now provides for an agronomist, entomologist and pathologist. The agronomist's position was continued while the Netherlands bi-lateral program seconded their entomologist to the IRRI program. A pathologist arrived in March 1975. The agronomist has also been designated team leader for the program.

The IRRI staff are currently participating in research on several problems important to the region. Among these are studies on the fertility status of major soils in South Sulawesi, fertilizer efficiency studies, insect phenology and ecology studies, evaluation of cropping systems, and investigations on isolate variation of the tungro virus and *Xanthomonas oryzae*. Varietal screening has developed into an important component of entomological and pathological studies. Tungro virus screening activities have been increased. Varieties and breeding lines are being screened for reaction to stemborers, brown planthopper, whorl maggot, leaffolder, sheath blight and bacterial leaf blight.

In addition to investigations on rice, the Maros station also engages in studies on secondary crops. Therefore, IRRI staff members also spend an estimated 20-30% of their time participating in studies on other crops.

Future research programs conducted by the Maros Station staff should emphasize continued disease and insect screening activities, especially for tungro virus and stemborers. Moreover, some initial screening of varieties better adapted to adverse conditions such as salinity and zinc deficiencies should be undertaken. Increased emphasis should be placed on improving the efficiency of fertilizer and insecticide applications suitable for local environmental and economic conditions. Additional studies should be undertaken on the fertility status of soils so that refinements can be made on fertilizer recommendations based on soil groups. The Maros Station should become a senior partner in the national GEU program, not only to identify lines and varieties suitable for Sulawesi ecological conditions but also to contribute to the pool of information on lines suitable for other areas of Indonesia. The Maros staff program should play an active role in determining the crosses to be made in the national GEU program.

International Cooperative Network Projects

There have been various cooperative projects between IRRI and several institutions within Indonesia. Cooperative arrangements have been rather varied depending on project needs and the extent of contribution by both sides. All cooperative projects are linked to core IRRI programs and will be more fully covered during later phases of the review in Los Banos.

The cooperative projects serve to give IRRI scientists an overall picture of characteristics and conditions in rice growing areas of Asia. For the cooperating national program scientist, the projects provide opportunities to focus more closely on conditions within his country, to implement recent advances in research methods in his disciplines and to exchange his ideas with scientists engaged in similar investigations elsewhere. In some cases specialized training has been given to key personnel who will implement the project. Often financial support has been provided to supplement tight national research budgets during early credibility-building stages of a project. In all cases it is hoped that national research capabilities are strengthened by the cooperative projects with the ultimate effect of contributing to increased rice production and equitable rural development.

1. Germ Plasm Collection and Conservation. Perhaps the earliest cooperative project in Indonesia was for germ plasm collection and conservation. Although CRIA provided IRRI materials for the International Germ Plasm Collection in the 1960s it was not until 1972 that CRIA staff members began to systematically collect large numbers of traditional rice varieties on Java, Sumatra, Sulawesi and Kalimantan. Starting in 1972, an IRRI field advisor participated directly with CRIA and extension service personnel during most of the collection trips. Collections have been made in over 100 areas and since 1970 more than 4000 indigenous collections were made. Taking advantage of the diverse conditions under which rice is grown across Indonesia, the collectors were able to select lowland, upland and tidal swamp varieties believed to have resistances to various insect and diseases; tolerance to cold, drought, salinity and other adverse environmental conditions. Varieties with several different grain characteristics have also been collected. Samples were divided between CRIA and IRRI. Approximately 6000 viable samples are in the collection.

Unfortunately, the viability of many samples was lost because of poor storage conditions. The IRRI Genetic Conservation Program supplied CRIA with a cold storage box and other supplies to improve storage conditions and the viability of recently collected material has been better maintained.

It is the consensus of CRIA breeders that the CRIA staff should make further collections in some of the remoter parts of Kalimantan, Sulawesi and the Nusatenggara group.

2. "Changes in Rice Farming" Project. Another early cooperative project was undertaken between IRRI and the Agro-Economic Survey and the Research Institute in Social Sciences of Satya Wacana University. The objectives of this project were to determine the extent of HYV adoption in selected areas, the major factors determining adoption, how benefits from adoption have been distributed and what changes were induced by HYV's. Survey questionnaires designed to collect a common core of data from farmers in three Javanese villages were used. By collecting a common core of data, comparisons of adoption factors could be made across the broad geographic zones and economic settings found in other countries cooperating in the project.

Surveys were conducted twice between 1971 and 1973. Data has been analyzed and results published in "Changes in Rice Farming in Selected Areas of Asia". During the project, cooperators attended two planning workshops, a progress review workshop and a final workshop. Supplemental financial support was provided for carrying out the surveys and analyzing results.

3. Farm Machinery Development Network. In 1972, a machinery evaluation project was developed between the Directorate of Technique's Machinery and Equipment Section and IRRI. The project was implemented to field-test IRRI-developed machinery under Indonesian conditions. The axle-flow thresher, power-tiller, table thresher, push weeder, six-row seeder, bellows pump, batch-type grain drier and granular applicator have been tested. The project has begun to seek and assist small-scale manufacturers who are capable of producing the machinery. Recently, interest in the power-tiller, weeder, axle-flow thresher, applicator and batch drier has emerged. To produce the machinery on a financially sound basis, advice on manufacturing techniques and marketing is needed by the small indigenous manufacturers. In selecting markets, the appropriateness of the machinery in terms of labor absorption or displacement must be considered for different regions. Differences between "inner island" and "outer island" labor situations are important considerations in future market identification. The national development policy of increasing employment opportunities must be given consideration in making marketing decisions. A small training element is being considered which would support graduate student studies on the functional suitability of selected pieces of equipment and the place of such equipment in rural development programs.

4. The International Rice Agro-Economic Network (IRAEN). The initial IRAEN activity has been carried out in cooperation with members of the Faculty of Agriculture, University of Gajah Mada, Yogyakarta, beginning with the 1974-75 wet season.

The study location is characterized by small farm size, intense labor use, excellent water management and relatively high yields. Even though the regional average yield is high, there are inclusions where low yields are common and also groups of farmers who regularly obtain low yields. A second cooperative project has just been implemented with CRIA staff members. The study site for this project is on the north coastal plain of West Java, about 20 miles east of Sukamandi. Relatively speaking, farms in this region are larger, labor inputs are lower, water management is less precise and yields are lower.

For both projects the goals are the same: to determine the factors holding yields at low levels in the farmers' fields when farmers have at least nominally available to them the same set of technology that research station staffs have shown can regularly double yields. Reasons for the differences may be grouped in physical, economic or social categories and the research methods being employed are designed to pinpoint and quantify the major constraining factors with these categories.

IRRI's contribution has been in the form of general training in research methods, funds to supplement field experimentation and surveys early in the project, and assistance in the development research designs necessary to undertake the studies.

5. International Cropping Systems Network

In terms of resources contributed by IRRI, the cropping systems study is by far the largest of the cooperative projects undertaken. In this instance the cooperative institution is CRIA. However, CRIA is in turn cooperating with extension and production units at both the planning and implementation levels. This program has been in the planning stages for over a year and was funded in September of this year.

Objectives of the project are to develop technologically sound cropping systems for rainfed and irrigated rice producing regions, and, on a pilot basis, test these systems in farmers' fields. In order to carry out the project, selected pieces of equipment have been purchased and new CRIA staff members have been recruited and are undergoing on-location training. As can be seen in Table 4, Page 16, a substantial number of cropping systems staff members from CRIA and other units have been trained at IRRI. Many of these former trainees will be at least partially utilized in the project. The project also calls for further specialized training for a few selected positions. In addition to equipment procurement, recruitment of staff and implementation of research, the project calls for the cooperative planning of various research activities.

The IRRI cropping systems agronomist in Bogor and his counterpart, the head of CRIA's cropping systems program, have been designated as joint project leaders. Both of these individuals have devoted much of their time toward planning and otherwise facilitating the development of the project. The core cropping systems staff in CRIA is small but has functioned by providing budget for and cooperating with staff members from other departments within CRIA. A "working group" of about fourteen scientists has developed. This group planned and carried out a base line survey and made comprehensive project plans for cropping systems experiments in farmers' fields. Additional studies for each area involving fertility, entomological and weed studies and variety trials have also been planned. IRRI core staff have been available for consultation for the development of this project. Earlier this month CRIA hosted a planning workshop for project leaders from several other countries cooperating in the same network.

6. International Rice Testing Program (IRTP)

Although IRRI only recently formalized the international rice testing program, various forerunner international nurseries had been evaluated in Indonesia, mainly by CRIA scientists. Both lowland and upland yield and observational screening nurseries have been grown by CRIA scientists in the past. Tungro virus and cold tolerance nurseries have also been screened in earlier years. This year CRIA will cooperate by growing 25 international nurseries at 9 locations. Moreover, through IRTP the CRIA GEU program will nominate more than 100 elite lines for screening in the IRTP nurseries located in many cooperative countries. The results should improve the information CRIA scientists need to recommend their promising lines for release.

The international nurseries should also provide CRIA scientists with greater information about prospective parents to be used in the crossing program.

In addition to growing nurseries within Indonesia, senior CRIA scientists will go on monitoring tours to other cooperating countries to observe nurseries first-hand. During these tours the merits of various entries will be discussed. Also CRIA scientists will have an opportunity to exchange views on screening and classification procedures with scientists from other national programs. This past year a breeder, an entomologist and a pathologist participated in international monitoring tours of gallmidge, brown planthopper and tungro virus nurseries.

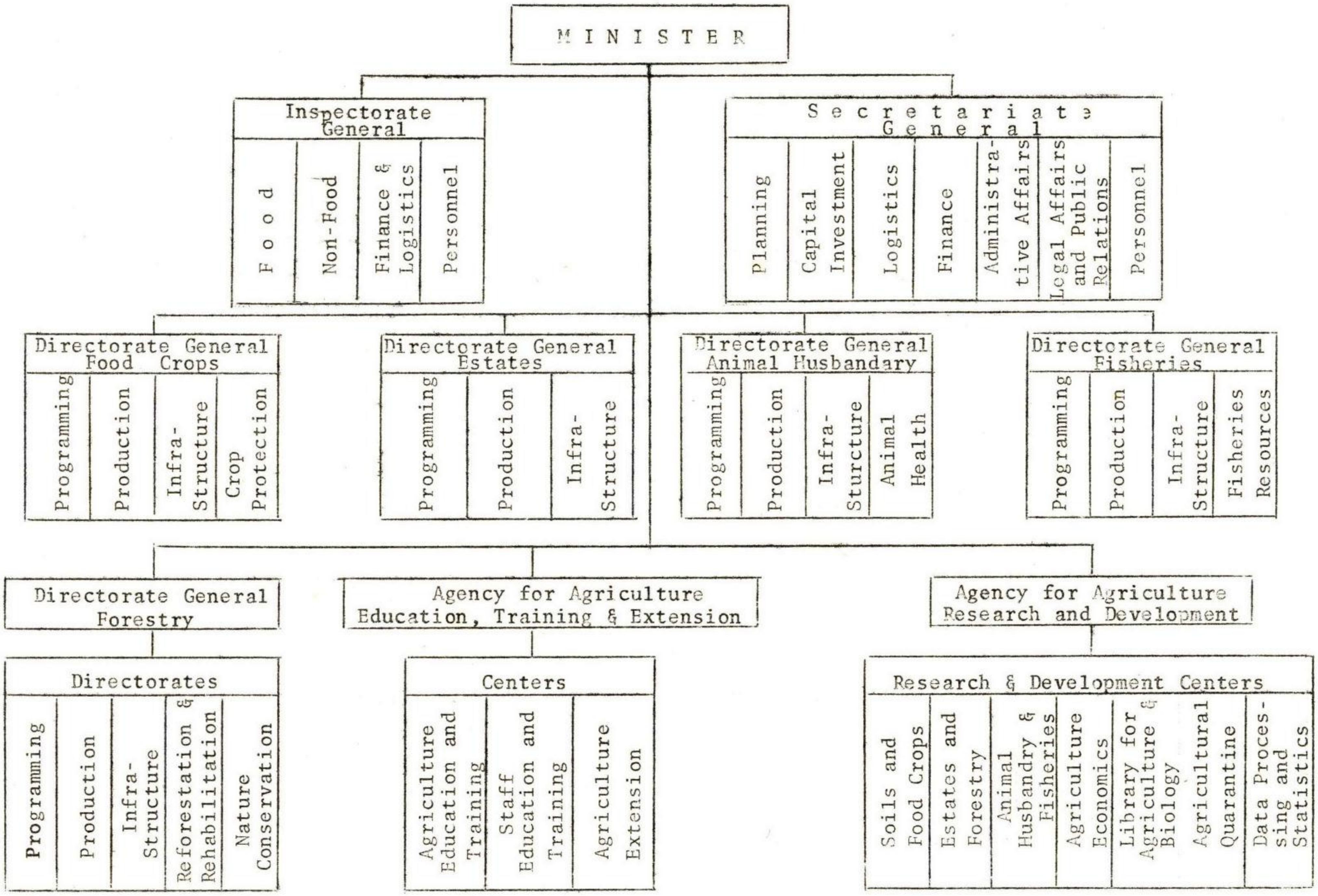
Appendix Table 1. CRIA Experiment stations on Java, Sumatra, Kalimantan and Sulawesi with data for area, elevation, soil group, rainfall, and climatic classification.

Branches or Gardens	Location	Area (ha)	Height above sea level (mt)	Soil group	Rainfall/year (mm)	Rain-days	Climatic Classification
WEST JAVA							
SUKAMANDI (Branch)	Subang	430	10	Alluvial	1600	110	Af
Cikeumeuh	Bogor	20	237	Reddish brown latosol	4117	229	Af
Muara	Bogor	40	270	Brown latosol	4134	225	Af
Singamerta	Serang	7	15	Grey hydromorphic	1670	124	An
Citayam	Bogor	11	100	Reddish brown latosol	3058	176	Af
Pacet	Cianjur	1	1138	Andosol	2935	212	Af
Ciwalen	Cianjur	2	1150	Andosol	5938	238	Cfa
Pusakanegara	Subang	40	5	Alluvial	1426	100	An
Kuningan	Kuningan	25	480	Reddish brown latosol	2448	166	An
CENTRAL JAVA							
Jakenan	Pati	30	7	Red-yellow podzolic	1556	100	An
EAST JAVA							
Ngale	Ngawi	40	50	Grumusol	2046	139	An
Mojosari	Mojokerto	30	30	Regosol	1558	104	An
Kendalpayak	Malang	20	450	Grumusol	2172	123	An
Jambegede	Malang	10	350	Andosol	2029	104	An
Muneng	Probolinggo	40	40	Andosol	1315	83	An
Genteng	Banyuwangi	25	145	Alluvial	2180	117	Af

Appendix Table 1 Cont.

SUMATRA							
Bandar Buat	Padang Pariaman	3	25	Alluvial	4453	191	Af
Sukarami	Solok	50	400	Latosol	2141	145	Af
Rambatan	Tanah Datar	5	460	Latosol	2061	128	Af
Tamanbogo	Lampung Tengah	25	20	Red-yellow podzolic	2532	136	Af
KALIMANTAN							
Handilmanarap	Banjar	30	2	Organosol	2369	172	Af
Balandean	Banjar	30	-2	Organosol	2369	172	Af
Hambawang	Banjar	-	-	Organosol	2369	172	Af
SULAWESI							
MAROS (Branch)	Maros	100	7	Alluvial	2500	125	Af
Bontobili	Gowa	21	45	Latosol	4076	172	An
Lanrang Lappang	Sidrap	43	28	Alluvial	2003	130	Af

Appendix Figure 1. ORGANIZATION CHART
DEPARTMENT (MINISTRY) OF AGRICULTURE

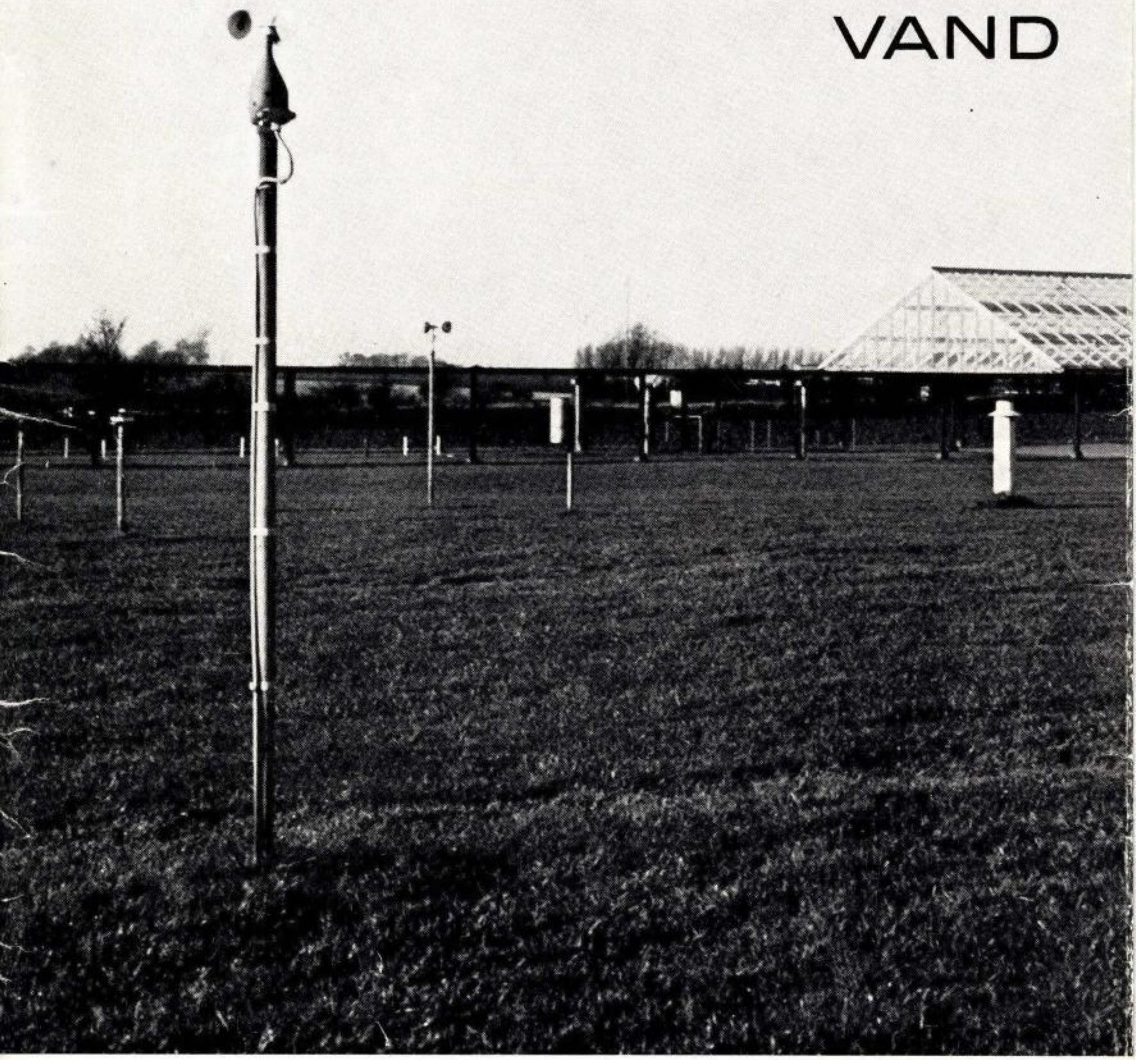


Appendix Figure 2. Map of Indonesian Archipelago

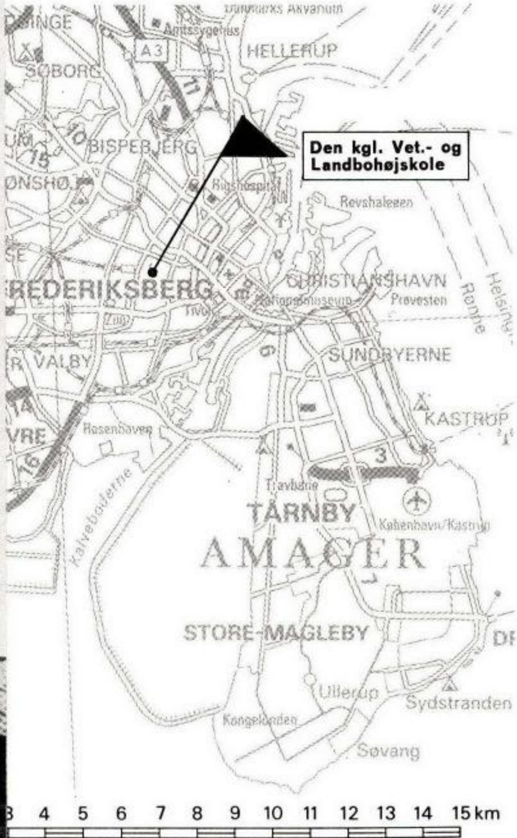
HYDROTEKNISK LABORATORIUM 1950-1975

25 år

MED KLIMA JORD VAND



DEN KGL. VETERINÆR- OG LANDBOHØJSKOLE · KØBENHAVN



ATORIUM OG KLIMASTATION

ndbohøjskole

(01) 99 26 13
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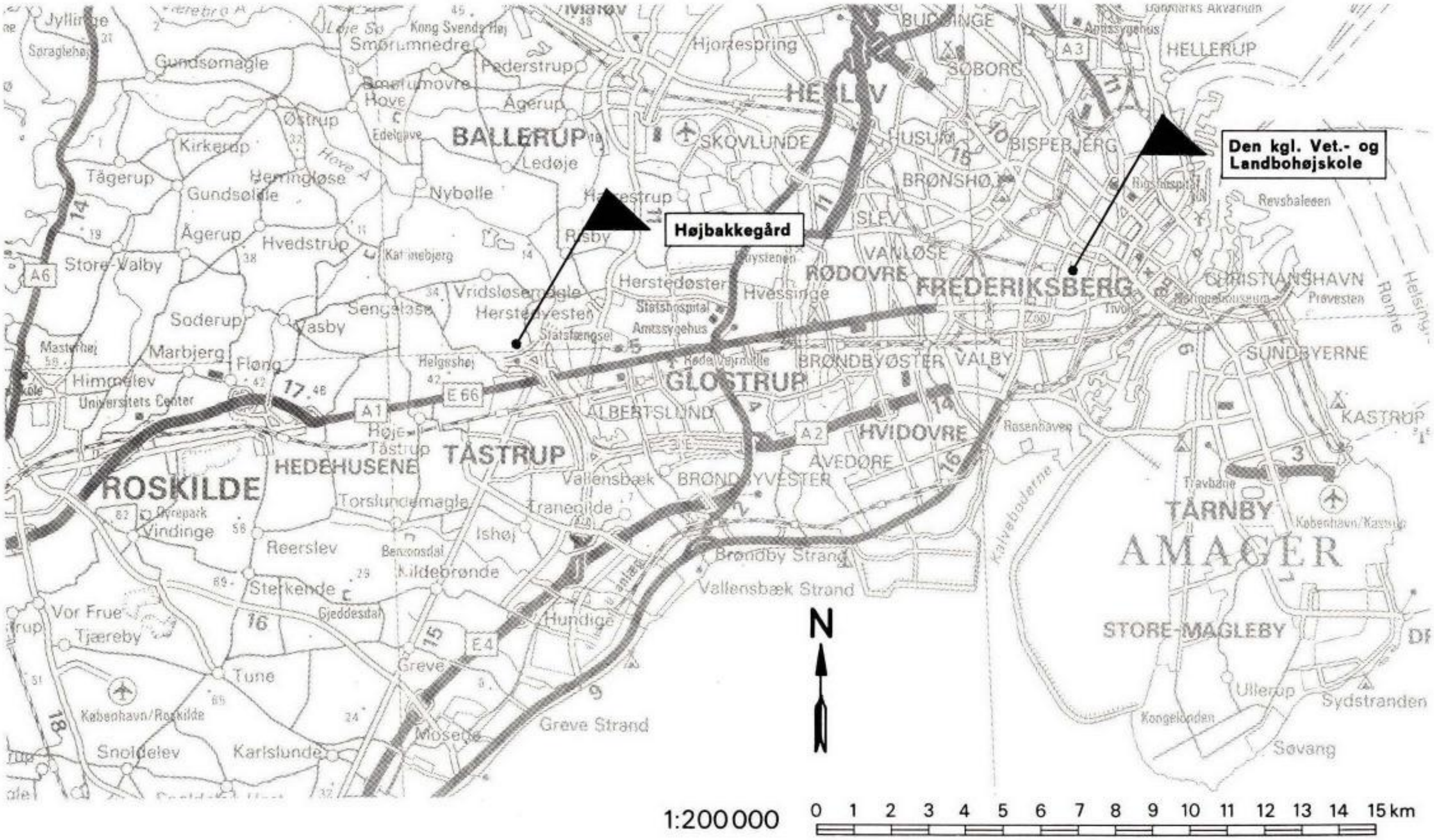
DK-2630 Tåstrup



Forsidebillede:

Klima- og Vandbalancestationen på Højbakkegård. I forgrunden ses instrumenter til måling af vindhastighed og vindretning. I baggrunden lysimeteranlægget med glastaget i parkeringsposition og midt i billedet nedbørsmålere af forskellig type. — Yderst til venstre ses apparatur til strålingsmåling.

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Den kgl. Veterinær- og Landbohøjskole

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HYDROTEKNISK LABORATORIUM 1950-1975

25 år

MED KLIMA JORD VAND

DEN KGL. VETERINÆR- OG LANDBOHØJSKOLE · KØBENHAVN

INDHOLD

PUBLIKATIONER 1975

Lærebøger i Kulturteknik

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Hydroteknik som økologisk fag beskæftiger sig med betydningen af klima, jord og vand i planteproduktionen.

Vandets betydning som klimafaktor og dets kredsløb under indflydelse af solenergi og med jord og planter som mellemled sætter vide grænser for fagets teoretiske og praktiske arbejdsområde.

Fagets mål er kontrol med de tilgængelige vandressourcer og med udnyttelsen af disse i planteproduktion gennem en kulturteknisk indsats bestemt af et økologisk helhedssyn.

Hydroteknisk Laboratorium beskæftiger sig derfor med studier af og undervisning i naturgivne faktorers fysiske og kemiske forhold og deres fysiologiske indvirkning på planters produktionsmuligheder.

I det følgende beskrives afdelingens historie og arbejde gennem de 25 år fra 1950 til 1975.

Baggrunden

Den 1. januar 1950 oprettedes Hydroteknisk Laboratorium som en selvstændig afdeling ved Den kgl. Veterinær- og Landbohøjskole. Den nye afdeling fik til opgave at varetage undervisning og forskning i faget Kulturteknik. Undervisningen inden for dette fagområde havde hidtil været varetaget af en ekstern lektor under faget Landbrugets Jorddyrkning. Med overgangen til selvstændigt fag omnormeredes lektoratet til docentur. Ledelsen af den nye afdeling blev overdraget H. C. Aslyng, der et år (1947) havde studeret jordfysik i U.S.A. (Berkeley) og netop havde tilendebragt to års studieophold på Rothamsted Experimental Station, afsluttet med doktorgraden fra Londons Universitet.

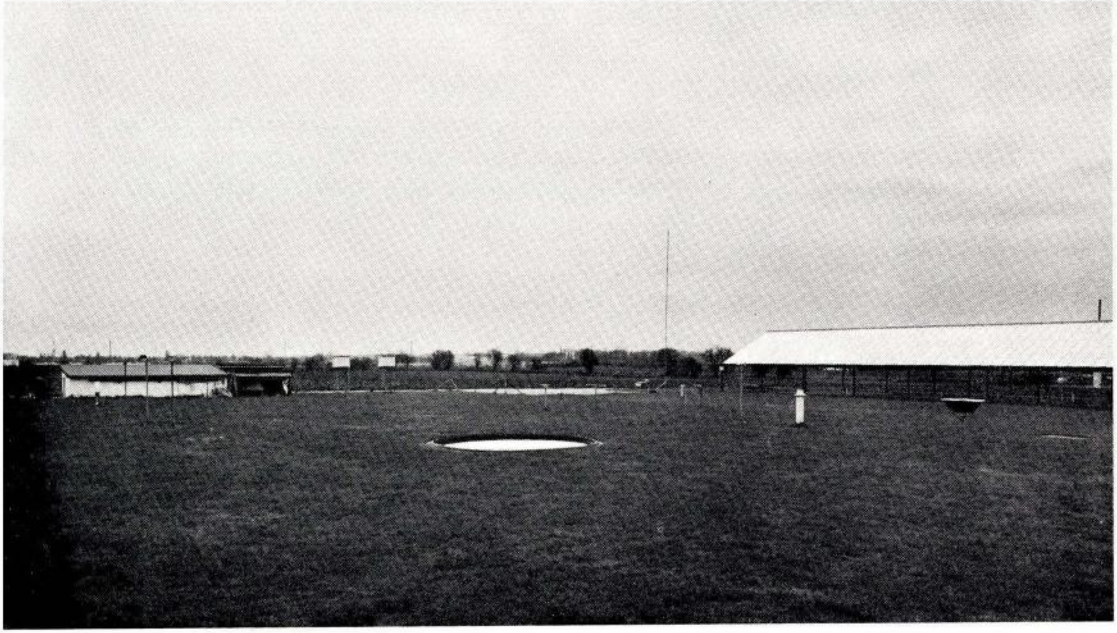
Undervisningen i Kulturteknik omfattede traditionelt fortrinsvis jordbrugets afvanding samt landvinding og nyopdyrkning. På grund af ansættelsesformen havde fagets lærer kun haft begrænset tid til at arbejde med mere grundlæggende forskning. Specielt på det jordfysiske og agroklimatiske område var Danmark derfor kommet langt bagefter lande som f. eks. U.S.A. og England. Krigsårenes afsondrethed vanskeliggjorde endvidere informationstilgangen fra andre lande. Den nye afdeling, der fremover skulle varetage undervisning og forskning inden for det fagområde, der på undervisningsplanen stadig betegnes Kulturteknik, kom således i gang på et tidspunkt, hvor nye impulser og ny teknik efter grænsernes genåbning var begyndt at strømme til landet.

Etablering og opbygning

Navngivelsen af den nye afdeling gav anledning til nogen diskussion. Da det erkendtes, at faget nødvendigvis måtte udvides og intensiveres på det teoretiske niveau, fandtes navnet Kulturteknik ikke at være tilstrækkeligt dækkende. Den nye leder så det som afdelingens opgave både i undervisning og forskning at beskæftige sig med relationerne mellem solenergi, vand, jord og planter. Navnet Hydroteknisk Laboratorium blev foreslået og godkendt.

Hydroteknisk Laboratorium begyndte småt i lejede lokaler i tagetagen i Det kgl. Danske Landhusholdningsselskabs bygning, Rolighedsvej 26. Forskningsbetingelserne var ikke ideelle. Temperaturen i de benyttede lokaler kunne variere meget og hurtigt, hvilket især var uheldigt for fysiske jordundersøgelser.

Hydroteknisk Laboratorium voksede langsomt, men sikkert i de følgende år. Flere videnskabelige og tekniske medarbejdere blev tilknyttet afdelingen. Med væksten blev lokaleforholdene efterhånden så trange, at laboratoriearbejdet yderligere var vanskeligt. Dette forhold bedredes væsentligt, da afdelingen i 1960 fik rådighed over nyindrettede laboratorielokaler og et værksted i „Rolighed"s tidligere udbygninger, Rolighedsvej 21. Herefter



Klima- og Vandbalancestationen på Højbakkegård. Til venstre i billedet ses bygningen med registreringsapparatur. Til højre for denne to vejrhytter, hvor lufttemperatur og -fugtighed måles. Længst til højre ses lysimeteranlægget dækket med glastaget. Midt i billedet en 12 m² fordampningsmåler og omkring denne forskelligt udstyr til måling af stråling, vind og nedbør.

kunne laboratorieprojekter gennemføres af afdelingens personale og licentiatstuderende, ligesom laboratorieøvelser for ordinære landbrugs- og havebrugsstuderende i begrænset udstrækning kunne inddrages i undervisningen.

Hydroteknisk Laboratorium overtog i 1966 lokaler i nybygningen, Bülowsvej 23. De tidligere erhvervede lokaler, Rolighedsvej 21, bibeholdtes dog, indtil den på Højbakkegård projekterede laboratoriebygning stod færdig i 1968. På dette tidspunkt overflyttedes en del af afdelingens personale hertil for at varetage drift af og forskning ved den etablerede klima- og vandbalancestation.

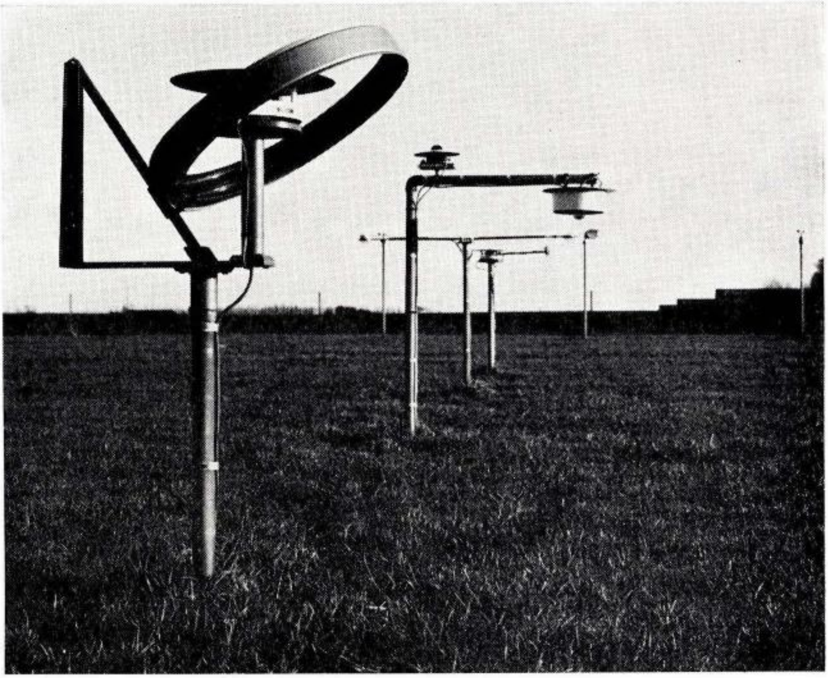
De nye lokaler betød en væsentlig forbedring af afdelingens undervisnings- og forskningsmuligheder. På Bülowsvej fik man rådighed over større øvelseslaboratorier og termoregulerede laboratorier, og fra 1968 over et klimakammeranlæg, bestående af fire individuelle enheder, hvor temperatur, luftfugtighed og belysning kan styres. I to af enhederne kan rodområdets temperatur styres uafhængigt af lufttemperaturen.

Klima- og Vandbalancestationen

Med højskolens overtagelse i 1953 af Højbakkegård i Tåstrup påbegyndtes her opførelsen af Klima- og Vandbalancestationen, hvis udbygning er fortsat siden. Stationen er opført på et fritliggende horizontalt terræn på 60 $\times$ 100 m. Bevoksningen er kortklippet græs. Her foretages kontinuerlig måling af luftens temperatur og fugtighed og af vindhastighed og -retning, alt i 2 m højde, samt af global og reflekteret stråling med solarimetre og nettostråling med netradiometer af afdelingens egen konstruktion. Nedbør måles med standardmålere i forskellig opstilling, bl. a. med henblik på at konstatere den mest hensigtsmæssige opstilling i åbent terræn. Det nuværende måleprogram omfatter udover de nævnte programmer den ikke synlige, globale stråling og den synlige (fotosynteseaktive), globale og reflekterede stråling.

De kontinuerte målinger blev oprindeligt registreret med skrivende instrumenter. Fra 1965 optoges disse data desuden på hulbånd med 10 minutters scanningsinterval. De bearbejdede klimadata, der foruden døgngennemsnit eller døgnsummer af observerede elementer også omfatter nedbør, solskinstimer og beregnet potentiel fordampning, meddeles månedlig til de på Højbakkegård arbejdende afdelinger og institutter samt til andre interesserede. Årsrapporter (fra 1966), indeholdende de samme data, er tilgængelige på afdelingen og på højskolens bibliotek.

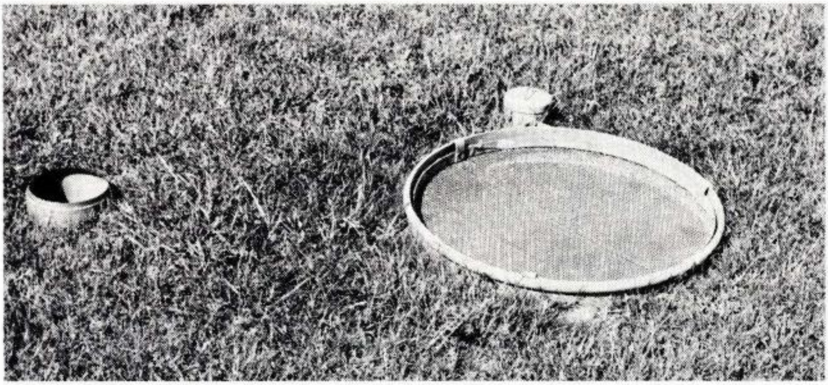
På stationen foretages også direkte måling af vandfordampning fra en 12 m^2 fri vandoverflade, fra $\frac{1}{3}$ m^2 evaporimetre og fra 2 m^2 vejebare anlæg (evapotranspirometre). De sidste er bevokset med græs og kan registrere vægtændringer, svarende til



I forgrunden instrumenter til måling af stråling; helt i baggrunden til måling af vindhastighed og -retning.

0.05 mm fordampning eller nedbør. Ved optimal vanding og vegetationstæthed giver anlægget direkte den potentielle fordampning.

I 1963 byggedes et nyt lysimeteranlæg i tilknytning til Klima- og Vandbalancestationen. Anlægget består af 36 individuelle lysimeterkar i to rækker, adskilt af en tunnel. Hvert lysimeter er 2 × 2 m i areal og 1 m dybt. I 1967 blev anlægget yderligere forsynet med et glastag, der automatisk føres hen over lysimetrene ved begyndende regn, og returnerer til parkeringspositionen, når regnen er ophørt. Herved kan den naturlige nedbør stort set udelukkes fra lysimetrene. Hvert lysimeter har sit eget permanente vandingsanlæg og kan vandes og gødes efter ønske.



Fordampningsmåler type HL 315 (⅓ m²) med nedbørsmåler i jordoverfladen.

Undervisningen

Ved Hydroteknisk Laboratoriums oprettelse i 1950 var der på forelæsningsplanen afsat 24 timer i et semester til „Kulturteknik". Eksamen i faget afholdtes til og med 1951 som en del af den mundtlige prøve i Landbrugets Jorddyrkning. Fra 1951 fik faget selvstændig eksamen, og undervisningen udvidedes til 33 timer, der blev givet i forårssemestret. Der blev givet grundlæggende forelæsninger over de væsentligste klimatiske og jordfysiske forhold af betydning for jordbrugets vandbalance og dennes regulering, herunder også lævirkning og jordbearbejdning. Moderne vandingsteknik blev også inddraget i undervisningen. Det første nye lærebogsmateriale kom med kompendiet „Kulturteknik I" i 1953. Lærebogsmaterialet udvidedes og ájourførtes med årene, som det vil fremgå af publikationslisten.

I 1963 øgedes antallet af forelæsningstimer til ca. 60, fordelt over de to semestre med to ugentlige timer.

Laboratorieøvelser kunne af pladsmæssige årsager ikke gennemføres de første år, hvorfor øvelserne alene omfattede beregningsopgaver. I forbindelse med ny studieordning blev laboratorieøvelser dog gennemført i begrænset omfang fra 1964. Det skrift-

Øvelseslaboratorium med forsøgsopstillinger.

lige øvelsesprogram bestod herefter af vandings- og afvandingsprojekter. Med overtagelse af de nye lokaler, Bülowsvej 23, kunne laboratorieøvelser gennemføres i fuldt omfang.

For kandidatstuderende under valgsystemet tilbydes nu to kurser i kulturteknik. Det grundlæggende kursus „Kulturteknik 1" omfatter klimatiske og jordfysiske faktorer og deres betydning for plantevækst, faktorernes indbyrdes forhold og virkning samt energi- og vandbalance. Endvidere gennemgås jorderosion, virkning af læ, jordbehandling og regulering af vandbalancen.

I „Kulturteknik 2" gennemgås biologiske, tekniske og økonomiske forhold i forbindelse med vanding og afvanding i jordbruget. Desuden gennemgås vekselvirkninger mellem miljø og jordbrug, specielt forurening af grundvand, søer og vandløb med plantenæringsstoffer, organiske stoffer samt giftstoffer.

I tilknytning til hvert af de to kurser afholdes øvelser 4 timer om ugen. Laboratorieøvelserne i forbindelse med „Kulturteknik 1“ omfatter jordfysiske og klimatiske målinger, og beregninger. Øvelserne i forbindelse med „Kulturteknik 2“ omfatter projektering af vandingsanlæg og dræning samt valgfrie laboratorieprojekter. Udover forelæsninger og øvelser kan de studerende vælge skriftlige opgaver, studiekredse samt hovedopgave i faget.

Siden kulturteknik blev selvstændigt fag har næsten 3000 kandidatstuderende modtaget undervisning heri.

I forbindelse med licentiatuddannelsen afholdes hvert år ugentlige kollokvier, hvor klimatologiens og jordfysikkens betydning for planteproduktionen gennemgås på et mere avanceret niveau. Herudover bidrager de licentiatstuderende med en selvstændig forskningsopgave, valgt i samråd med lærerne ved afdelingen. Fra afdelingen er udgået 16 licentiater med hovedfag og 9 licentiater med bifag.

Flere forskere fra institutioner og universiteter i udlandet har i årenes løb arbejdet som gæster ved Hydroteknisk Laboratorium, og en værdifuld sum af viden og erfaring er således blevet udvekslet.

Forskningen

Forskningsmulighederne var som nævnt ret begrænsede i de første år efter oprettelsen af afdelingen i 1950. Undersøgelser over klimaforhold og disses indflydelse på planter begyndte dog kort tid efter afdelingens oprettelse. Moderne apparatur, der overvejende erhvervedes for Marshall-midler, blev taget i anvendelse, først på Albertslund i Vridsløselille og senere på Højbakkegård, som et led i opbygningen af Klima- og Vandbalancestationen. Muligheden for at konstruere og opbygge egnet forskningsapparatur forbedredes i takt med det finmekaniske værksteds udbygning.

Fra begyndelsen var dog også det gamle lysimeteranlæg i den daværende forsøgsmark ved Bülowsvej til rådighed. Undersøgelser over planters vandforbrug i marken på arealer ved forsøgsgården Albertslund og ved forskellig behandling i lysimetre blev gennemført; bl. a. ved hjælp af tensiometre og modstandsblokke, hvis brug netop var introduceret her i landet.

Dyrkningsforsøg i lysimetre viste betydningsfulde vekselvirkninger mellem vand og næringsstoffer, især kvælstof og fosfor, bestemt ved planternes næringsstofindhold og deres optagelse af jordvand gennem vækstperioden.

Der gennemførtes endvidere en karakterisering af en række jordtyper med henblik på tekstur- og strukturforhold og på deres vandretention.

Med de bedre faciliteter, som afdelingen efterhånden kom til at råde over, både på Frederiksberg og på Højbakkegård, kunne forskningen intensiveres. Der gennemførtes undersøgelser over betydningen af jordens vandindhold og jordkolloidernes ionbelægning for jordbearbejdning og jordens hydrauliske ledningsevne. Undersøgelser vedrørende næringsstoffers tilgængelighed udtrykt ved deres kemiske potential kunne genoptages og udvides, og potentialernes relationer til jordens og jordvæskens indhold af næringsstoffer og til planternes næringsstofoptagelse blev undersøgt.

Herved blev plantefysiologiske undersøgelser i stigende grad inddraget i arbejdet, som udvidedes til at omfatte kinetik ved ion- og vandoptagelse, rodvækstens afhængighed af jordfysiske forhold samt bladenes produktionskapacitet under varierende vandforsyning og ved høje ionkoncentrationer, bestemt på baggrund af resultater fra samtidige og kontinuerte målinger af transpiration og fotosyntese i klimakammer.

Klimakamrene gav således mulighed for nøjere studier af planters reaktioner overfor definerede klimatiske påvirkninger, og med udbygningen på Højbakkegård forbedredes også mulighederne for at udforske planters reaktioner under naturlige vækstbetingelser. Med denne kombination af faciliteter er afdelingens forskning i vid udstrækning nu koncentreret om udnyttelse af de naturgivne ressourcer i planteproduktion.

De forbedrede forskningsmuligheder resulterede i en række licentiatarbejder og andre videnskabelige arbejder, som det vil fremgå af oversigten over afdelingens publikationer. I det følgende gives en kort beskrivelse af igangværende projekter.

Vandbalancestudier.

Hydroteknisk Laboratorium har taget initiativ til oprettelse af et net af fordampningsmålestationer. Disse stationers drift varetages nu af Statens Forsøgsvirksomhed i Plantekultur med Højbakkegård som en af de indberettende stationer. Formålet med stationerne er at konstatere den lokale potentielle fordampning, hvorved dyrkningsbetingelser kan vurderes og vandingsbehov bestemmes.

Studier over forskellige landbrugsafgrøders vandbehov og måling af jordens udtørringsgrad under karakteristiske vegetationer foretages på Højbakkegård ved brug af neutronspredningsteknik. Det aktuelle vandforbrug sammenholdes med klimatiske forhold, og der arbejdes med en model, hvorefter aktuel fordampning kan beregnes ud fra kendskab til potentiel fordampning, jordtype, planteart og planternes udviklingstrin.

Internationale hydrologiske Dekade (IHD) (1967—1977).

I 1967 tiltrådte Danmark den af UNESCO organiserede Internationale hydrologiske Dekade. Under Hydroteknisk Laboratorium blev der 1968 i hvert af de to udvalgte repræsentative områder (Karup og Stevns) oprettet 6 klimastationer. Stationsnettet består af en hovedstation, hvis måleudstyr svarer til den under klimastationen på Højbakkegård beskrevne, og 5 understationer med måleudstyr i mindre omfang.

Interiør fra klimakammer. Undersøgelser af blyoptagelse i havreplanter.

Disse stationers daglige drift forestås af medarbejdere ved Hydroteknisk Laboratorium. Medarbejdere herfra er ligeledes repræsenteret i den nationale styrelse og i arbejdsgrupper, som indgår i et nordisk samarbejde.

Formålet med disse undersøgelser er at få en fuldstændig beskrivelse af karakteristiske områders hydrologiske forhold. Klimastationernes opgave er herunder foruden at karakterisere klimaet at måle områdernes potentielle og — støttet af jordfugtighedsmålinger — aktuelle fordampning.

Planteproduktion og miljø.

En forøgelse af planteproduktionen vil for mange plantearters vedkommende være betinget af øget tilførsel af vand og næringsstoffer, specielt kvælstof. Konsekvensen heraf kan blive en yderligere belastning af miljøet, f. eks. ved øget tilførsel af kvælstof (nitrater) til overfladevand og til grundvand.

Ved Hydroteknisk Laboratorium gennemføres i lysimetre på Højbakkegård undersøgelser med henblik på at bestemme den potentielle, d.v.s. klimabetingede maksimale planteproduktion.

I undersøgelsen indgår forskellige kombinationer af vand- og næringsstoftilførsel. Indhold af forskellige næringsemner i det høstede materiale, jordvand og drænvand bestemmes med korte mellemrum. I forbindelse hermed foretages også laboratorieundersøgelser over nitrattransport og -fordeling i forskellige jordtyper ved forskellig gennemstrømningshastighed af vand. Projektet skal belyse energi-, vand- og kvælstofbalancen ved potentiel planteproduktion.

Bly i jord og planter.

På baggrund af miljøproblemerne i forbindelse med de tunge metaller er et projekt i gang vedrørende blys forhold i jord og planter. Blykoncentrationen, blyionaktiviteten, akkumuleringen af frit bly og komplekst bundet bly undersøges i jord for herigennem at kunne vurdere, hvilke mængder der kan transporteres til planterødder og grundvand. I klimakamre undersøges planters optagelse og translokering af bly ved varierende betingelser.

Simuleret planteproduktion.

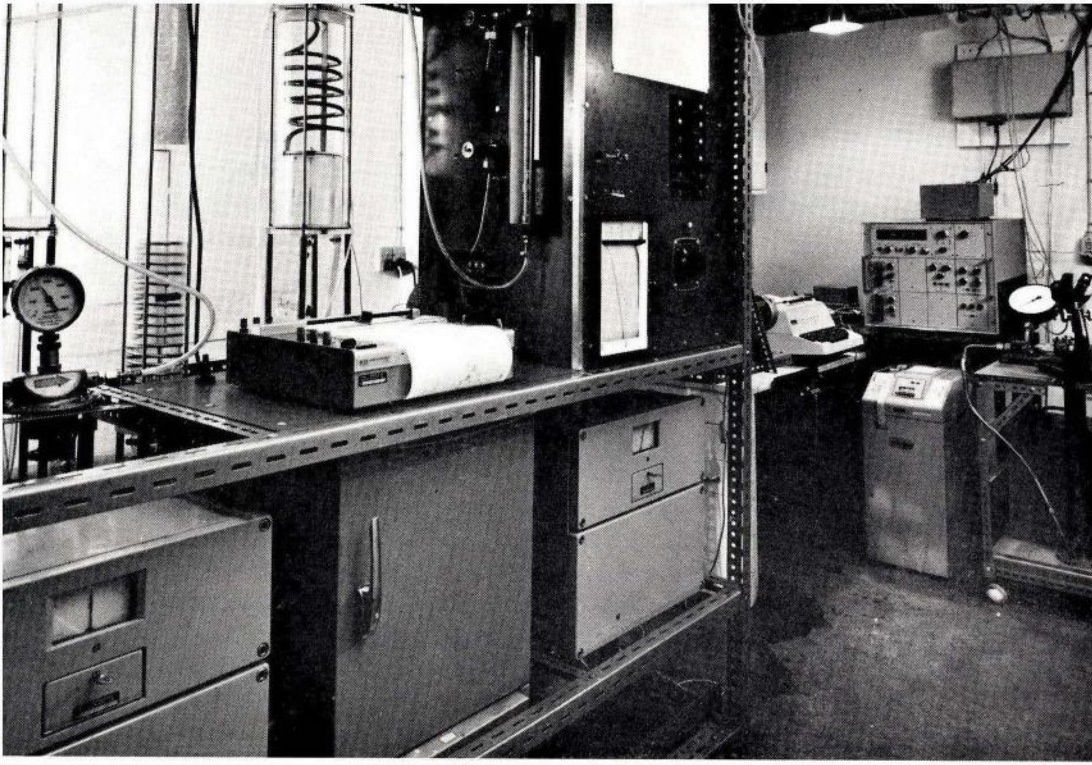
Dynamisk simulering af planters produktion i relation til deres miljø er blevet mulig med udvikling af simuleringssprog for EDB. Ved at konstruere modeller, der indeholder de væsentligste kendte parametre for planternes produktionsprocesser og vekselvirkningen mellem planter og miljø, er det muligt til enhver tid med en model at beregne situationen i en afgrøde. Ved hjælp af modeller er det muligt at vurdere hver enkelt parameters indflydelse på den samlede produktion og herigennem koncentrere indsatsen om de faktorer, der er begrænsende.

Under projektet arbejdes vekslende med model og forsøg i laboratoriets klimakamre og mark. Undersøgelserne omfatter bestemmelser af de jordfysiske parametres indflydelse på rodvæksten og fordelingen af vand og næringsstoffer, af planternes fotosyntese og respiration samt af transportprocesser af vanddamp og kuldioxyd i og over en afgrøde. Modellen testes på resultater, opnået under markforhold.

Strålingsbalance.

Den globale stråling, der når en vegetationsdækket jord, vil enten reflekteres, absorberes eller transmitteres, afhængig af vegetationens tæthed og alder. Den absorberede energi vil medgå til transpiration, varmeudstråling, opvarmning og fotosyntese. Den transmitterede energistråling vil medgå til evaporation, jordopvarmning og langbølget stråling.

Der gennemføres undersøgelser med henblik på at bestemme størrelsen af flest mulige af omsætningens enkelte led. Målingerne omfatter en opdeling af spektret i synlig (fotosynteseaktiv) og ikke synlig stråling. Global, reflekteret og transmitteret strå-



Apparatur for kontinuerlig måling og registrering af fotosyntese og transpiration i klimakamre. Yderst til højre trykbombe for måling af planters vandpotentiale.

ling måles med forskellige strålingsmålere. I forbindelse med disse målinger bestemmes afgrødevækst, bladareal, aktuel fordampning og ændringer i jordens varmeindhold.

Afgrøders primære produktionsprocesser.

Tørstofproduktionen i planter er resultatet af synteseprocesser, hvor substratet er fotosynteseassimilater. Omdannelsen af assimilatet til plantevæv er energikrævende og er en funktion af den del af respirationen som er samhørende med væksten. Herudover er der en vedligeholdelsesrespiration, der fremkommer som følge af de synteseprocesser, der er nødvendige for at kompensere for nedbrydninger i eksisterende plantevæv.

For at undersøge planters udnyttelse af fotosyntesen i tørstofproduktionen ved varierende ydre betingelser er der under markforhold gennemført samtidige målinger af respirationen fra jord, jord og planter samt fra intakt afgrøde. På grundlag af målingerne beregnes respirationen fra planterødder og afgrødens overjordiske dele hver for sig.

Under kontrollerede betingelser i klimakamre undersøges ved kontinuerlige målinger af fotosyntese og respiration, i perioder af 3—4 uger, på samme planter, udnyttelsesgraden og fordelingen af assimileret kuldioxyd. Målingerne foretages samtidig på top og rod hver for sig under varierede betingelser.

Styring af plantedyrkning i væksthus.

Hydroteknisk Laboratorium er sammen med Statens Væksthusforsøg, Statens plantepatologiske Forsøg og Afdelingen for Planternes Ernæring (KVL) repræsenteret i en arbejdsgruppe (VSOP-gruppen), bestående af 5 medlemmer.

Arbejdsgruppen arbejder med planter dyrket i væksthus og forsøger gennem undersøgelser og registreringer af en række vækstfaktorer, omfattende klima, vand, næringsstoffer og dyrkningssubstrater, at opbygge det nødvendige teoretiske grundlag for udvikling af rationelle metoder til automatiseret styring af vækstbetingelserne. Arbejdet har således direkte erhvervsøkonomisk sigte.

Udadvendte aktiviteter

Gennem årene har medarbejdere ved Hydroteknisk Laboratorium repræsenteret højskolen eller afdelingen i en række faglige organisationer og udvalg. Faglige arrangementer af både national, internordisk og international karakter er gennemført ved medarbejdernes medvirkning, ligesom medarbejderne har deltaget som foredragsholdere eller lærere ved kongresser, seminarer og kurser.

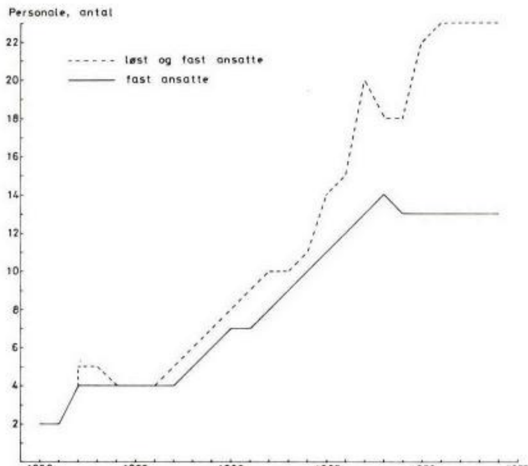
Personalet

Mange har gennem årene været knyttet til afdelingen, meget ofte som licentiatstuderende eller som vikarer før eller efter et licentiatstudium, mens andre har haft orlov og har besøgt andre institutioner og universiteter. Fem har således været i U.S.A. ét år og studeret ved forskellige universiteter (Berkeley, Cornell og Nebraska), mens to medarbejdere har studeret i Australien ved institutter under Commonwealth Scientific and Industrial Research Organization (CSIRO).

Nedenstående figur viser afdelingens vækst gennem tiden, men også at denne vækst i væsentlig grad skyldes mange licentiatstuderende og særlige aktiviteter (UNESCO's Internationale hydrologiske Dekade fra 1968).

De faste stillinger omfatter for tiden 7 videnskabelige og 6 tekniske medarbejdere, mens de øvrige er stipendiater eller ansatte på basis af særlig bevilling eller fondspenge til forskningsprojekter.

En fortegnelse over alle, der for tiden er tilknyttet afdelingen, findes på omslagets 3. side.



Udviklingen i antallet af ansatte ved Hydroteknisk Laboratorium fra 1950—1975. Afstanden mellem kurverne er et udtryk for den stigende aktivitet vedrørende særlige forskningsprojekter.

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Klima- og Vandbalancestationen i aftenlys.

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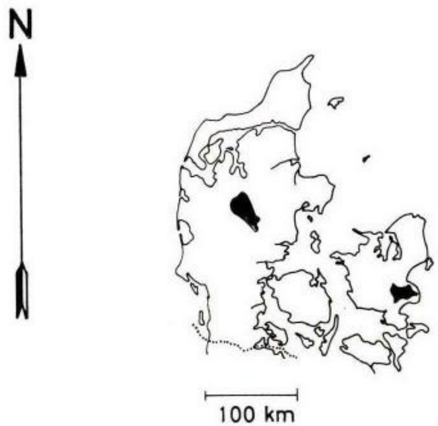
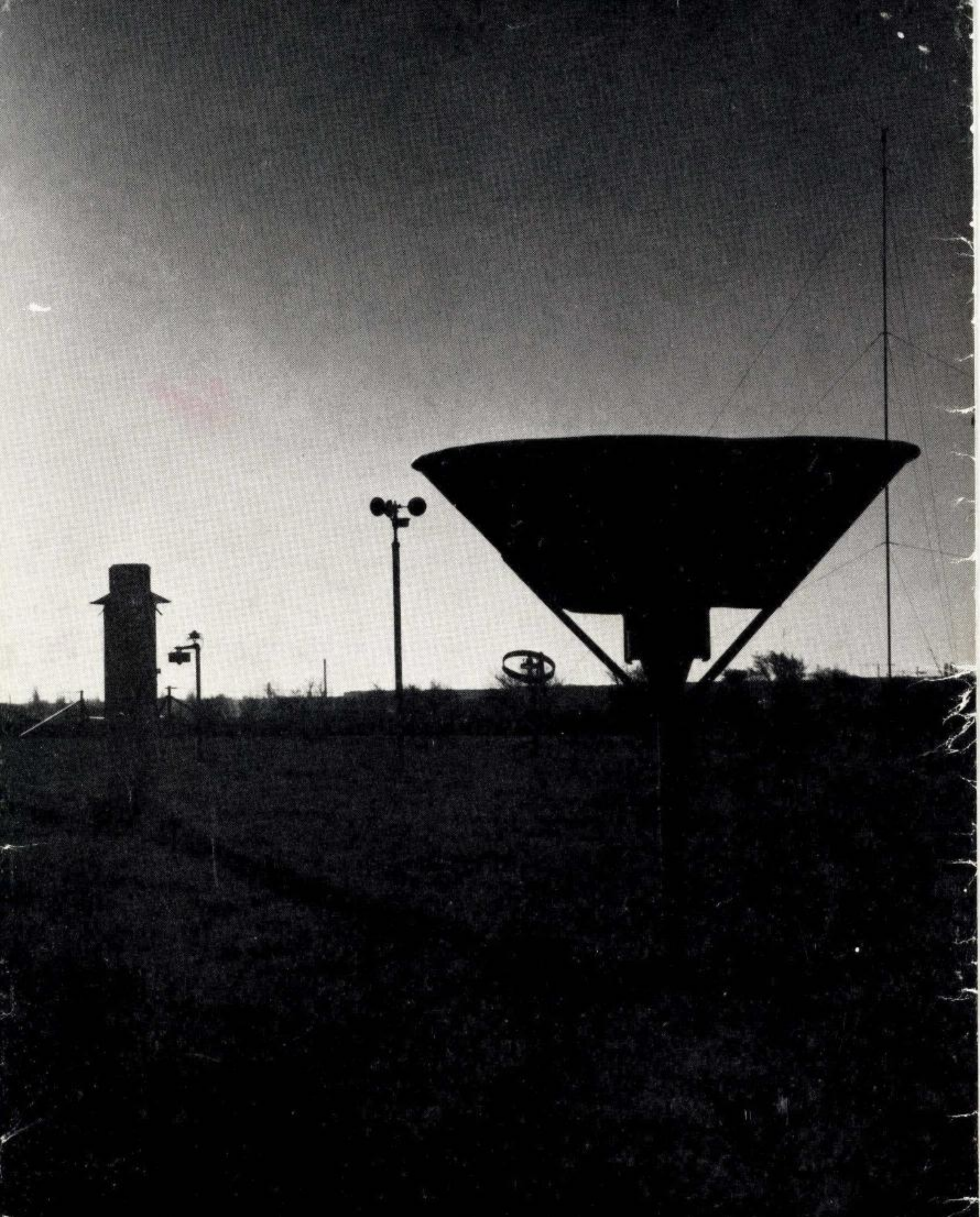


Hydroteknisk Laboratorium deltager under UNESCO's auspicier i projektet Den internationale hydrologiske Dekade. Laboratoriet gennemfører ved 6 klimastationer i hvert af de repræsentative områder Karup og Stevns omfattende undersøgelser vedrørende klimaet og den naturlige vandbalance.



SIXTY-THIRD SESSION
OF THE
INDIAN SCIENCE CONGRESS
WALTAIR, January 3—7, 1976

SCIENCE AND INTEGRATED RURAL DEVELOPMENT —AN AGENDA FOR ACTION

INDIAN SCIENCE CONGRESS ASSOCIATION
14, Dr. Biresh Guha Street, Calcutta-700017

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1

INTRODUCTION

The General Body of the Indian Science Congress Association decided during the 62nd Session of the Congress held at Delhi in January 1975 that starting from the 63rd Session of the Congress, each Session should have a focal theme which will lend itself to cross-disciplinary discussion. It was also decided that the focal theme for the 63rd Session will be "Science and Integrated Rural Development". The Executive Committee of the Association was asked to work out the details of the focal theme and circulate it to members. The Executive Committee at its meeting held at Calcutta on April 19, 1975, finalised the outline of the discussion and classified the different topics under the following three major groups :

(a) Rural Assets and Liabilities

(b) Science and Technology as Related to Rural Development

(c) Blueprint for Action

The outline was circulated to all members and discussions were also organised by some local Chapters of ISCA in the respective areas in order to generate thinking on the involvement of the scientific and academic community in rural development. The Executive Committee also asked the General President, Dr. M. S. Swaminathan, to introduce the focal theme in his Presidential Address.

The 63rd Session of the Indian Science Congress was held at Waltair under the auspices of the Andhra University from January 3 to 7, 1976. About 2,100 scientists from all parts of the country and about 50 scientists drawn from 21 other countries participated in the Congress. Several hundred scientific papers were presented in the following 13 Sections, two Committees (Science and Economic Development, and Science and its Social Relations) and the Forum on Home Science and Nutrition :

Section 1 : Mathematics
Section 2 : Statistics
Section 3 : Physics
Section 4 : Chemistry
Section 5 : Geology & Geography
Section 6 : Botany
Section 7 : Zoology, Entomology & Fisheries
Section 8 : Anthropology & Archaeology
Section 9 : Medical & Veterinary Sciences
Section 10 : Agricultural Sciences
Section 11 : Physiology
Section 12 : Psychology & Educational Sciences
Section 13 : Engineering & Metallurgy

(14) Forum on Home Science and Nutrition

(15) Committee on Science and its Social Relations

(16) Committee on Science and Economic Development.

There were 30 Symposia, 4 Evening Panel Discussions and 23 Special Lectures. The Evening Panel Discussions provided opportunities for audience participation.

A special exhibition was also organised to focus attention on recent scientific developments having a bearing on the focal theme.

Another distinctive feature of the Waltair Congress was the participation of representatives of several voluntary scientific and educational organisations engaged in rural development work in different parts of the country. Representatives of mass media also participated in a discussion on the "Role of Mass Media in Carrying Science to Villages".

A major aim of the Science Congress Association in choosing a focal theme for the Congress was to develop broad guidelines for action by the scientific community itself, in addition to offering the views of the members of the Association to

Central and State Governments on matters relating to public policies. The suggestions which emanated at the Congress were discussed by Sectional Presidents in their respective Sections. They were also discussed in meetings convened by the General President with Sectional Presidents, Officers of the Association and Local Secretaries. The recommendations arising from these discussions were presented to different Sections on the forenoon of January 7, 1976. They were approved by the Executive Committee, the Council and the General Body of the Indian Science Congress Association on the afternoon of January 7, 1976. At the concluding session on January 7, 1976, the recommendations were formally presented to Shri P.N. Haksar, Deputy Chairman, Planning Commission, and Chairman, National Committee on Science & Technology.

The General Body of ISCA decided that the President of the 63rd Session should set up a task force to take follow-up action on the recommendations and that the action taken should be reported on the opening day of the 64th Session of the Congress at Bhubaneswar. The General Body further decided that the focal theme for the 64th Session would be "Survey, Conservation and Utilisation of Resources". It was felt that this topic would help to stimulate more micro-level studies which are needed for the effective implementation of some of the suggestions of the 63rd Session of the Congress.

In pursuance of these decisions, the present brochure containing the Address of the Prime Minister of India at the inauguration of the 63rd Session, parts of the General President's Address relating to the focal theme, the valedictory address of Shri P. N. Haksar, and the general and sectional recommendations, has been brought out.

2

Address by Shrimati Indira Gandhi, Prime Minister of India

WE HAVE JUST STEPPED into the last quarter of the century. Much has happened in the past three quarters. Empires which had grown in the nineteenth century finally crumbled in the last three decades. The theory of superior races, sought to be reinforced by the scientific discoveries of last century's evolutionists, has yielded place to ideals of coexistence and equality. Earlier, Nature was viewed as the object of conquest and exploitation. Now there is a fuller recognition of the miraculous balance between various forms of life and non-life. Technologically, man, never content with his two-dimensional existence, finally leaped into the sky and his mind learnt to grasp the continuum between space and time. Having broken matter into energy, he is now attempting to acquire the other attribute of godhead—to create life by assembling the elements. Scientists have begun speaking—some in ecstasy and some in alarm—about genetic engineering and its many potentialities.

"*It is almost the year 2000*", wrote Robert Frost. But 2,000 million people, half the world's population, are still in want. Science, with its spectacular aehievement in increasing production and multiplying a thousand-fold the speed of man's movement and the range of his sight and sound, has aroused limitless expectations. And what is more, it has the capacity to fulfil them. The challenge before leaders of science and the moulders of national and international policies is to direct the known and proven capacities of science towards the removal of hunger, want and the diseases of privation.

The focal theme chosen for this year's Science Congress acknowledges that scientists are conscious of the unfinished tasks of their vocation. In addition to publicising and reviewing the latest works of various scientific disciplines, the Science Congress is directing the insights and skills of different fields towards the problems of rural development. You could not have chosen a more urgent and worthy subject.

The relationship between villages and towns has been one of the earliest problems of civilisation. Etymologically, the very word civilisation connotes urbanisation and thus carries in it a bias against villages. Science has, by and large, been an ally of industrialisation and urbanisation and has not given adequate attention to a comprehensive study of rural problems. The drain of talent from village to town is the oldest form of brain drain, except in ancient India where the great *ashrams* were located in villages and a wise, institutionalised attempt was made to take city youth to learn in rural and sylvan environments. No less notable is the economic drain from rural to urban areas. Much initial capital for industrial growth, whether in the capitalist or the socialist system, has been accumulated through a conscious policy of denying the villages their due share of social investment. In the Indian pattern of development, it was our deliberate effort to avoid this wrong.

Gandhiji was tireless in pointing out that the freedom and progress of India was synonymous with the self-government and economic regeneration of its villages. Maintaining that "If the village perishes, India perishes too," he did not want cities to live off villages. His economic ideas were designed to provide more work for rural people. He was not against machinery as such but against machines which forced idleness on rural hands. He did not object to villages using even modern machines and tools, provided the self-reliant character of rural industry was not jettisoned. In the West, the evolution of machinery was motivated by the desire to displace labour. But Gandhiji was for production by the masses, as distinguished from mass production in its common connotation.

Jawaharlal Nehru is acclaimed for his contribution to the industrialisation and modernisation of India. His understanding of and concern for rural problems has not received due recognition. It has even become fashionable to accuse him of neglecting agriculture. On the contrary, he steered Indian planning so that there would be no danger of industrialisation hampering agriculture. He laid stress on irrigation, agricultural extension and research, and other essential requirements of rural regeneration, such as land-reforms. Where he differed from the more orthodox school of rural thought was in his emphasis on science as the catalyst to visibly increase agricultural output and improve rural life. He looked to our scientists to find answers to the main problem of our villages and our country, poverty.

Dr. Swaminathan has referred to the anomaly of India having the world's third largest stock of scientists and yet continuing to be underdeveloped. I have no doubt that given time and a reordering of its objectives and priorities by the scientific community itself, this anomaly can and will be remedied. Even in more advanced societies, with all their resources of money, equipment and training, science has not been able to solve problems of living. In many of the most affluent, even hunger and malnutrition still exist. Do problems ever disappear ? They only change. In many societies, as we know, science (or rather, technology) itself has become a problem. Pollution is a product of science. The prospect of global annihilation is another. It is only now that science has become aware of its monster children.

Our science should give itself a rural bias. The overwhelming majority of our people lives in villages and will continue to do so for years to come. I would go further and say that we don't even want to uproot them. All over the world, urbanisation has brought comfort and stimulation ; but who could claim that it has not given rise to complicated problems and complexes ? Rural life should be so enriched as to prevent the migration of people and resources from villages to towns. Expedients worked out in countries where the agricultural population form but a small part of the work force cannot serve our country. Obviously, we must find our own solutions.

Dr. Swaminathan has outlined some of these : I welcome his plea for making better use of sunlight and water. We also need to educate our villagers in the difficult science of pest control. After initial distrust of modern agriculture, our farmers have tended to become over-enthusiastic about fertilizers and pesticides. Perhaps we should encourage some native caution and their traditional reverence for life, so that they appreciate the value of maintaining ecological balance. There must also be greater emphasis on the technology of storage and preservation of produce. Some of the most important areas of immediate research and development which have to be undertaken are the utilisation of groundwater, post-harvest technology, nitrogen fixation and solar energy.

There should be greater attention to rural engineering, a subject on which I have been laying emphasis in my meetings with scientists. Rural electrification has made rapid progress but we have not yet succeeded in teaching villagers how to use power to advantage. Many farm implements lie idle for months owing to poor maintenance. There is a woeful lack of rural technicians and of innovative work. The Village and the Home should become laboratories for inter-disciplinary scientific and technological investigation. This would open vast new employment opportunities for rural youth. If the village housewife's drudgery and worry (especially about her family's health) could be reduced, she would be an enthusiastic agent for change.

Dr. Swaminathan has spoken of taking advantage of the steroid properties of widely known plants for family planning. There is a well-known story about Charaka, the ancient physician. When asked by his teacher to bring plants which were quite useless, he returned empty-handed remarking that there was no such plant. Old familiar household remedies are being lost. A few may have owed their efficacy to faith rather than science ; but science is gradually discovering that not all folk remedies are unscientific. We must encourage rural women and children to identify and preserve valuable plants. We should also popularise wider cultivation and the use of plants which supply nutritional deficiencies. The first step in rural uplift is to inculcate in villages a greater pride in their environments, in local flora and wild life, in their own arts and crafts. Modernity does not imply alienation.

Hence universities and laboratories must come closer to villages. I wonder what proportion of our grants to universities and laboratories is devoted to research which is not intellectually or socially relevant or useful even in the intellectual training of young scholars. Our centres of science and higher technology should attach as much importance to the man who takes science to the field as to him who publishes a thesis.

In urging that science be given a rural bias, I do not wish to minimise the importance of scientific investigation which advances industry or fosters national strength. In fact, alongside with the strengthening of agriculture we need to look to the entire field of energy and metallurgy. Nor am I, in stressing the practical aspects of science, unappreciative of the role of basic theoretical work. There is room and necessity for all: for the pure mathematician who celebrates the majesty of number and for the agronomist who helps to grow two ears of corn in place of one.

A scientist is international in outlook; but how can he who does not care for his country care for the world? A concerted attack is now being directed against us as a nation. People who have not bothered about democracy in other countries, who abet the overthrow of liberal governments and aid authoritative regimes are loud in bemoaning the so-called abridgement of democracy in India. It takes no great imagination to see that what they find unpalatable is our growing strength, political and technological. The good account we gave of ourselves during the political and military challenges of 1971 was the signal for an outburst of anti-Indian propaganda. After our peaceful nuclear explosion of 1974 and the launching of Aryabhata last year, the propaganda grew louder.

We were criticised for pursuing prestigious projects and accused of starving our people. Hardly a word was written about the massive and successful organisational effort to prevent starvation. How can we possibly solve our basic problems unless our science is self-reliant ? Can a country of our size remain a technological client ? So prejudiced are some supposedly objective observers that a London Journal has come out with the preposterous accusation that I have neglected agricultural production in the ten years that I have been Prime Minister ! I need not remind this audience of the increase in agricultural production, especially wheat, since 1966. Dr. Swaminathan has mentioned the doubling of wheat production in the last five years. Last year's level was 24.24 million tonnes. There has also been a 40 per cent increase in rice production and a 50 per cent increase in cotton. Did all these happen by themselves ?

I believe in the complete human being. Buckminister Fuller has written : "General systems science discloses the existence of minimum sets of variable factors that uniquely govern each and every system. Lack of knowledge concerning all these factors and the failure to include them in our integral impose false conclusions." Specialisation is necessary to an extent, but if it means that each expert sees only his own subject in isolation and feels no responsibility except for his experiment, then he cannot do justice to his work or be a whole person.

India and Indian science must be prepared for more onslaughts. Attempts will be made to discredit leading figures in our science, as they are being made to denigrate leading figures in our politics. Scientists of advanced countries find it hard to overcome attitudes engendered by colonialism and long distortion of history. The affluent countries were early and we are late. Our best scientists have won laurels through their own effort and merit ; but many others tend to attach too high a value to foreign acceptance. As Indian science comes of age, attitudes of rivalry will come to the fore. While we welcome international cooperation, we should learn to rely increasingly on recognition and reward at home.

I wonder if you have read Robert Graves' poem "R & D Classified." It runs as follows (I am skipping some lines in between) :

We reckon Cook the best chemist alive
And therefore the least certain to survive . . . . .
Those goblins, guessing which of us is what . . . . .
Must either pinch his know-how or else wipe him.

I quote this stanza not as a cautionary tale, but as a reminder that however cosmopolitan an Indian, he will still be regarded as Indian wherever he goes, and that in serving knowledge, scientists must equally serve the nation.

I hope that your innovation in choosing a focal theme for the annual session and that the ever-relevant one of our rural development will give added content and direction to governmental policies.

My good wishes to the Conference and to Andhra University who are its hosts.

3

General President's Address

by

Dr. M. S. Swaminathan

This is the first session of the Science Congress when, in addition to discipline-centred papers and symposia, there will be a cross-disciplinary examination of a topic of national relevance. The aim is to utilise the vast inter-disciplinary expertise present at the Congress for a deeper understanding of a specific national problem. "Science and integrated rural development" was chosen at our last session held at Delhi as the focal theme for this session. Scientists, both from our country and abroad, and our Sectional Presidents have taken much trouble to articulate their thoughts on what scientists can and should do to promote rural development and agrarian prosperity, and I am confident that we will have a useful discussion on the various facets of this theme. The exhibition has also been suitably restructured. For the first time we will have a Forum on Home Science and Nutrition and will give special attention to Fisheries. The major suggestions arising from our discussions will be summarised on the last day when the Deputy Chairman of the Planning Commission, who is also the Chairman of the National Committee on Science and Technology, has kindly agreed to receive them personally.

We have the privilege once again of having our Prime Minister, Shrimati Indira Gandhi, with us at this opening session. By holding charge of the portfolios of the Departments of Science and Technology, Atomic Energy, Space Research and Electronics, in addition to serving as the President of the Council of Scientific & Industrial Research, our Prime Minister has shown her firm commitment to the harnessing of science for national development. To the concept of economic growth with social justice, she has also added the dimension of growth with ecological balance so as to harmonise the short and long term goals of development. On behalf of the scientific community, I thank our Prime Minister for her presence and for her clear policy direction for the promotion of a symbiotic interaction between science and society.

The various initiatives taken by our Central and State Governments since 1947 under the leadership of Shri Jawaharlal Nehru have now placed our country in the third position in the world in scientific and technical manpower. On the other hand, we were included at the World Food Congress held in Rome in 1974 among the "most seriously affected" (MSA) countries with regard to food, which is the first requisite in the hierarchical needs of man. Why do we find this mismatch between our position in the world of science and the quality of the lives of a majority of our people ?

It seems to me that a basic deficiency of our developmental system is our inability to emulate our genes, in each one doing his or her specific task properly and well and everyone working together in a coordinated manner. Let me elaborate this further. I wonder how many of us realise that the total weight of the chemical substance of heredity, de-oxyribose nucleic acid (DNA), for our entire population is only about 4.2 mgs, if we add up the weights of DNA present in the single cell embryo of each individual from which we grow. By the same method of calculation the present population of *Homo sapiens* would have a DNA content of about 28 mgs. In these 28 mgs of DNA, the specifications for the heritable characteristics of our entire species are inscribed. How has the genetic system combined economy with such remarkable efficiency and precision ?

Genes have three essential properties. Each gene has a specific function: each is capable of replication or making exact copies of itself; and each is capable of mutation or heritable change. The function of a gene is regulated both in terms of its particular location on a chromosome and also in terms of a particular time sequence in development. During the reproductive phase, genes are able to combine in different ways and this process of recombination followed by segregation generates wide variability. Thus, in practice, except for identical twins, no two individuals are exactly similar. Mutation, or heritable change, adds to the capacity to respond to changing selection pressures.

Another remarkable property of genes is the system of vertical and horizontal coordination to which they subject themselves. Thus, each gene performs its specific function and is able to replicate itself, to change and to work cooperatively and sometimes competitively with other genes. Integration of vertical and horizontal coordination has invested the heredity system with precision and power. If only everyone of us was aware of the way in which our own bodies function and applied the lessons learnt from it in our daily life, we might be more successful in achieving what individually and collectively we wish to accomplish.

What is it that we want to accomplish ? In my view, the most important task is to draw the greatest benefit from our existing human resource and to limit its further unplanned growth. Past experience suggests that human resource cannot be effectively used by traditional approaches to "creating jobs", which often tend to degenerate into doles. What is needed is the growth of employment policies from an overall strategy of resource utilization designed to convert sunlight, soil, water, mineral, plant, animal and other resources into wealth meaningful to people. Instead of devoting undue attention to brains drained to other countries, we should pay serious attention to the utilization of brains within the country. The starting point is obviously the village, which is where both untapped assets and native brains exist. This is why the Science Congress has chosen integrated rural development as its first focal theme.

Eighty per cent of our population now live in rural areas. Some experts have calculated that this percentage will be 71 in 2000 A.D. Even if the percentage goes down, the rural population is expected to grow in number from 441 million in 1971 to 662 million by 2000 A.D. Of the existing rural population, nearly 50 per cent is believed to suffer from poverty. Rapid rural development based on the scientific utilization of all our resources, both natural and human, is therefore a must.

It is worth noting that countries which have gone too far on the road of urbanisation are now repenting this choice. Rapid urbanisation has generated a steep rise in the consumption of non-renewable forms of energy. For example, the transport needs of large cities have grown so vast that the number of motor vehicles in the world increased by 120 million during the 1960s, generating problems of atmospheric pollution and human temper. There is today a marked movement back to the countryside, but with the integration of some of the basic benefits of urban life with rural living. A planned reclustering of jobs, services and amenities more widely throughout the country in accordance with the agro-ecological potential and socio-economic needs of each area will facilitate this movement.

Rural-Urban Relationships

Gandhiji stressed that only a marriage between intellect and labour could lead to rural regeneration. Education, in the past, particularly at the university level, uufortunately tended to promote the concept that rural jobs, which were mostly related to agriculture, required only brawn and not brain. The exodus of the educated caused neglect of the hinterland. Yet we now know that unless life in a rural community is made tolerable for all, the problem of poverty can not only not be solved but will get worse. Therefore, a national policy of scientific rural-urban development as an integrated package is essential.

So far we have generally tended to pay only lip service to the cause of rural development. People living in cities talk about the freshness and beauty of nature but would not like to go and enjoy them even after retirement. Similarly, public policies have tended to promote an interest in urban living.

For example, today if a scientist or a public servant moves from a Class "A" City to a smaller place, he loses in his total emoluments. It is only in the case of the Defence Services that the principle of serving all parts of the country has been developed with appropriate provisions for non-family postings. Recently, the Indian Council of Agricultural Research has introduced the concept of compulsory service for a specific period in a tribal or neglected area by all members of the Agricultural Research Service. Compulsion alone cannot yield the desired results. What is important is to incorporate, in personnel policies, appropriate provisions for the education of children and for medical facilities to enable qualified scientists and technologists to work in areas where these facilities do not yet exist.

Rural Assets and Liabilities

An important task for this year's Science Congress is to review our rural assets and liabilities and the present state of the art of harnessing science to improve rural economy and living. On the basis of such a review, certain broad guidelines are to be developed for using the tools of science to enhance the assets of rural life.

Though our assets are well known, it is worth repeating them because they are so impressive. First, we have the second largest human population in the world, most of whom are young. Although a considerable proportion of the adult population is classified as illiterate in the formal sense, they have shown a great capacity to absorb, adapt and benefit from modern technology. There are abundant recent examples to justify this statement. The doubling of wheat production within a span of five years, the progress made in improving rice and wheat production in areas where they were unimportant before, the spread of maize, formerly regarded as a *kharif* crop, in the *rabi* season along the Indo-Gangetic Plains, the spurt in long staple cotton production, the availability of apples everywhere in the country, the progress in the production of potato, tapioca and other tubers, the development of low-cost ground water exploitation technology like bamboo tubewells, the spread of *Gobar* gas plants and the growing diversification of export products from the rural sector are all indices of rural capability. Striking changes are visible in several parts of our country in farming systems, and animal husbandry is beginning to get more efficient. Our farmers have thus shown their readiness to adopt new technology provided it is economically viable and low risk in character and if appropriate packages of services and public policies help to ensure a reasonable return for their labour and investment.

Our animal wealth is also vast. We have over 16 per cent of the world's cattle population, 45 per cent of the buffalo population, over 69 million goats representing the largest population in the world, over 43 million sheep occupying the sixth position in the world and rich populations of poultry and inland and coastal fisheries. We are also endowed with excellent wild life resources. Our soils are by and large robust and productive, although in some areas lack of care has led to considerable erosion and the development of salinity, alkalinity and other problems. Shifting cultivation is still the major source of living for nearly two million people in the north-eastern Himalayan region. This method of handling the soil was developed hundreds of years ago as the only then available answer to the law of the diminishing return from the soil. There is however no place for it now.

Our water resources are vast and varied, and the National Commission on Agriculture has calculated that the area under irrigation can almost be doubled during the next 25 years from the present 42 million hectares. In the gross sown area of about 164 million hectares, regions with high (1150 mm and above), medium (750 to 1150 mm) and low (less than 750 mm) rainfall occur in almost equal proportion. Thus, over 45 per cent of the net sown area in the country has a reasonably assured water supply. Even in the arid zone of Rajasthan there is fortunately a good underground water reserve. The water quality is by and large good, although there are areas where the groundwater is saline. An integrated strategy for the utilization of ground and surface water and for harvesting all rain water in each ecological and topographic area will help to transform our agriculture and rural economy.

The high priority accorded to irrigation, command area development and groundwater exploitation in the Fifth Plan and in the 20-point economic programme should help to make our agriculture self-reliant and provide considerable resilience in crop planning. If we consider only light duration (energy), water availability and temperature, which are three of the major factors regulating crop production potential, the period of maximum insolation in the tropics and sub-tropics unfortunately coincides with low availability of water and high temperature. The latter would lead to high evapo-transpiration and consequently greater demand for water. In the absence of irrigation, water becomes the chief limiting factor in crop productivity. Thus, the period of potential maximum yield unfortunately becomes in reality a period of minimum productivity. In contrast, in the temperate zone the period of maximum day length fortunately coincides with periods of precipitation and temperatures conducive to growth (see table). The high and stable yields obtained with irrigation during *boro* and summer seasons in our country with several crops have fortunately focussed attention on this problem.

Estimated yield potential and per cent achieved in four rice-growing countries*

Country	Approximate duration of effective grain-filling period (days)	Average sunlight (Cal. $cm^{-2}day^{-1}$)	Estimated yield potential (t/ha)	Average yield** (t/ha)
Spain	35	500	17.9	6.27
Australia	35	600	21.1	6.25
Japan	35	350	12.1	6.02
India (*Kharif*)	25	300	7.3	1.85
(Andhra Pradesh) (*Rabi*)	25	500	13.4	2.20

*Efficiency for solar energy utilization is assumed to be 2.5%.
**FAO Production Year book 1973.

Our plant resources are vast and we have nearly 20,000 plant species, a greater number than in countries with a much larger geographical area. This is yet another index of the varied agro-climatic conditions prevalent in our country which offer scope for a wide range of plant species to thrive.

Thus, if one draws an agricultural balance-sheet purely in quantitative terms, our assets are great. It is an irony therefore that we should still find it difficult to provide for the basic minimal needs of our population and that we should face problems of unemployment and under-employment both in rural and in urban areas. Since I consider the population-food supply equation and the population-employment equation equally important and interdependent, I would like to dwell briefly on certain scientific aspects of these two equations.

Food Requirements

According to the estimates of the National Commission on Agriculture, our population by 1981 may be about 668 million. The total food needs for the present population and estimated population of 945 million by 2000 A.D., are about 122 and 220 million tonnes respectively. The major nutrition problem of our country is inadequacy of calories in the diet of the economically handicapped. Under-nutrition, in turn, has been attributed in many instances not so much to lack of food in the market as to lack of purchasing power in the hands of the urban and rural poor. Therefore, the food problem in many areas needs to be stated not just in terms of a certain quantity of foodgrains alone but also in terms of certain person-years of jobs which would provide the wherewithal to buy food.

If we separate the problem of increasing food production from the ability of the market to absorb it at remunerative prices we will find that there should be no difficulty in producing the food we need. In several countries of Asia, an increase or decrease in food production by a margin of about 5% may make all the difference between an uncomfortable glut and acute scarcity. Consequently, price fluctuations tend to be high, thus making it difficult for poor farmers to decide how much to invest in inputs. Some form of crop insurance will help, but this presents many operational difficulties. Ideally, there should be a global solution to this problem. The World Food Congress had recommended the establishment of an International Food Security system through a nationally or regionally held but internationally financed grain reserve of about 80 million tonnes. If implemented, this will provide a mechanism for channelling adequate external resources for the purchase of home-grown food. Both an uneconomic depression in prices and considerable loss of surplus produce in poor home storage structures can be prevented in this way.

Improvement in Productivity

Ultimately, the only real mechanism for achieving improved standards of living is increased productivity both in farms and factories. In the area of crop productivity, we occupy an unenviable position in the world.

The National Commission on Agriculture has calculated that even by 1985 the above average yield of rice and wheat in our country would be only of the order of 1.6 and 2.1 tonnes per hectare respectively. The position with regard to *jowar*, pulses and oilseeds is even worse. For these crops the National Commission feels that the average yields in 1985 will range only between 8 and 9 quintals per hectare. We have only to compare this with the average yields of rice of 5 to 6 tonnes per hectare prevalent even now in countries with small holdings like Japan and Taiwan to see the large gap between what seems to be possible and what we are able to accomplish. Unless we take speedy action to identify the major constraints to productivity in each cropping pattern and remove them, ours will be a very inefficient farming system. Further, there is a positive correlation between productivity and stability of yield—the higher the average yield, the greater is the stability.

In my view, the keys to achieving a comfortable position on the food front in our country in the near future are rice and *jowar* (sorghum), which occupy over 50 million hectares. I would hence like to refer briefly to some institutional arrangements which will have to be made to achieve a higher growth rate in productivity in these crops.

The following are some of the serious problems affecting rice production during the south-west monsoon period.

(a) Inability of farmers to raise nurseries and transplant at the optimum time.

(b) Lack of availability or application of improved technology for direct-seeded and upland rice.

(c) Difficulties in efficient water management, resulting either in too much or too little water.

(d) Inability to control pests effectively and in time.

(e) Poor fertilizer use efficiency.

(f) Poor post-harvest technology.

How Can We Tackle Such Problems ?

In several of our rice-growing areas and more particularly in the tribal areas, a farmer spends over two months in preparing rice seedlings for transplanting. He collects cowdung and other organic refuse and often burns this material in the place intended for raising seedlings. He uses a thick seed rate and thereby gets thin seedlings. As a result, he plants a bunch of weak seedlings together and places them rather deep in the puddle. Such practices need to be almost reversed if the yield potential of the new strains is to be realised. Community nurseries provide an institutional solution to this problem. The timely supply of healthy seedlings to farmers enables not only transplanting at the optimum time but also correct varietal choice, according to the particular situation of the farm in the village and the supply of nutrients like phosphorus and zinc at the seedling stage.

Scientific water and pest management would also need community endeavour. The new plant varieties form a dense crop canopy. This kind of crop canopy also promotes the greater incidence of some pests which were not important before, such as the brown plant hopper, which has played havoc with rice production in Indonesia and also in some parts of our country like Kerala. It would be difficult for each small holder to undertake the necessary tasks himself, even if he has the requisite will. According to the National Sample Survey, farm holdings below one hectare increased from 19.9 million in 1961 to 26.1 million in 1971. In fact, the Agricultural Census of 1971 estimates that holdings below one hectare are 35.7 million. Whatever be the correct figure, the trend is towards an increase of small holdings, which is in accord with the national policy. It would be necessary to match the national policy on size of holding with appropriate institutional arrangements for helping small farmers not only to overcome their economic handicaps but also the biological handicaps beyond the control of an individual farmer. Devices like farmers' service societies, small and marginal farmers' agencies and more recently rural banks have been set up to tackle the economic and input supply aspects of this problem. However, in my view, unless we approach the problem in its totality, it will be difficult to achieve substantial jumps in productivity which are otherwise well within our reach purely on scientific and ecological considerations. This is particularly urgent since the technology of the future will be increasingly based on recycling principles and integrated approaches which will demand collective action by farmers in a village or watershed for efficient adoption.

As in rice, there is immense scope in *jowar*, a major food crop of unirrigated areas, for improving yield and production. Our average yield today is only about 500 kg per hectare, while in many countries where *jowar* is grown for feeding cattle and pigs, the average yield is about ten times higher. A breakthrough in rainfed agriculture can be expected only by planning for large quantum jumps rather than for slow and graded annual targets which are within striking distance of environmental fluctuations. The predominantly black soil belt of *jowar*, as in Madhya Pradesh, Maharashtra and parts of Karnataka and Andhra Pradesh, usually grows tall varieties of 5 to 6 months' duration. By substituting such varieties with a 3-month hybrid or variety, assured yields can be expected even during years with sub-normal rains. However, if the rains are plentiful as happened during 1975, a ratoon crop of *jowar* can be taken up or alternatively a second crop like safflower, sunflower or chickpea can be grown. It has been estimated that nearly 4 million hectares out of about 18 million hectares under *jowar* would provide opportunities for taking a double crop in years of normal rainfall, provided short-duration varieties and hybrids are grown. The establishment of single maturity *jowar* zones with regard to varietal distribution would help to minimise pests like midge.

Scientists should make, block by block, a detailed analysis of the factors impeding biological and industrial productivity. Even in a crop like sugarcane, which is one of our great botanical assets, we find that our yields are low for a variety of reasons. The National Commission on Agriculture has calculated that even by 1985 the *gur* yield will only be 6 tonnes per hectare as against about 5 tonnes per hectare now. Sugarcane is the most efficient natural quantum converter that we know today as a collector and storer of solar energy in a useful form. The efficiency of quantum conversion to sugar is about 0.25 per cent, which is very good for a field crop. Countries like Brazil where land is not a limiting factor are trying to exploit the botanical efficiency of sugarcane, even to produce ethanol and thereby cut down the import of petroleum products. For example, it has been calculated that in the San Francisco River region of Brazil, where yields are high, only 1,50,000 hectares of sugarcane will be needed to meet 10% of the annual gasolene requirements of Brazil. Why are we lagging behind in exploiting the yield potential of this wonderful crop?

Some answers to this question have been provided by the district of Visakhapatnam, where our Congress is being held. The yields in this district were formerly poor. But by a correct varietal choice and by extending the needed help to growers through cooperative societies which run all the sugarcane factories in the district, there has been a steady increase in sugar production. Similar cooperative endeavour in the supply of disease-free planting material, scientific nursery and planting practices and pest management will have an immediate beneficial effect on sugarcane yield in States like Uttar Pradesh and Bihar.

Scientific Discovery, Production Advance and Prosperity Improvement

In my view, a few basic steps are needed if we want to convert the scientific breakthrough now taking place in most crops, farm animals and in inland and coastal aquaculture into a production advance, and a production advance into improved prosperity for all sections of the rural community. First, all groups must accept the concept of productivity. For this purpose, minimum productivity targets will have to be fixed and a farmer who does not achieve the target continuously for a few years without valid reasons should stand every chance of losing his land. Minimum targets such as 3 tonnes per hectare per year from two crops on irrigated land and 1 tonne per hectare per year in areas with over 1000 mm rainfall are neither ambitious nor unrealistic if proper institutional arrangements are made for supporting farmers. Appropriate Agricultural Productivity Acts by our State Governments could provide the social compulsion for cooperative efforts in areas like soil and moisture conservation and pest control. As an ingredient of such legislation, consideration deserves to be given to minimum limits to operational land holdings, below which the holding should not be fragmented as a unit of management, whatever be the ownership pattern.

The second need is to match the obligations of farmers under Agricultural Productivity Regulations with corresponding obligations on the part of State Governments. For this purpose, the Gram Sabhas or Panchayats may have to be restructured in such a manner that every member of the Panchayat assumes specific responsibility to organise the social support necessary for the effective adoption of a technological innovation. Unless there is a link between those who move society and those who move science and technology, it will be difficult to achieve the ends we desire. Every prospering experiment in our country in rural transformation owes its impact to a combination of these two factors.

Unlike in industry, no depreciation can be allowed on the basic assets of agriculture. The land-man ratio has already reached critical limits in several parts of our country. The history of agricultural advance of the past century has shown that in many countries productivity has continuously risen through scientific farming without any harm to the long-term production potential of the soil. As productivity increases, the area under a specific crop can go down and more land could become available for energy plantations and silvi-pastoral systems, which are essential for meeting rural fuel and feed needs. In a few States like Karnataka, there is evidence that total production is going up in a few major crops side by side with a reduction in area. This trend should become national.

Need for Accelerated Research

I have talked so far of the institutional and policy packages needed for increasing the feasibility and efficiency of adoption of new technology in our villages. Emphasis on this does not mean that all that needs to be done on scientific front has been accomplished. On the contrary, every change produces several reactions, some favourable and some adverse. Scientific vigilance and vision will be needed to maximise the beneficial effects and minimise the negative consequences of new technology. I have already referred to the undesirable association between a "high-yield environment" for plants and a corresponding favourable atmosphere for pests. Unscientific multiple cropping and monoculture of the same genetic strain of a crop over large and contiguous areas compound the problems of pests, which are even otherwise serious in the tropics and sub-tropics. Not only annual crops but perennial crops like citrus, mango, coconut and sandal, are affected by serious disease problems which are still evading solution. Besides pest management, I shall refer to a few more obvious areas where research work needs to be stepped up speedily.

(a) Of the highest priority is more intensive work on the preparation of an integrated inventory of land, water, mineral and other natural resources, area by area, and the development of scientific land and water use plans. Such an inventory should indicate the steps needed to reclaim large areas now stricken by salinity, alkalinity and acidity, as well as to conserve water, soil fertility and germ plasm of plants and animals.

(b) A more careful examination of weather in relation to crop and animal productivity is needed. Fortunately, a close coordination has of late been developed between meteorologists and agricultural research and extension workers. Day-to-day decisions by farmers require the correct interpretation of short-range weather outlook. We have a good mass media network and we can easily develop the capability to convey accurate and timely advice to farmers. Meanwhile, research on soil-crop-weather correlations, weather modification, hail dispersal and efficient forms of utilising dew should go on.

(c) The efficiency of conversion of cultural energy (i.e. all forms of energy introduced by man after he domesticated plants and animals) into digestible energy has to be improved. The most important components of cultural energy are implements and farm power, water and nutrients, particularly fertilizer. In the technology developed so far in the affluent countries, the ratio of conversion of cultural energy into digestible energy became less coincident with an increase in productivity. For example, David Pimental and co-workers in a recent article in "SCIENCE" (Vol. 190, 754-761) point out that the use of U.S. agricultural technology to feed a world population of 4 billion a high-protein calorie diet for one year would require the equivalent of 5000 billion litres of fuel. If petroleum were the only source of energy for food production and if we used all petroleum resources solely to produce food, the estimated reserve of 66053 billion litres would last a mere 13 years. The challenge therefore lies in developing techniques which will help to improve productivity continuously without a concurrent loss in the efficiency of conversion of cultural energy. This will need a stepping up of research on tillage, water use, integrated nutrient supply and recycling of recoverable sources of energy. Also, this area needs support from well-defined public policies. For example, the conservation and use of all organic wastes would need the introduction of a rural fuel supply policy based on a combination of steps such as raising energy plantations, organisation of community bio-gas plants, supply of coal or lignite at subsidised prices and supply of electricity and other forms of energy at reasonable rates.

(d) Research relating to the control of the menace posed to crops through the triple alliance of pests, diseases and weeds must be stepped up. It is obvious that for the foreseeable future chemical pesticides will continue to be used. For applying them with due care and caution, surveillance and early warning systems need to be developed more extensively which will facilitate the timely application of the minimum quantity of pesticide needed. Simultaneously, work on genetic resistance through screening at 'hot-spot' locations and through collaboration with International Agricultural Research Centres needs to be stepped up. Diverse genes for resistance will have to be identified since biotypes occur in many serious pathogens and insect pests, lending to the breakdown of host resistance.

(e) All aspects of production physiology aiming at the improved utilization of solar energy and reduction of photo-respiratory losses by genetic or chemical means will have to receive greater attention.

(f) The whole area of biological nitrogen fixation both by symbiotic and non-symbiotic mechanisms requires more attention. Nitrogen Fixation Research and

Development Centres might well be established at State level jointly by Agricultural Universities and State Departments of Agriculture. Here, collection of nitrogen-fixing micro-organisms, both symbiotic and free-living, could be maintained. Such Centres could distribute pure cultures of recommended strains for further multiplication and also administer quality control programmes. Since considerable basic work involving sophisticated instruments is also needed, the establishment of a National Nitrogen Fixation Research Centre supported by all the major scientific agencies might be desirable.

(g) We need more work on fertilizer technology in order to prevent the loss of fertilizer taking place during the *kharif* season through leaching. Some work has been done on reducing losses through blending nitrogenous fertilizers like urea with neem and other cakes and by using shellac-coated urea and sulphur-coated urea. What we need is a low-cost method involving locally available material which could simultaneously help us to reduce leaching losses and provide the needed micro-nutrients. Fertilizer technologists should concentrate on local problems and local solutions. Fertilizer is the most effective as well as most expensive input, and our requirement will grow not only for crop production, but also for animal and fish production. A national grid of small, medium and large fertilizer plants and compost units and an expanded soil testing service will hence be needed for sustaining agricultural advance. Since data on the fertilizer needed for specific yield targets are becoming available for major crops, fertilizer could be used as an effective trigger in any national policy of stabilising food production.

(h) Forestry research, including the development of quick yielding fuel and pulp trees such as annual strains of bamboo, needs more intensive attention and support.

(i) Increasing the production of domestic animals, poultry and fish by breeding, reduction of infertility, better nutrition and health care requires much closer study. The exploitation of hybrid vigour in cattle and fish deserves more attention. Disease problems of new genetic strains of cattle and sheep, and the harnessing of non-conventional sources of feed, particularly call for more scientific work. Recent research on fish culture in both inland and coastal waters has opened up new vistas of production. This will have to be supported by vastly expanded research on fish diseases and nutrition.

(j) Genetic engineering involving the transfer of genes from one species to another is being increasingly regarded as a potential tool for achieving recombination of favourable genes. Basic research in this area requires expensive facilities. A recent symposium on basic research as relevant to agriculture, organised by the Indian National Science Academy, has stressed the advisability of creating such facilities.

(k) A serious lacuna in our present research and development efforts is the inadequate attention to problems of post-harvest technology. An uneven match between production and post-harvest technology has resulted from our relative neglect of the latter. Even in areas where rice is cultivated with improved varieties and fertilizer, the harvested crop has to be dried most times by small farmers on paved roads. The high moisture content of grains at the time of harvest and inadequate drying prior to storage, particularly during the *kharif* season, are resulting in increasing problems of food toxins. Studies by scientists of the Central Food Technological Research Institute in Gurupur village in coastal Karnataka revealed a heavy fungal growth and high levels of aflatoxin in rice consumed by the population. Hepatitis outbreaks due to toxins in food have been reported by scientists of the National Institute of Nutrition (Proceedings of the Nutrition Society of India, No. 12, 1975). Thus, appropriate post-harvest technology is essential both for the farmer to get the maximum return for his labour and investment and the consumer to get food of good quality.

Population Growth and Opportunities for Gainful Employment

The next area to which I wish to refer is the population-employment equation, which, in my view, will assume even greater importance in the coming years than the population-food supply equation. The obvious first step is a vast intensification of our research and developmental efforts in the area of population stabilisation. Recently opened areas of research, such as vaccination against fertility, male contraceptives and immunisation with specific placental proteins, need to be extended full support. The cultivation of improved strains of plants containing certain steroids is now part of our strategy for reducing the cost of oral contraceptives.

The Bhagwati Committee had estimated that total employment opportunities of the order of 22.52 million man-years would have to be created in rural areas in 1969, if full-time employment was to be provided to all the available labour force. Other calculations have shown that at least 10 million man-years of employment need to be provided immediately in the rural areas. If we measure unemployment by the criterion of productivity per person-day, the figure becomes very high, as several economists have pointed out. Ultimately, it is only productivity per person-day that can provide the basis for true prosperity. Thus, rural employment, productivity and prosperity are all interdependent. Nutrition, in turn, is related to this triangle.

The National Commission on Agriculture has calculated that to generate full employment, at least 30 per cent of the rural labour force may have to be employed in the non-agricultural rural sector, including processing, textiles and other village industries. The Commission has hence suggested both agricultural and non-agricultural programmes for generating the needed number of jobs. Rapid generation of non-agricultural, though agro-based, sources of employment is also essential if a minimum limit to operational holdings is to be introduced.

Among non-agricultural occupations in the rural sector, the development of infrastructure such as roads, housing, irrigation works, electrification and agro-service centres, has been important in the past. As agriculture advances, marketing, trade, processing, storage, distribution and transportation will demand more labour as has already been observed in north-west India, where the rice-wheat rotation and mixed farming practices are making substantial progress. There has been much talk of the growth of village and small-scale industries and the planned allocation of labour intensive industries to rural areas, but in practice it has been difficult to make such projects viable. The non-availability of improved management and marketing techniques has rendered sustained advance difficult. Thus, wherever sericulture or honey production or any other such occupation makes progress in a village, marketing problems soon become overwhelming and farmers are unable to sustain their interest in the new vocation. There are, of course, outstanding exceptions to this trend and these are usually associated with either well-organised cooperatives or exceptional selfless individuals who command the respect of the rural society and are able to organise the entire production system efficiently. Considering the fact that about 75 million people may have to be employed in the non-agricultural sector during the next two decades, we need to pay urgent attention to the development of self-replicating models of rural growth. All the calculations mentioned by me take it for granted that children need not look for jobs and that they can be spared for schooling. Today, child and woman labour, much of it unpaid, constitutes a dominant component of the rural work force. While steps have been taken to ensure that women and men get equal wages, only economic progress can result in the child being freed for school.

Steps have been taken recently through the establishment of rural banks to channel more credit to rural areas. Similarly, rural agro-industrial complexes are being developed. In addition to the various pilot employment schemes of the

Central Government, different State Governments have initiated programmes to meet the objective of full employment. Thus, Maharashtra is operating an Employment Guarantee Scheme and Gujarat a "Right to Work" project. Other projects include the Labour-cum-Development Banks of Kerala, organisation of a Land Army in Karnataka and Mobilization of Labourers in the Rajasthan Canal Project area. The Small Farmers, Marginal Farmers and Agricultural Labourers Development Agencies aim to generate more opportunities for self-employment through a diversified farming structure. A weakness of some of these programmes is the lack of detailed scientific attention to resource use. Little benefit has generally been derived from the data available from different surveys including the recent rural engineering surveys. Scientists, technologists, educationists and rural communities have not been involved in an organised manner in such exercises. In the Maharashtra Employment Guarantee Scheme, a nutritional dimension has been incorporated and this process of integrated scientific approaches to human resource use needs to be fostered.

Education for Rural Development

The ultimate success in achieving balanced rural-urban growth will depend much upon the nature of our educational system and its integration with other developmental inputs. Different countries have approached this problem in different ways and case studies from 17 countries compiled recently for the World Bank by Manzoor Ahmed and P.H. Coombs indicate that the greatest success by any criteria has been achieved where there is a clear and overpowering national ideology and strong leadership committed to this ideology. Also, success has been assured where education, formal or non-formal, has been developed as an ingredient in a package where economic initiatives are central. Two other points emerge :

(a) Women as a group have been almost universally neglected, and so too the landless, since most of the agriculture-based education programmes benefit only those with ability to farm land.

(b) The danger of internal stratification developing between formal and non-formal education is very great. This could further strengthen undesirable urban-rural, elite-masses and educated-illiterate distinctions.

Our country has been a leader in many areas of educational thought and endeavour. What are our assets? We have (a) a huge and by and large well-organised infrastructure of formal education which can be reoriented to new needs and objectives; (b) a large reserve of educated manpower, especially at the high levels, though insufficient at the middle levels; and (c) well-developed mass media which can be geared to educational purposes. Our major liability is that the imperial legacy has tended to withstand too well the encroachments of innovation.

When we became independent in 1947, it was generally assumed that quantitative expansion of the formal system of education at all levels, with suitable diversification, and qualitative improvement would be sufficient to take care of the needs of both economic development and social transformation. A radical change of consciousness is today evident for it is now recognised that the vast mass of human beings outside the formal system of education constitutes and will continue to constitute the majority of our citizens for a considerable time to come. As a result, non-formal education is now seen as the major task for the future. The new role for formal education in this larger context will be to underpin, support and contribute to the development of non-formal education in a variety of ways. The blend of both approaches will depend upon local needs.

Our attempts to equalise educational opportunities for children of all strata of society have also not been fully successful. While incentives like mid-day meals have been of some help, the main tool for equalisation has been the scholarship schemes. A drawback of these schemes is that the child who has dropped out is not considered, while selection by tests tends to leave out the very persons whom it should help. Unfortunately, culture-free tests to evaluate natural abilities by unconventional approaches in villages and urban slums are yet to be devised. We could enrich science with unusual talent and skills with effective talent-scouting.

Vocationalisation as a Response to Unemployment

The assumption behind vocational education has been that it will equip a person with certain technical knowledge and skills to enable him to make a livelihood through a vocation. The absence of a close linkage between the available avenues of employment on the one hand and the training on the other has invalidated this approach. For example, though agriculture, forestry and fisheries account for the employment of over 80% of the labour force, the fewest number of vocational courses are available in these areas. There is a shortage of teachers who can effectively teach these subjects even if courses were offered, and there has been no serious effort to train teachers on a large scale in these skills. Agro-industries too have been neglected.

Another lacuna is training for self-employment. Very few courses are offered in the skills needed for self-employment on a small or medium scale at the middle levels of education. Only recently, the Indian Council of Agricultural Research has started establishing *Krishi Vigyan Kendras* which will cater to the needs of practising farmers and fishermen. Nearly all non-formal educational programmes for women undertaken by welfare agencies in the last twenty-five years have concentrated on teaching skills like sewing, embroidery and tailoring. Women tailors however are notoriously few. More recently, non-formal education programmes for women have emphasised home-based skills related to health, nutrition, child care and kitchen gardening. Schemes for training women in skills related to agriculture, forestry and fisheries are still few, despite the fact that 50% of the agricultural labour force are women, and 80% of all women in employment are engaged in the production and post-harvest aspects of agriculture.

Expansion of Higher and Professional Education

The pattern of higher education and professional training in the past has evolved from colonial models on the assumption that quantitative expansion and high 'quality' ('quality' being measured according to hypothetical 'world' standards rather than in relation to national needs or objectives) would automatically take care of our scientific manpower needs. It is now recognized that the 'brain drain' is in part an outcome of a mismatch between the type of specialised education offered and the types of employment available. In retrospect, it appears as though unconsciously we have trained our scientific manpower to meet the requirements of Western industry, science, technology and society. That 'content' is an important ingredient in 'quality' is now being realized. The recent committee on the restructuring of medical education has made a breakthrough in the subject by beginning from the needs and goals of the country for medical care and analysing the ingredients of a medical education suited to meet them. Similar exercises are needed in other areas. Agricultural education has generally tended to remain close to the field. Such nearness to field problems has a pay-off in research, as is evident from the fact that we are the first nation to cultivate hybrid cotton on a commercial scale, using labour-intensive technologies. Agricultural Universities which have not yet done so should develop experimental and demonstration farms which will inspire farmers and serve as windows into our agricultural future.

Social Responsibility of Science

Though lip service is often paid to the ideals of social commitment, our system of selection, training and evaluation of scientific personnel at all levels, or of the teaching profession does not provide for it. For instance, selection and later promotion are mainly based on academic records and attainments and publication of papers. Job requirements rarely include such elements as participation in developmental activities. These could take a variety of forms, ranging from the writing of textbooks and preparation of kits, toys, games and educational materials to participation in mass media programmes, demonstration and extension campaigns for the popularisation of science, and work in teacher training and lower-level education and training programmes. Such elements could be built into the system if the relevant activities with 'social' value that a scientist could legitimately engage in were spelt out.

Some Significant Innovations in Education

Lest the foregoing should give the impression that we are not trying to change, I would like to cite a few significant recent innovative approaches.

(i) The recent introduction of compulsory work experience in schools, which has its roots in earlier aspirations expressed in Basic education, has a great potential for making education more meaningful and relevant to life. For its proper handling, however, the active assistance of all scientific agencies in the country will be essential.

(ii) The introduction of 10+2+3 pattern has as its major objective the task of making secondary education terminal and reducing the rate of expansion of higher education. Earlier attempts in this direction have not met with success chiefly because of a lack of a positive correlation between educational content and employment possibilities. Detailed planning will have to be done on this, if this scheme is also not to fail for the same reason. Until this gap is bridged, there may be some merit in linking education and employment in the same Ministry of Government.

(iii) The Farmers' Functional Literacy Project and similar schemes in adult education and their success in the last decade have indicated the tremendous potential for need-based and functional adult education.

(iv) The National Social Service for youth and the experimental mass programmes for youth, such as Youth Against Famine and Youth Against Dirt and Disease, are others with potential for increasing the contact of students with the realities of our rural life.

Some smaller programmes which are still in an experimental or pilot stage but which need to be watched carefully for their possible use as prototypes for change are:

(i) The establishment of Nehru Yuvak Kendras in 100 districts to channelise the energies of rural youth.

(ii) The Bhumiadhar experiment in non-formal education carried out by the National Council of Educational Research and Training.

(iii) The Science Education Centre of the Bombay Municipal Corporation launched and supported by the Tata Institute of Fundamental Research and the Community Science Centre, Ahmedabad.

(iv) The programme for improvement of primary science education, primary curriculum development and community participation in education being developed in certain areas with UNICEF/UNESCO support.

(v) The establishment of Krishi Vigyan Kendras by the ICAR for imparting the latest technical skills to practising farmers, fishermen, rural youth and women.

In the non-official or voluntary sector, some significant experiments have been made. They have many lessons to teach in regard to planning, supervision, methods and objectives, and a careful evaluation of such programmes would be rewarding. Often, such programmes tend to be linked inevitably with certain dedicated individuals and their fate also becomes linked with the fate of those individuals. We should hence evolve an organised way of institutionalising such innovative procedures.

Criteria for a Suitable Infrastructure to Relate Science and Education to Rural Development

Taking the existing institutional and educational patterns as given, I shall try to indicate the directions in which they need to move to become a force for the regeneration of our rural economy and life. A satisfactory system should—

(a) Enable the formal education system and all scientific laboratories to become instruments which can further the non-formal education of the masses. Ways can be found, but the first essential is that institutions accept the servicing of the non-formal sectors as one of their basic objectives.

(b) Encouraging group effort and group development in contrast to the attempt to lift individual from one level to another. Acharya Vinoba Bhave's concept of simultaneously fostering a spirit of cooperation and competition among students by making a "group of students compete with their own past" has to be translated into curricular and extra-curricular procedures.

(c) Relate vocational education and training to the job requirements of the present and the future through intensive local studies.

(d) Spell out the goals of professional education at all levels—from paraprofessional through middle level to high level specialists—in terms of the objectives and needs of our country.

(e) Spell out the social responsibilities of scientists (in both research and education) and of academics in all disciplines in concrete terms of job requirements. People should be enabled to understand and fulfil their responsibilities to development through professional contributions and not merely by being associated in their leisure time with political, social welfare or educational organisations.

With these as guiding principles, let me now indicate briefly the necessary mechanisms to get the system moving.

(i) Every institution of higher education (including university departments, colleges, research and training institutions, junior colleges and schools) should incorporate some form of development activity into their regular teaching-learning programme. This could take the form of placements of students in projects as part of their field practical work, or as apprentices;

involvement of the staff or the institution itself in "action or operational research" and other possible studies. Such participation should be a condition for the receipt of financial assistance from Government. I would like to stress that this involvement be not thought of merely in terms of "adopting a village", holiday work camps and other sporadic activities, or different forms of "Sunday social work" but be a part and parcel of the regular programme of work and be regularly budgeted for. As an example of what can be done, the ICAR had submitted to Vice-Chancellors of our Universities a programme for student and faculty involvement in rodent and pest management, control of noxious weeds like "carrot-grass", and tree planting. The response has so far not been encouraging, except from a few Agricultural Universities.

(ii) Projects taken up will have to be extremely localised in character so that in each case it would be possible to have some kind of coordination between the various agencies concerned.

(iii) Grant-giving agencies and Government departments funding scholarship schemes should introduce more group awards as recognition of contributions of inter-disciplinary groups to society in any walk of life, and group scholarships to enable institutions to strengthen themselves and provide better education and services to a whole community.

(iv) Academies and research organisations should start honouring those who have done good work under difficult circumstances, for example, in tribal and neglected areas.

(v) Curriculum planning at +2 level should incorporate a period of field work placement as an integral part of the course for both academic and non-academic streams. Several ways are possible, including :

(a) Employment for specific period in an appropriate development project in the area.

(b) Survey or field study.

(c) Apprenticeship in a working agency.

These may sound fairly small steps to be taken now. However, the task is enormous and requires intensive work in localised studies, planning, working out of details, field surveys, coordination of a number of agencies, and learning new ways of working together. The involvement of students in the planning exercise is vital, as unless they are convinced of the utility of such an approach for their future, the attempts are unlikely to prove successful. Few of the steps that I am advocating, for instance, are new. They have been advocated many times before, separately and by many persons, including myself. Yet, movements in this direction seem pitifully small in comparison to the magnitude of the effort needed.

Spreading the Innovative Procedures

All over our country, there are hundreds of little programmes pursuing innovative approaches. We are not short of ideas or the men to carry them out. But to transform these myriad efforts into part of an organized plan and to involve the entire academic community in this effort is the task I see before us now. It is a task of an order of magnitude which is probably unprecedented in the history of our education or scientific endeavour. Time is short. We may have forestalled the prophets of doom who predicted a future of starvation for our country, but shall we be content to drag the spectacle of our misery into the next generation ? How much longer shall we drift, making valiant uncoordinated individual efforts here and there to hold back disaster but seemingly unable to gear up the total organism to the challenge ? This is the question to which the scientific community gathered here must address itself.

We need to fully exploit our human ability to create rational patterns of collective activity. Such patterns will continue to be coloured by personalities, but the basic structure should lend itself to replication, like the DNA molecule. It is easy to state this principle but the pathways of achieving it are by no means within easy reach, since they encompass our entire working culture. Nevertheless, we should begin by applying ourselves to the question of the basic common requirements that would enable us to move in the right direction and evolving the appropriate legislation that would serve as a framework for action. Legislative measures for integrated rural and urban development designed to promote the symbiotic growth of the village and the city can take into consideration the following needs :

(i) the setting up of scientific and administrative consortia for each block and town which can help to develop and implement ecologically sound rural works and urban growth programmes (in the scientific consortium, all scientific and technical institutions in the area as well as colleges and schools should be involved, and in the administrative consortium appropriate representatives of all rural community, mass media, industry and input supply agencies will have to be members) ;

(ii) minimum limits for land productivity and operational holdings for irrigated and unirrigated land in each area to provide the social stimulus for cooperative endeavour and proper use of land ;

(iii) reservation of specific industries, credit and energy for the rural sector ;

(iv) an employment guarantee scheme as an integral part of an overall resource utilisation strategy ;

(v) reservation of unproductive land for non-agricultural uses like brick-making, construction of buildings, etc. and avoiding the use of good soil for such purposes ;

(vi) a rural drinking water and fuel supply policy ;

(vii) a scientific plant-animal-man food-chain policy for each agro-ecological area based on long-term considerations of the fertilizer, feed, water and land requirements of each production system ;

(viii) soil and water conservation and tree plantation ; and

(ix) an integrated formal and non-formal educational system involving participation by students and teachers in appropriate rural/urban development programmes.

A beginning towards providing ecological guidelines for development has been made through the Water (Prevention and Control of Pollution) Act of 1974. Comprehensive legislation for integrated rural-urban development will be a continuation of this process. However, we should also guard against the tendency to feel that once a law has been enacted all that is necessary has been done. Good administration and implementation of policies alone can make the legislation worthwhile.

4

General Recommendations

I. INTRODUCTION

These recommendations are intended to be acted upon by individuals, institutions, organisations and governments. They have been grouped so as to address directly those responsible for action.

A. *Organisations* : University Grants Commission, Indian Council of Agricultural Research, Council of Scientific and Industrial Research, Indian Council of Medical Research, National Council of Educational Research and Training, Department of Space, Department of Atomic Energy, Department of Science and Technology etc.

B. *Individual scientists, Research Institutions, Universities*

C. *Government of India and State Governments*

D. *All Agencies*

E. *Indian Science Congress Association*

II. NATIONAL AGENDA FOR RURAL DEVELOPMENT

Since all action must take place within a national policy framework on development, it is suggested that a National Agenda for Rural Development should be drawn up.

Resource and talent utilisation at present is heavily oriented in favour of urban areas. Industrial estates and commercial investments have been mostly in the urban sector. Communications and transport have received relatively little attention in many rural areas. About 98 per cent of educational resources go to the formal sector which benefits more the urban elite and middle classes. Mass media also tend to become "class media". Out of about 18 million radio sets in the country, only about 20,000 are in schools and that too mostly in urban schools. There are about 100 million rural illiterates and yet only about one minute per hour goes to educational programmes for rural areas. The cost of sources of energy used in villages has also risen to a much higher extent than the predominant sources of energy used in cities. Thus, taking the unit cost in 1961 as 100, the costs of electricity and charcoal/wood in 1975 were respectively 224 and 348. Hence, little option has been left for the rural poor except to migrate to cities. This process can be continued only at a grave risk to economic and political stability. The time has hence come when a National Agenda for Rural Development should be drawn up and enforced. Since rural development cannot be viewed in isolation from the growth of the country as a whole, the Agenda for action should spell out a strategy for the harmonious and mutually beneficial growth of both rural and urban areas.

III. RECOMMENDATIONS

A. To Organisations and State Governments

1. *Creating jobs in the non-agricultural rural sector*

As at least 30 per cent of the rural labour force may have to be employed in the non-agricultural sector to ensure productive employment and improved purchasing power, the following steps should be taken to generate opportunities for employment :

(i) More intensive R & D efforts towards developing economically viable rural industries are needed. Some suggestions concerning possible areas of investigation have been given by the various sections and committees.

(ii) All universities, deemed universities and Institutes of Technology and Management in every State should set up immediately a consortium to plan and organise in suitable villages *Research, Development and Extension Centres for Appropriate Technology.* The major aim of these centres should be to develop with the help of the rural, population, technologies for harnessing wind, sun, water, minerals, bio-gas and other energy sources, and for improving houses, transport, roads, public health, and drinking water supply systems suited to the area. The CSIR, ICAR, ICMR, Department of Electronics, the Department of Science and Technology and other agencies should render help, where needed. Private and public sector industries and voluntary organisations could provide financial and other inputs. The Congress suggests that each State Government may name appropriate Chairman and Convenors for organising such consortia as soon as possible, since it feels that without such R D, and E Centres for appropriate technology in rural areas, it will be difficult to generate and spread technologies suited to the local conditions and potential. At the Central level, the Department of Science and Technology could serve as the focal point.

(iii) The Council of Scientific and Industrial Research may set up *Udyog Vigyan Kendras*, on lines similar to the *Krishi Vigyan Kendras* being set up by ICAR. Where appropriate, the Krishi and Udyog Vigyan Kendras may be located together so that an integrated approach to training as related to resource utilisation and to promoting self-employment can be introduced. These Kendras should be based on the principle of techniracy or learning by doing. CSIR and ICAR may jointly implement this recommendation.

(iv) Efforts should be made by scientific organisations to interest entrepreneurs, rural banks and other credit agencies in economically viable projects in rural areas.

2. *Micro-level analysis of data on resources*

Nearly all data now available on climate, resources. nutrition, health, etc. tend to be at the macro-level. Hereafter, the approach will have to be more intensive micro-level identification and analysis of problems. For this purpose, appropriate statistical and computer analysis designs and facilities will have to be created. The National Committee on Science and Technology (NCST) and the University Grants Commission (UGC) could stimulate such work.

The All-India Soil and Land Use Survey Organization of Indian Council of Agricultural Research, the National Remote Sensing Agency, the National Water Resources Council, the various surveys of the Department of Science and Technology, the Space Application Research Centre of the Department of Space and other concerned agencies should be brought together to evolve a co-ordinated strategy for resource surveys at the micro-level. NCST could co-ordinate this work.

3. *Ecological considerations*

(i) The consequences of every technological innovation should be critically analysed by an action-reaction analysis, before the innovation is introduced on a large scale. Each laboratory/university should be encouraged to set up special inter-disciplinary groups, including social scientists, to examine both the constraints and consequences of new technology.

(ii) Immediate attention should be given to extend

(a) survey and monitoring of pesticide residues in foods and crops, and in representative groups of blood samples of children and adults, (b) studies of pesticidal stability under tropical/ subtropical conditions (photo-chemical, biodegradation, etc.), and (c) overall risk-cost-benefit evaluations and development of alternative methods of pest and disease control. The ICAR, CSIR, and ICMR may take up these problems jointly.

(iii) Training programmes at the national and regional levels on the safe use of pesticides and monitoring agencies at the district level should be established. The monitoring agencies could be multi-purpose and could also check on water and air pollution. State Governments could initiate appropriate action.

4. *Education*

(a) Procedures for involving students at the +2 stage in the 10+2+3 system in development work should be worked out jointly by NCERT and UGC in association with State Governments.

(b) The UGC/ICAR/CSIR/ICMR/NCERT/Department of Space should sponsor (and conduct as examples as a few) orientation courses for heads of faculties/colleges/ institutions on the following topics :

(i) Identification of scientific results which are immediately applicable and preparation of plans for their application in rural/urban development.

(ii) Project planning and preparations for rural/urban developmental programmes with special emphasis on manpower use and breakdown of jobs to suit availability of students.

(iii) Working out means by which multi-disciplinary teams including social scientists could develop such projects, monitor and evaluate student contributions.

(c) A fixed proportion of the scholarships under purely merit schemes such as the National Science Talent Search Scheme should be reserved for those from socially and economically disadvantaged sections and appropriate testing procedures developed for this purpose. The Union Ministry of Education may take appropriate action to introduce this principle from 1976.

5. *Personnel policies, awards, and incentives*

(a) Personnel policies should enable scientists (a) to get higher salaries without having to shift from their respective fields of specialisation; (b) to work in rural/ tribal/hill areas without foregoing good educational opportunities for their children and other benefits, and

(c) to work in different organisations without losing the benefit of past services.

(b) National agencies giving awards and incentives to scientists should institute :

(1) Awards for institutions doing meritorious work in harnessing science for the benefit of rural development under difficult/remote conditions.

(2) Awards for institutions doing meritorious work in providing education under difficult/remote conditions.

(3) Award for inter-disciplinary or inter-institutional projects involving the use of science/technology/education/research for rural development.

B. To individual Scientists, Research Institutions and Universities

The discussions at the Congress revealed that so far the involvement of the scientific, academic and student communities in tackling problems of rural development has been only marginal, barring sectors like agriculture, medicine and veterinary sciences. The Congress therefore proposes that the staff and students of our universities and scientific institutions should develop action plans for their involvement in the following programmes.

1. *Research and extension*

(a) Undertaking relevant research (for this purpose, every section of the Congress has identified several priority problems which will be circulated by the Indian Science Congress Association).

(b) Participating in well-planned extension programmes and developing integrated communication strategies in co-operation with the All India Radio, local newspapers and extension services.

(c) Undertaking research and extension work on all aspects of human productivity, since the poverty trap in which a considerable proportion of our rural population is now caught, can be broken only through improved human productivity; for this purpose, local studies on the major constraints to enhancing productivity (such as resource endowments, technical inputs, health, education and socio-economic conditions) need to be undertaken.

(d) Undertaking resource surveys and intensifying research on all aspects of resource conservation and utilisation.

UGC may take suitable initiative in this matter.

2. *Ecological reconstruction*

The Congress is of the opinion that the staff and students of our universities should launch during the south-west monsoon period of 1976 a movement for ecological regeneration, in all parts of the country and more particularly in hilly areas and catchments of major river systems.

The staff and students of every university in the country should plan on planting from 1977 about 1,00,000 trees every year and ensure their survival. For this purpose, every university should develop during 1976 a nursery of appropriate plants. Facilities for establishing a nursery for undertaking a task of this dimension such as a tubewell, pots, etc., should be approved by UGC Visiting Teams.

3. *Education*

(a) As a preparation for the introduction of compulsory national service for 12th year students which will be a pre-condition for granting of degrees, universities and all institutions concerned with the 2-year course should immediately work out detailed plans, in collaboration with governmental and non-governmental agencies concerned with development projects, for the placement of students from various subject disciplines in appropriate projects.

(b) All universities, research institutions, institutions for higher learning, institutions of professional training and departments concerned should prepare programmes of operational research and action research on participation in development programmes, according to subject-discipline, which will enable every faculty member and student to take part, during the course of the year, in some rural/urban developmental activity. These projects should be carefully prepared with proper budgets and assignment of academic credit to students, so as to achieve the twin aims of the programme, namely, learning by doing and acquisition of experience which will foster relevant research.

(c) Immediate attention should be given to the development of 'culture-free' testing procedures which will enable children and youth from socially and economically disadvantaged sections to be evaluated more fairly in relation to those with educational advantages for their innate abilities.

The Union Ministry of Education could initiate the necessary steps to provide assistance to the State Departments of Education in this task.

4. *Communication*

Since almost all those in academic and professional careers will be expected to communicate ideas and knowledge effectively at all levels, universities, teacher-training and other professional training institutions and institutions of research and higher education should develop and introduce: (i) short courses in communication for all workers, and (ii) regular degree/diploma courses in communication for professionals.

All such courses should be conducted by multi-disciplinary teams as well as communication specialists. The Institute of Mass Communication could initiate the necessary follow-up action.

5. *Social responsibilities of scientists*

All universities, professional training institutions, institutions of higher education, research institutions, etc., which employ scientifically trained staff should spell out in detail and include in their evaluation and reporting schedules the social responsibilities of scientists, by defining the nature of tasks which may be undertaken and the lower and upper limits of time that may be spent in such activities in addition to the other responsibilities associated with each job.

NCST may take the initiative in implementing this suggestion.

C. **To Central and State Governments**

The Science Congress welcomes the various steps taken by the Government of India to integrate economic growth with ecological balance and social justice. The Water (Prevention and Control of Pollution) Act of 1974, the strengthening of various resource surveys, the setting up of a machinery for scientific land use, the recent decision to set up a Water Resources Council and the re-organisation of the National Committee on Science and Technology (NCST) under the chairmanship of the Deputy Chairman, Planning Commission, are all significant steps.

The 63rd Session of the Indian Science Congress has generated many ideas and much enthusiasm for promoting harmonious and rapid rural-urban development. In order to ensure that this enthusiasm and fund of knowledge is not dissipated, the Congress requests the Government of India to take appropriate action through a Parliamentary Resolution for developing blueprints for scientific rural-urban development. No national blueprint can obviously be useful and should be attempted. Working blueprints should be prepared only at the block level with the active participation of the representatives of the rural population. However, certain flexible guidelines can be prepared at the national level and in this connection, the Congress endorses the following components of the blueprint for action suggested by the General President in his address :

(i) the setting up of scientific and administrative consortia for each block and town which can help to develop and implement ecologically sound rural works and urban growth programmes (in the scientific consortium, all scientific and technical institutions in the area as well as colleges and schools should be involved, and in the administrative consortium appropriate representatives of all rural community, mass media, industry and input supply agencies will have to be members) ;

(ii) minimum limits for land productivity and operational holdings for irrigated and unirrigated land in each area to provide the social stimulus for co-operative endeavour and proper use of land ;

(iii) reservation of specific industries, credit and energy for the rural sector ;

(iv) an employment guarantee scheme as an integral part of an overall resource utilisation strategy ;

(v) reservation of unproductive land for non-agricultural uses like brick-making, construction of buildings, etc., and ensuring the optimal use of good soil for productive purposes ;

(vi) a rural drinking water, public health and fuel supply policy ;

(vii) a scientific plant-animal-man food-chain policy for each agro-ecological area based on long-term considerations of the fertilizer, feed, water and land requirements of each production system ;

(viii) soil and water conservation and tree plantation ; and

(ix) an integrated formal and non-formal educational system involving participation by students and teachers in appropriate rural/urban development programmes.

On the basis of such a national policy resolution, State

Governments could initiate appropriate legislative and other measures.

D. To all agencies

1. *Operational research projects*

The Congress recommends that integrated operational research projects, involving agriculture, industry, health, nutrition, home science and other relevant areas, may be organised by all the major scientific agencies and universities. Such operational research projects could provide opportunities for work experience for school children and for a continuous updating of the knowledge of primary health visitors, Gram Sevikas, Gram Sevaks and all village functionaries, besides helping to generate integrated development. At least five such projects may be organised in each State and the needed funds may be provided during the mid-term appraisal of the Plan. NCST could initiate the necessary action in consultation with the Planning Commission.

2. *Communication strategy groups*

The Congress considers that mass media including radio, SITE and newspapers have a vital role in rural development. To be effective, the medium and the message must be in step with a close interface. It hence recommends that at the district level, a communication Strategy Group consisting of media and message representatives may be set up. The All India Radio may take the initiative in setting up such Groups.

E. To the Indian Science Congress Association

1. *Scientific support for rural development*

Realising the need for an appropriate body to co-ordinate work in the specialised field of 'applying science for rural development' the Congress resolves that a national co-ordinating body may be set up to stimulate and encourage voluntary efforts in this field. For this purpose, it authorises the present President of the Indian Science Congress Association, Dr M. S. Swaminathan, to take appropriate follow-up steps.

2. *Task force follow-up action*

ISCA should set up soon a Task Force headed by the President of the 63rd Session of the Science Congress to take the necessary follow-up action on these recommendations. This Task Force should report on the evening of the opening day of the 64th Session at Bhubaneswar the action taken and the results achieved.

3. *Focal theme for the 64th Session of the Science Congress*

The Focal theme for the next Session will be "Survey, Conservation and Utilisation of Resources." The General and Sectional Presidents for the 64th Session are requested to draw up an appropriate programme. All Members of ISCA are requested to initiate micro-level studies on resource utilisation and report the results at the next Congress.

5

Recommendations of Sections and Committees

1. MATHEMATICS

1. Mathematicians can help in providing a suitable type of education to children coming from rural areas. This can be achieved by :

(i) setting up mathematical clubs, libraries, discussion groups, etc. in these areas ;

(ii) providing suitable teachers, on at least part-time basis, to rural areas ; and

(iii) encouraging preparation of suitable but cheaper text-books and other teaching aids for the students from rural areas, collecting particularly such examples as may be based upon conditions in villages.

2. Mathematicians, in collaboration with Meteorologists, can help to study the effect of mountains on air flow. With the help of this study one can determine if agriculture can become possible in these areas on mountains where it is not carried out at present.

3. Recognition and encouragement be given to persons engaged in doing research in applying mathematical knowledge to indigenous systems of medicine.

2. STATISTICS

1. There was a general consensus that ecological factors and socio-economic variables vary widely from area to area. It is therefore necessary to plan economic development of rural areas at micro-level.

2. For the development of rural areas the present rate of population growth has to be arrested. In addition to family planning, other measures like population education, nutrition education, maternal and child welfare programmes, non-formal education of adults, etc. should be taken up.

These measures should be evolved on the basis of reliable data. Adequate steps should be taken up for collection of data, their analysis and interpretation not only at the stage of planning alone but also concurrently during the progress of the programme. The Central and State Governments should be responsible for implementing them.

3. Before their implementation, an identification of groups of people and area is necessary. For identification of the groups of people needing different levels of development, extensive information on their various socio-economic, cultural and demographic characteristics is needed.

4. Statistical evaluation of development programmes should be made an integral part of the programme. For effective evaluation data at the micro-level are urgently needed. It is noted that serious gaps exist in the available data and a scheme of continuous collection of data at micro-level should be introduced. Concurrent analysis of the data is very necessary to provide a feedback to the policy-makers for modifying their programmes suitably.

5. Success and failure of crop production in an area largely depend on its weather conditions. It is necessary to make critical studies of weather for evolving suitable cropping pattern. Such studies should be taken up at the micro-levels taking into account the data on rainfall, soil classification, etc.

This should be taken up jointly by Meteorological Department of the Government of India and Agriculture Departments and Agricultural Universities of the State Government.

3. PHYSICS

1. The programme of the SITE experiments must be more

instructional in character, and science-oriented.

2. When basic nuclear power stations are developed, a part of that power should be made available for rural development.

3. Solar water heaters being made at a cost of Rs. 1,000/- in the National Physical Laboratory now must be made available at lower cost to rural areas where electricity is not available.

4. Solar stills which can provide pure drinking water facility to village must be provided in large number of villages at reasonable cost.

5. Bio-gas plants, which can provide fertilizers and food to cattle and poultry as by-products, should be set up in a large number of villages.

6. A serious attempt must be made at producing low grade silicon and mass producing it through thin ribbon technology and thus making available Solar cells at a cost of Rs. 2/- per watt of consumption. The factory in Orissa which is now engaged in production of Polysilicon, may be entrusted with this R and D work. R and D work at other centres may be encourged to make more efficient Solar cells using either Cadmium Sulphide or Gallium Arsenide.

7. Solar pumps may be developed and supplied to rural areas at reasonable cost.

8. A large network of stations collecting observation on duration and intensity of Sunshine may be set up to collect data every hour throughout the year, for making meteorological predictions useful for the farmer more reliable. Moisture adequacy parameter may also be measured simultaneously at those stations.

9. Micrometeorological information must be collected extensively in rural areas. The rural masses must be educated to consult the meteorologists on problems of agriculture, cottage industries, etc.

10. Infra-red scanners in Satellites may be used more extensively to make observations of warm water patches off the coast of Arabian sea and correlated with monsoon intensity, so that recommendations may be made on the problem of using thermo-nuclear device of megaton range in the Arabian Sea to render the otherwise weak monsoon strong. Computerised numerical modelling of possible effects of nuclear explosion in the Arabian Sea on monsoons in India is necessary before practically attempting any experiment.

11. Infra-red colour photography taken by remote sensors in Satellite may be used to make sample surveys of cultivation of different varieties of crops for more reliable procurement.

12. Scientists must analyse the data available in the form of large number of infra-red photographs from Satellite and obtain information which can be useful for rural development.

13. Preparation of annual rainfall maps and those of soil grades of India and superimposing them together will give useful information for agricultural planning. This has been done for Maharashtra now and is being done now for Karnataka. Such surveys may be undertaken for other States as well. It is estimated that 20-30 people will be required for covering the whole country in four years at a cost of about Rs. 20 lakhs.

4. CHEMISTRY

1. A long term programme should be formulated for adoption of Gobar-gas plants in villages.

The fermentation process takes about 30 days in summer. The digestion period increases considerably in winter. However, it is possible to utilise solar energy to increase the rate of fermentatian which will help to reduce the digestion period. Perhaps the efficiency of a Gobar-gas plant can be increased by artificially increasing the growth of particular bacteria in the digester.

2. Gadgets for utilising solar energy in villages should be popularised. It is essential to develop storage facilities and

provide alternate source of energy during rainy season. Storage does not pose difficult problem when solar energy is to be used for supplying hot water. Conversion of solar energy into electricity is very expensive at present. So its economic use in the form of electricity is almost impossible at the present level of technology.

3. Sufficient data about wind power are not available especially with reference to the exact wind speeds prevailing in the different parts of the country. Extensive survey should be carried out immediately to collect the necessary data.

It would be necessary to design the wind mills at a speed as low as 10 km/hr. The main problem in the use of wind mills is that of its economics, the capital investment being formidable as compared to the other source of energy. Therefore, if the wind mills have to succeed in assisting agriculture, especially for water pumping, then attempts must be made to bring down the capital costs to a minimum. The designing for lower wind speed increases the cost of the wind mill.

A possible solution might lie in preparing critical design and making wind mills out of local inexpensive materials which can be replaced easily. One could possibly couple a wind mill with the existing means of drawing water, such as Persian wheels, rope and bucket arrangement, and counterpoise lifts. Whenever the wind fails the same devices could be utilised with the help of bullocks or with manual labour.

A programme may be taken to design wind mills capable of supplying power in the range of 5-15 KWH with regulated voltage and frequency. Large wind mills can be located at selected places and a cluster of such mills can be set up for feeding the electrical grids.

A coordinating organisation should be established to bridge the gap between the institutions, academic and research, and organisations in the village levels for implementing various programmes.

4. A survey of water-quality in village should be undertaken immediately.

5. Increasing use of insecticides in agriculture may cause pollution of drinking water in wells/ponds. A sample survey of pesticide residues in important crops may be carried out. After the survey data are made available and if it is found that pesticide residues persist in agricultural products in significant quantities, then it may be necessary to screen items containing pesticide residues before these are allowed to be marketed. Alternative methods for killing insects and pests may be evolved.

6. It is suggested that Central and State environmental pollution control agencies be formed whose activities may cover prevention and control of water, air and noise pollution.

5. GEOLOGY AND GEOGRAPHY

1. Study should be carried out to demarcate the land and categorise the areas for various uses by scientific geomorphic survey of the land with the help of aerial photographs and field survey. Broad-based features like alluvial areas, levee areas, flood plains areas, upland areas are to be recognised by trained personnel and detailed recommendations should be adopted, if necessary, by legislative support.

For this, action should be taken by Central Government organisations like the Geological Survey of India, Survey of India, I.P.I., I.C.A.R., etc., in collaboration with various educational institutions and State Government agencies. It may be desirable to set up a Land Use Survey Organisation to coordinate and guide these activities.

An important aspect is to demarcate the areas where soil conservation is imperative and necessary steps may immediately be taken up to rectify the situation.

2. The basic and primary need for the development of rural areas, as indeed or urban areas, and for agricultural and industrial growth is water, both from surface and subsurface resources. For small-scale lift water supply for domestic or industrial use surface maps of potential streamlets should be

prepared, drainage surveys carried out and the construction of bunds undertaken. Small reservoirs may prove to be more useful than large dams built at immense cost for the gestation period of the latter often runs into decades and the submerged areas are large. Availability and need of these resources should be assessed with proper budget. Detailed surveys should be undertaken by the Central and State Government agencies, State Irrigation and Agricultural Departments and comprehensive plans prepared.

For the development of groundwater potentialities in rural areas, survey, in the first instance, should be undertaken to delineate the areas where groundwater is abundantly available as against areas where it is not available in large supplies through geological mapping and the Central Groundwater Board may have to be strengthened and given more powers.

Study should also be carried out for controlling saline water intrusions in coastal areas and the prospects of converting the saline water invaded aquifers into potable water aquifers by means of artificial storage; etc. Legislation is immediately needed to prevent groundwater mining, for this can do a lot of harm to future generations. Chemical constituents of water should be studied in detail because excess or deficiency of certain chemical constituents, even micronutrients and trace elements in water may be harmful to certain crops while others may be harmful to the health of both animals and human beings.

3. For industrial development in rural areas detailed surveys on the availability of various mineral raw materials for small scale industries form the most urgent need. Numerous industries that are labour-intensive and yet can be started with small capital investment can benefit the rural lot, as for example, the manufacture of clay insulators and pottery, plaster of Paris, abrasives, lime, cement in vertical shaft mini-plants, puzzolana, plaster of Paris boards, mineral based-paints, decorative building stones, etc. State Directorates of Industries and Geology and Mines should immediately be geared to render all help and provide technical advice and guidance to

these small entrepreneurs. It may be necessary to prevent these industries clustering around urban areas in the so-called "Industrial Estates" and to see that they remain rural-based.

4. An important aspect of rural industrialization is the provision of power. Whatever source is locally available should be preferred over transportation from long distance. The advantages of taking up mini-projects for this purpose is now a practical proposition and should be developed further.

5, For the successful implementation of any scheme on rural development, the involvement of local people is of prime importance. Pilot demonstration and mobile units may, therefore, be needed and training courses may have to be initiated in different areas for the different industries. Thus, whatever scheme is found suitable in diffcrent areas for its development, the people should be made conscious about its benefits.

Last, but not the least important, is the need for help in marketing the products and for procuring orders for the supplies. For this purpose, banks may have to advance funds against goods in godowns so that money does not remain tied up in unsold stock during the lean periods.

6. BOTANY

1. Survey may be undertaken of plants of medicinal and economic value, for example, those yielding oil, protein, camphor, resin, gum and so on, followed by their improvement and intensive cultivation. New sources may be investigated, as for example, mangrove for sannin and sea weeds for agar-agar. Special emphasis may be laid on plants yielding steroidal hormones.

2. Hot-spot locations most conducive for the development of epiphytatics of important pests and diseases of different crop plants should be identified. Germplasm should be screened for resistance at these sites.

3. Conservation of germplasm and natural ecosystems

should be studied and an integrated method developed for its implementation, with special reference to hilly region ecosystems.

4. Emphasis should be laid on biofertilizers, on nitrogen fixation by algae and on possibility of the transfer of nitrogen-fixing property to non-leguminous plants.

5. Commercial cultivation of edible mushrooms is already underway in different parts of the country. Steps should be taken to make it a profitable cottage industry in rural areas. This would ensure utilization of the abundant waste plant material.

A number of thermophilic species of fungi can be usefully employed in bringing about cellulosic decomposition of waste plant material to result in the preparation of compost on a commercial scale.

6. A survey of oil and protein yielding seeds of trees naturally occurring in the rural as well as forest areas should be undertaken. The potential species among these must be selected. A pictoriai guide for the identification and methods of gathering and storing the seeds must be prepared. Processing the seeds on a cooperative and commercial scale be developed to suit the local conditions.

7. Plant and seed gums are extensively used in industry and there is much scope for chemical improvement and intensive agronomical study for upgrading the gum sources.

The National Botanic Gardens, Lucknow, the Forest Research Institute, Dehra Dun and the Botanical Survey of India, in collaboration with the Khadi and Village Industries Commission, may act as Centres to coordinate the work throughout India.

8. The rural populations along the coastal belt of India should be encouraged to take up small-scale cultivation of seaweeds. Pilot scale cultivation, collection and processing of seaweeds for the production of agar-agar, algin, etc. may be initiated at the Central Salt and Marine Research Institute at

Bhavnagar and at the Central Marine Biological Research Institute, Mandapam, and the Oceanographic Research Institute, Panaji.

9. The country abounds in mangroves which are very rich in tannin. The State Governments may be asked to take necessary steps to harness these rich resources by the rural community.

10. Plantations of suitable forest tree species which yield oleo-resins and incense materials and are becoming rare in the wild state may be made by State Governments to boost the rural economy.

11. Combined culture of *Singhara Trapa* and fish is suggested in all the perennial *Trapa* tanks throughout the country.

12. A scientific study of the methods of storage already in vogue in the rural areas be made to improve them so as to suit the local conditions to reduce the loss in storage.

13. Facilities for disease and pest surveillance and disease forecasting need to be enhanced so as to predict the appearance of the causative agents for taking up timely remedial measures.

14. Studies on toxic residues of different agricultural chemicals, the persistence of systemic fungicides, insecticides, their bio-degradation products and their efficiency under varying climatic conditions need to be strengthened.

15. The policy of providing clean and healthy seed to all farmers can be still more rewarding if quarantine measures are strictly enforced.

16. The Universities can play a cardinal role in taking up basic research on crop diseases. Plant pathologists of agricultural research institutes including experimental stations and Universities should be involved.

17. The saline and alkaline soils can be reclaimed by the culture of suitable plant species like *Matricaria chamomilla, Anathum graveelens, Solcnum vairum* (syn. *S, khasianum*) *Resa damasecna*, etc.

18. Hill forest ecosystem should be studied in an integrated manner for balanced exploitation and conservation of natural resources. This is particularly important in order to have mixed plantations of forest cover in localised habitats.

19. An integrated project study of agro-ecosystem should be undertaken in selected areas in the various sectors of the Himalayas in particular and other hilly tracts of the country, especially those located in the predominantly tribal belts of North Eastern India. The prevailing methods of cultivation and the possibilities of improving them without disturbing the traditional practices should be examined.

20. A coordinated effort involving Central as well as State authorities should be made to preserve selected ecosystem types as protected reserves.

21. The problem of grazing by sheep practised by nomadic populations in the high altitude regions and the management of grasslands at high altitudes deserve careful study.

22. A detailed study of the various aquatic ecosystems in hilly areas is recommended, with a view to exploiting these aquatic formations.

23. The adaptation of plants and animals to high altitudes and the stresses to which they are put as well as the morphological and physiological pattern of growth form of such plants and animals are some of the problems which deserve study.

24. The north-eastern hill region, particularly certain locations in Arunachal Pradesh are rich in wild germplasm, particularly of some of the important crop species like rice. Immediate measures should be taken to have protected reserves for conserving the germplasm.

25. Due to overgrazing and lack of proper grassland management policies in the hilly regions, a number of trouble some weeds like *Eupatorium* occupy continuous stretches of useful land. Their biology and population dynamics should be taken up urgently in order to devise biological control.

26. The agencies to examine and implement these recommendations will be the Scientific Surveys of the D.S.T., the 'Man and Biosphere' programme in India, the I C.A.R., the State and Central Forest Agencies. The newly started Universities like the North-Eastern Hill University, Himachal Pradesh University, North-Bengal University, Garhwal University and Kumaon University should pay special attention to the study of the Hill Ecosystem on a priority basis.

27. Medicinal plants should be identified correctly before chemical analysis. The foundation for drug research by making available various populations of a single promising species in pure form can be laid by competent taxonomists.

28. In order to encourage the cultivation of medicinal plants it will be necessary to create multidisciplinary teams of experts including botanists, agronomists and chemists. Such teams may select suitable varieties for specific areas, work out the agronomic and cultural practices and economics of cultivation and demonstrate the profitability to the farmers, providing guidance in marketing problems. Rural and tribal co-operatives may be encouraged to take up medicinal plant cultivation. Initial infrastructure inputs such as drying plants or distillation stills may be provided by the government.

29. The national laboratories and medicinal plant research institutes and centres which already have expertise, can play the role of promoter in their respective areas, together with the State Agriculture Departments. The government may issue instruction to these bodies to orient their programme and reorganise their set up to fit in the new activity of medicinal plant cultivation. Extra financial commitment by the government is not necessary. A part of the finances recently allotted by the Government of India and State Governments for the uplift of tribal and other backward communities may be usefully utilised for this programme. Quality control of the basic crude drugs as supplied to the manufacturers of the ayurvedic, unani and allopathic medicines, has to be firmly ensured.

30. In the field of cultivation of medicinal plants, the potential of tissue culture technique should be profitably used

for the rapid multiplication of superior clones production of haploids, somatic hybrids and virus-free stocks. There is also a great need for intensive effort to produce phyto-chemicals of pharmaceutical interest by suspension culture.

31. The country imports hop (*Humulus lupulus*) worth Rs. 64 lakhs every year for brewery. There is need to develop at least 405 ha under hop cultivation in suitable areas to meet the requirement of the country and stop imports. This would ensure employment and high returns to the farming community.

7. ZOOLOGY, ENTOMOLOGY AND FISHERIES

A. Areas of research in inland and Coastal aquaculture which need to be intensified and supported.

(a) Fin fish and shell fish, other animal wealth, e.g. silk worm etc.

1. Genetics and Cytogenetics chiefly with a view to produce genetically superior, fast growing, nutritionally rich and hardy varieties (emphasis to be given on polyploids).
2. Nutritional studies on desired fauna.
3. Physiology and endocrinology.
4. Parasitology and Pathology; control and treatment of diseases.
5. Behaviour and ecology, specially adaptive behaviour of desirable varieties and inter-relationship of fauna within ecosystems.
6. Pollution; biodegradation of pollutants; disposal and utilisation of sewage and reclamation of water; pesticides related to animal health specially fish and shellfish; uptake of pollutants at different trophic levels in aquatic ecosystems.
7. Life-history studies.

8. Running water fish culture and cage culture.

9. Reservoir fishery development.

10. Resources survey for aquaculture.

11. Breeding and culture of catfish (*Mystus* sp; Wallago, *Arius* etc.) caridean prawns, edible oysters and window-pane oysters, olams, eel, *Sillago*, crabs, lobsters, turtles, sponges, holothurians, chanks, cephalopods, useful insects and birds such as ducks.

12. Aquatic weeds and eutrophication.

(b) Utilisation of inundated coastal and estuarinc areas, mangrove swamps for aquaculture.

(c) Coastal engineering problems including pond construction.

(d) Development of processing, marketing and infra-structure facilities.

(e) Supported by

1. ICAR, CSIR, AEC, INSA, UGC.

2. Finance may be provided to Universities to undertake research by these agencies.

(f) Addressed to above.

A. Changes needed in course content and methodology of education and training programmes required for rural development :

(a) *Structural changes :*

1. Free mobility of scientists between the research institutes and teaching institutes/Universities for exchange of ideas and technology on various fields, is possible by introducing short/long-term inter-institutional visiting

fellowships, joint research projects and invitation schems.

3. Training programme to be framed for rural workers in diverse fields of aquaculture at various research organisations.

3. Establishment of a suitable agency for stage to stage contact/exchange/transfer of experience in the laboratory for trials in fields, perfection of field technology, training of field worker and rural entrepreneur (organisation for review and popularisation of new techniques for development of national resources).

(*b*) *Changes in content of education and new courses/ experiments*

1. To incorporate suitable elementary information on aquatic wealth, ecology, conservation, development and pollution in primary and secondary school levels.

2. To utilise suitable media such as diverse types of audio-visual aids, extension and training programmes for educating rural communities on technologies.

3. Universities should also formulate extension programmes for undertaking extension activities on development of animal wealth for rural areas. Immediate and adequate financial support should be given for such programmes to specialists in the universities by the ICAR, INSA, CSIR, AEC, UGC and other agencies.

(*a*) *Government Legislative actions*

1. Government should accept integrated rural development as a National/State policy and instruct the concerned Department accordingly. Necessary provision in Ministries, Government undertakings and statutes and ICAR/CSIR and universities; permitting free movement and coordination between scientists of universities and research institutes.

(*b*) *Administrative actions*

'State-level Coordinating Body' in each State to be formed in which the specialists of agriculture, aquaculture, entomology and wild life from research institutes and Universities should be represented.

(c) *Structural changes :*

1. Free, speedy and mandatory execution of the projects based on the guidelines suggested by the above mentioned 'State-level Co-ordinating Bodies" obviating the bottlenecks.

2. Grants from ICAR, INSA, CSIR, AEC, UGC, Ministry of Science and Technology, ARC, AFC and Nationalised Banks should be made available for integrated rural development programmes.

8. MEDICAL AND VETERINARY SCIENCES

1. Improvement in the delivery of services.

2. Provide composite training to selected staff who should attain competence to further train lower staff at Block and village level. The details to achieve the above objectives are as follows :—

(a) to advise a curriculum for the training of the personnel to be posted at a minimum of the District level of various States.

(b) The training syllabus should be chalked out by an expert advisory committee constituted by experts from the fields of Nutrition, Home Science and Public Health. The recommendation guidelines of this Advisory Committee should be passed on to State Governments for firm implementation.

(c) Employment of one instructor at the District level involving an additional expenditure of about Rs. 4,000/ per year per person will be the only additional financial burden on the State Government.

2. Research in computarisation of balanced food and ideal cooking techniques applicable for infants, growing children, expectant mothers and adults as a National Health Programme. This should be undertaken by ICAR and Home Science Departments.

3. The Government of India should ensure implementation of the programme through a legislation or adequate administrative control if necessary.

Operational

4. More effective use of available technology to control arthopod vector population and extension of education.

Research

5. By Central and State Institutes under the ICMR, Ministry of Health and the ICAR should intensify research on (a) applied and fundamental research for control of arthopod vectors and (b) development of vaccines.

6. Pooling of resources by medical and veterinary diagnostic laboratories and research institutes for diagnosis and control of related diseases and diseases communicable between man and animals which by now number more than one hundred and fifty would be very beneficial.

9. PHYSIOLOGY

1. For the increase of production, material resources only are being taken into consideration while the human resources, e.g., the cultivators, the industrial workers, etc. are being neglected. It is, therefore, resolved that the knowledge of physiology as a science with special referrence to work capacity, work performance in relation to environmental factors, nutrition etc. must reach the door step of common man and necessary facilities for such education, must be provided at all levels. Further there should be a national survey of human resources from physiological angle from infancy to old age under different climatic conditions for their proper scientific utilisation.

2. The problem could be tackled (i) by introducing the

study of physiology in the educational curriculum in the school level (10+2 system) and (ii) by organising seminars on the physiological problems of the human body in Secondary and Higher Secondary Schools (10+2 system).

The principles of human physiology, of population control, nutritional needs, work physiology, ergonomics, etc. could better be explained to the people in the rural areas by graduate students and teachers of physiology in Secondary and Higher Secondary Schools (10+2 system). Their services should be utilised for the purpose as medical people may not be available in enough numbers; and incentives shall be provided by the Government to these teachers by considering this work as an extension of their legitimate duties.

10. PSYCHOLOGY AND EDUCATIONAL SCIENCES

1. To identify the target groups amongst the poor, regional maps in terms of various indicators, such as—education, land-ownership, land-income, caste, residence, etc. is to be prepared.

2. Profile of each target group should be prepared in terms of behavioural characteristics. Considerable data are already available on some areas of behavioural characteristics. Some of these known areas are (a) Cognitive and related areas, (b) Personality and motivational areas, (c) Attitude, values and general coping mechanisms. In this record the periods of child development from 0-2 and pre-school and primary school are important.

3. To develop strategies of intervention following from research in the areas mentioned above (Items 1 and 2).

4. Percentage of drop-outs in rural children is very high. Apart from socio-cultural factors, there are very strong psychological factors, some of which are identified and others remain to be investigated. These factors are to be identified and strategies to impart education to be adopted.

5. Lack of risk-taking behaviour amongst the small far-

mers and illiteracy amongst the land labourers. These lead to inefficient resource management and resistance to innovation. Training to be given at individual and small groups level. The small farmers must be trained in managerial skills to increase production.

6. Change to be brought about in perception, cognition and motivation at the micro level. In motivating the farmers the incentive must be related to higher production. Existing needs to be chanalized in the direction of the goal; New needs to be created manipulated to achieve the goal.

7. Change and reorientation of attitude of rural leadership with a view to making the programme, people—centred instead of procedural-centred.

8. Greater attention be paid to the psychological factors acting as barrier to change. These factors to be identified by further research and measures developed to breakthrough the barrier.

9. Top priority for research in the following areas are needed. This research should be integrated one and multi-disciplinary.

(a) Functional literacy

(b) Non-formal education

(c) Population education

(d) Pre-school training and intervention programmes for socially disadvantaged children

(e) Educational programmes for changing the attitudes of rural leadership.

11. ENGINEERING AND METALLURGY

1. Technology Development Institutes should be established at village level where work on development of appliances, processes and extension work could be done with

direct participation of the villagers. Such development centres for technological inputs and rural development may be established in selected centres not exceeding 5 in a state. The activities of such development centres may be organised and supervised through a central agency.

2. An inter-disciplinary body or organisation should be set up for giving effect to available technical knowledge on Water supply, sanitation, waste re-cycling, low cost housing, production of bio gas, energy utilisation, development of fisheries, animal husbandry and agriculture as an integral part of the rural development programme.

3. It has been found that some papers are submitted for presentation in more than one section simultaneously. This practice should be discouraged and an effective process of screening be introduced to distribute papers to relevant sections. In case of papers covering more than one discipline, the author or authors should be asked to mention the section of their choice.

12. COMMITTEE ON SCIENCE AND ITS SOCIAL RELATIONS

1. The medium and the message must be developed in step with a close interface.

2. Danger of mass media being/remaining or becoming "class media" on account of urbab-elitist pull (eg., Entertainment-TV a luxury for India but potentially a powerful development aid)

3. All media are supplementary and should not become substitutes. Eg., SITE should not displace radio, print media, traditional media, etc.

4. Small-guage video recorder developed for Rs. 5,000/- is easily operable, relatively inexpensive and can be played back *in situ*. This is a breakthrough in production technology. (Need to compute cost—effectiveness of SITE but relate this to its impact and reach in a short time horizon).

5. Need to use appropriate technology and to use (advance) technology (like SITE) appropriately.

6. Radio—one biggest mass media (especially after transistor revolution)—must be more intensively used in rural areas and schools and as a development aid.

7. In view of linguistic, agro-climatic and sociacultural diversity "centralised" and generalised communication must be matched with "decentralised" add area-specific communication through local radio and other means.

8. The National laboratories and other scientific institutions often exist in a communication desert. Communication webs must be developed through the training of mass communication of quality in requisite numbers.

9. The popular science movement in Kerala is illustrative of a vast potential low-cost communication network.

10. To reach a huge, illiterate mass effectively, the message must be simple and repeated, become familiar and have locel relevance.

11. The media have a role to play in inculcating new value systems that are truely democratic rather than elitist and in building up ideas like gobar—gas plants into more status sympols that will transform such programmes into movements.

13. COMMITTEE ON SCIENCE AND ECONOMIC DEVELOPMENT

1. A detailed inventory of natural resources for each ecological region has to be built up.

2. Planning should be concerned with locally available resources and targets achievable through their optimum utilisation and should not be an exercise in financial inflows and outlays.

3. Suitable tools of science and technology should be used to identify, locate and assess natural resources as well as

to improve efficiency of utilisation of resources and labour supply available within each ecological system.

4. Local skills, skilled workers and empirical knowledge acquired should be made use in the execution of the development plans.

14. APPLICATION OF SCIENCE AND TECHNOLOGY FOR RURAL DEVELOPMENT

(1) Co-ordination should be achieved among available systems of medicines namely, the Ayurvedic, Yunani, Homeopathy and Modern Medicine.

(i) Energy systems (Renewable and organic waste)

(ii) Transport system (Goods transport in rural sectors)

(iv) Irrigation system (Conservation of water)

(v) Drinking water (watcr storage)

(vi) Grain storage (for landless or marginal farmer)

(vii) Textile technology

(viii) Low-cost housing

(ix) Post-harvest technology

(x) Education and information assimilation.

(xi) Integrated concept of total health (preventive, curative and promotive) in teaching and health care delivery.

(2) Involvement of researchers from various institutions, Universities and national laboratories (including Engineering and Medical Colleges) should be facilitated for

(i) Taking research finding to undertake developmental projects in villages.

(ii) Studying the problems (along with their dimensions and reservations of resources, etc.) that exist in the rural areas and which have to be taken to laboratories for research.

(3) All those researchers (from the category of research assistants, post-graduate and doctoral students, research fellows, research officers, research associates, scientists and faculty members) who wish to go and work (on their own commitment) in rural areas, should be given permission to do so in collaboration with

(i) Government agencies, viz., PHC's extension centres, Krishi Vigyan Kendras, Block Development Centres and Panchyats, etc.

(ii) One or more voluntary agencies working in that area for periods ranging from one month to one year (or more-under extraordinary conditions after showing a definite progress or initiation of a process; this permission has to be granted by the parent organisation).

(iii) The person (s) opting for this work shall be treated on duty and be on full pay. They shall be allowed to visit back their respective laboratories as and when desired and necessary to continue their work in the laboratories. Some reasonable contingency grant should be made available to these researchers, to meet petty expenses.

(iv) Their progress shall be assessed on the basis of work done in the projects and not on the basis of number of publications. Accordingly, the promotion policies shall be also changed.

(v) In case certain projects are to be taken up to start new processes or industries—with involvement of economically weaker sections, Banks or other credit agencies should be asked to provide finances in terms of interest-free loans or very marginal interests. Such schemes should also be encouraged by their parent organisations/laboratories, etc.

15. EVENING LECTURES AND PANEL DISCUSSIONS RECOMMENDATIONS

Education

1. As a preparation for the introduction of compulsory national service for 12th year students which will be a precondition for granting of degrese, universities and all institu-

tions concerned with the 2-year course should immediately work out detailed plans, in collaboration with Governmental and non-governmental agencies concerned with development projects, for the placement of students from various subject disciplines in appropriate projects.

2. All Universities, research institutions, institutions of higher learning, institutions of professional training and departments concerned should prepare programme of operational research and action research on participation in development programmes, secondly to subject-disciplines, which will enable every *faculty member* and student to take part, during the course of the year, in some rural/urban development activity. These projects should be carefully prepared with proper budgeting and assignment of academic credit to students, so as to achieve the twin major aims of the programme, namely, learning by doing and acquisition of experience which will foster relevant research.

3. All Universities, professional training institutions, institutions of higher education, research institutions, etc., which employ scientifically trained staff should spell out in detail and include in their evaluation and reporting schedules the social responsibilities of scientists by defining the nature of tasks which may be undertaken and the lower and upper limits of time that may be spent in such activities in addition to the other responsibilities associated with each job.

4. Immediate attention should be given to the development of culture-free testing procedures which will enable children and youth from socially and economically disadvantaged sections to be evaluated more fairly in relation to those with educational advantages for their innate abilities.

5. A fixed proportion of the scholarships under purely merit schemes such as the N.S.T.S. should be reserved for those from socially and economically disadvantaged sections and appropriate testing procedures developed.

Rural Fuel Supply Policy

1. Immediate attention should be given to developing

low-cost and practical means of storing, piping and distributing bio-gas with a view to developing community bio-gas systems that will enable users to collect gas in exchange for animal dung and other organic refuse.

2. Energy plantations should be established in all vacant community lands and marginal lands. Every Gram Panchayat or Sabha should establish a nursery of suitable shrubs and trees with the help of the village school. Credit should be made available for sinking well/tube-well for watering the nursery.

Economic Growth without Ecological Harm

1. Immediate attention should be given to extended survey and monitoring of pesticide residues in foods and crops, and representative groups of blood samples, studies of pesticides, stability under tropical/subtropical conditions (photochemical, biodegration, etc.) to guide overall risk-cost-benefit evaluations and development of alternative methods.

2. Training programmes at the national and regional levels on the safe use of pesticides and monitoring agencies at the district level should be established.

Awards and Incentives

INSA and other grant/award/scholarship giving agencies should institute immediately :

(a) an award for the institution doing meritorious work in harnessing science for the benefit of rural/urban development under difficult/remote conditions.

(b) an award for the institution doing meritorious work in providing education under difficult/remote conditions.

(c) an award for an inter-disciplinary or inter-institutional project involving the use of science/technology/education/research, for development.

New Courses

Universities, teacher-training and other professional training institutions and institutions of research and higher education should develop and introduce courses in (a) short courses in communication for all workers and (b) regular degree/diploma courses in communication for professionals.

All such courses should be conducted by multi-disciplinary teams as well as communication specialists.

Consortia for Micro Planning

In order to develop mechanisms for micro-level analysis, studies, planning for development and evalvation of developmental programmes, the universities should take the lead in setting up immediately multi-disciplinary consortia for their own district/town involving all the major governmental and non-governmental agencies concerned with survey, research and development as well as representatives of local governments and educational agencies.

6

Valedictory Address

by

P. N. Haksar, Deputy Chairman, Planning Commission

I have been wondering what I should say which might even remotely be of some relevance to the focal theme around which many of the deliberations of this year's Congress have directed themselves. Obviously, all of you present here including our friends from abroad are in one way or the other interested in the complex problem of change; of social, economic, political and cultural transformation of nearly 580 million people of our country.

The social transformation of a society as old as India; of a civilisation as old as ours : a civilisation which shares with our neighbour China a feeling of continuity with the past is a complex thing. Is there any tentative hypothesis one could formulate in respect of the broad parameters of this change ? Is there any pattern in the change which is taking place actually, concretely and specifically in this country ? Our ancient and old civilisation is in the process of three-fold transformation. I suggest this as a hypothesis so that you may test it, verify it or reject it in accordance with the normal scientific methodology and in the light of facts as you may find them.

What are these three processes of fundamental transformation of India ? Analogies and arguments by analogies are dangerous. But in deference to our foreign guests who might have come from the western world, I could perhaps explain the mysterious unknown phenomenon of Indian transformation in terms of their own historical experience. But, as I said, analogies must not be pushed too far.

The first process and a very basic one which began nearly in the latter half of the 18th and continued with increasing momentum in the 19th century and 20th century in India ; The extraordinary and painful process of constituting what has for centuries been a religio-cultural entity called India, into, what in European experience might be called, a nation State. A nation State is not part of any cosmology. A nation State is not part of any genesis; a nation State is not an act of creation even if one were inclined to believe in cosmologies and genesis as sanctioned by religion. Nation States in history are recent phenomenon. Britain, France, Germany, Italy, Bulgaria, Rumania, Hungary, Czechoslovakia, Egypt, Turkey are very recent phenomenon in history. The process, basically and fundamentally, gathered momentum after 1857. The first upsurge which moved millions of people in our country under the leadership of Gandhi, Nehru and thousands of other Great Sons and Daughters of India shook India and this impetus consummated finally in the formal constitution of the democratic, secular State of India. There is a tendency to take for granted the durability of this nation State. We cite our constitution as the final evidence that the process of national integration has been finally consummated and one can rest securely on durable foundations of a sovereign democratic secular nation State of India.

Why secular ? I wonder if we ask this ourselves. Is it a mere slogan or an essential ingredient to the cementing together of the wide diversities of our country and of our culture of which we are justly proud. Secularism, according to my way of looking is the final triumph of a process quite distinct in thought and in social structure from a theological process of thought and social structure. In India, with its wide, religious, cultural and ethnic diversities, secularism alone provides this necessary cementing factor to contain and to hold together the diversities which are the glory of India. Unlike China where civilisational process tended to subsume diversities within the broad pattern of a dominant Han civilisation and a Han culture, in India the genius lay elsewhere; it lay in encouraging, fostering, allowing diversities to grow into broad structural unity at the macro level to contain these diversities.

So, Mr. President this is a process of transforming India into in what in Europe is called a nation State, a process akin to the one in which the Venetians, the Lombardians, the Romans, the Florentines, the Tuscans were transformed into what is known as the modern Italian State or what was brought about by the union of England, Wales and Scotland in the latter half of the 18th century. May I submit that a nation State is not an immutable part of nature; its integrity and survival are heavily dependent upon conscious process of social engineering, of political engineering and of cultural engineering of our country. The vitality, the structural stability of this system called the sovereign secular State of India is very much dependent on basic structure of society, of economies and of politics on which it rests.

The second transformation is even more painful, even more difficult, but even more fundamental, because without it you cannot sustain the first. The second transformation is the socio-economic transformation of this society, of which caste is a significant element. The transformation of this ancient society, rooted in past, with its own value system, its own mythology and tradition deeply rooted in the soil of India, the transformation of this society into something "modern" can only be sustained by an unimpaired vision of the new society defined in some precise terms. We had a vision, which is laid down in the directive principles of our Constitution. A Sovereign Democratic Republic of India dedicated to the eradication of poverty from our midst; dedicated to an egalitarian society where men, women have equal rights; a society free from the inequitous social structure; a society dedicated to the uplift of the poor, the destitutes and the dispossessed; society free and liberal. How to reach this vision concretely in time and in space, taking into account Indian reality, has been a problem about which all of us have to think. Our scientists, our economists, our sociologists, our political thinkers, our politicians and our leaders have to ponder over.

We experimented with models of growth and change and found them inadequate. We have had nearly 27 years of experience, in working on borrowed models. Indeed when I hear the phrase "Integrated Rural Development", I often wonder whether we have carefully defined it or are being merely carried away by our periodic enthusiasms for some imported idea. It may be a fascinating slogan like the erstwhile community development. We used to feel that community development programme was a discovery of Archimedean proportions; we now realise that there were structural defects in the concepts which went into the definition of community developmedt. We had to seriously modify it and almost jettison it. We have had the I.A.D.P. which stood us in good stead, but almost all of us who have worked realise its limitation in solving some of the fundamental problems in our agriculture to which you, Sir, in your Presidential address have made a perceptive reference.

We have had schemes about growth centres. We have had other schemes more dramatic like crash programmes for employment generation or crash programmes for production of wheat in one year for which 150 crores were spent. In the light of all this experience, it is necessary to be very clear eyed as to what we mean by this very emotive word called "Integrated Rural Development". We had experimented a great deal with models and have come to realise that it is really contrary to any scientific methodology to seek to graft a model which is powerfully conditioned by specific parameters—historical, cultural, industrial economic and so on to entirely different socio-economic issues. I have often heared especially in Europe, ardent men arguing and advocating the Chinese way and have often wondered whether those who had been exhorting me about the Chinese way were actively engaged in subverting their society into the Chinese pattern. Of course, not. Academic advocacy of the Chinese way without accepting the compulsions of the total system of social transformation which produced China of to-day naturally remains academic. So, Indian scientists, engineers, sociologists, economists etc. have no easy option of importing a

Japanese or a Chinese model or an American model or the British model. Therefore, the problem of application of science and technology too is not easy.

I have heard in the course of this Science Congress that we possess one of the largest aggregate of scientific talent in our country as compared to the rest of the world. However, one has to consider how is it that this community—so large, so numerous in our country, fails to make an impact on the general evolution of society and of our country. Why is it so insignificant in having its voice heard in respect of problems of social, political, economic and even of scientific transformation. I have often said that the scientific community of India itself, lacks a focus. It has no focus; it has no platform; it has no organisation; it is something of a linear character; it is 1+1+1+1...upto infinity and can, therefore, never take to quantum jumps in making its impact.

You can pass hundred Resolutions ; you can have hundred Congresses, but you will cease to make any impact, because you lack the focal point yourself. We do not hear in India a united voice of scientists even in matters of science and quality of scientific organisations. There are disparate voices and I bemoan this fact as the Chairman of the National Committee of Science and Technology, which I have the honour to be now. Indeed, at the last meeting of our Committee, this was one of the points which I discussed with my friends and colleagues who are scientists. You can meet in Congresses ; you can pass Resolutions, but you can never be an input into the social system as a whole, unless you understand the very complex mechanics whereby science gets transmuted into a system of society.

Therefore, Mr President, I rejoice with you, that Indian scientists are having the first excitement of intimations of love and I know first intimations of love are very exciting. But remember when the first intimations are over and if you have social responsibility and if you are a gentleman, you should marry the 'young lady' and marriage means adaptations, adjustment to make it creative. This is a difficult problem.

I congratulate you, that the Science Congress for the first time, motivated by its own exertions, addresses itself to the very simple theme as to what it owes to the society and what it could do to the society and is making its first efforts to understand the working of the society. In the first transformation, of which you have read in history, some of you, who are here may have participated. My good friend Dr P.K. Bose, Vice-Chancellor, Calcutta University coming from Bengal must, in his youth, have had the first intimation of excitement of love of nationalism of which Bengal was such a stormy centre, and of which I have a very vivid recollection.

The founding of the Indian nation State is a continuing task ; the parameters of making it durable involve a consistent and conscious application of a secular principle, a conscious and consistent application of getting over the divisive aspects in the society and therefore doing everything to mitigate the divisions in society ; it means social and economic transformation of India which dissolves the growing dichotomies in our system.

The growing dichotomies of our system are : urban-rural dichotomy, the educated and uneducated dichotomy, the elite and non-elite dichotomy, the organised and unorganised dichotomy. There are serious structural problems and one cannot sit in the cities of India as we all do and pass Resolutions. We must understand the meaning of growth in the context of these dichotomies ; the why and wherefor of it, how is it that these 24 years of economic development has resulted in these dichotomies. These dichotomies mean that in this economy, some people are enjoying privileges at the expense of the vast masses of people. This may be morally repugnant but I am now not moved by mere morality alone. It is socially dangerous and economically disastrous. We have to think very clearly how to set this right. Here we come against vast number of problems, each problem incapable of being generalised on an all India scale.

The visage of poverty in India itself, is not a single one with the same features, the same hollow-sunken eyes, pot-belly rickety children etc. No. The poverty of Punjab has different face than the poverty of Orissa. If you were to set about solving poverty in a generalised way you would fail. The poverty of Punjab and the poverty of Bihar, of north Bihar as against South Bihar, poverty of Eastern U.P. as against western U.P., the poverty of the urban city dwellers of Bombay as against the poverty of Marathawada region, are very specific problems, concrete in their nature and character and the solution to these problems will be determined by the concrete parameters—the parameters of Marathawada or of Amritsar District, or of Darbhangha District, or of Santhal Paraganas, or of Meghalaya, or Arunachal, or Himachal. We have to understand the language, the traditions, the belief systems and aspirations of the people. What evokes response in a Bihari is not exactly the same thing that evokes response of a Malayali. Ramayana Katha can evoke tremendous response amongst Biharis, but will leave a Malayali cool because the Malayali social history has its own evocative memory. Any scientists, social or otherwise, seeking to engage in the process of Integrated Rural Development, will be like the proverbial blind-men of Hindustan—the seven blind men of Hindustan trying to comprehend an elephant and never succeeding in knowing the total reality.

Mr President, may I on my own behalf and on behalf o my colleagues at the Planning Commission convey to you and your colleagues my felicitations on the great earnestness in addressing yourself to one of the fundamental problems of India's evolution. I personally have no readymade solutions of formulas in this regard. As I tried to illustrate with reference to the nature of poverty, a work-force of about 180-200 million, out of the active manpower between the age-group 15-59 years of about 300 millions produces a G.N.P. of about Rs. 52,000 crores. If only we could activate another 120 million people, that national product could easily be doubled without taking into account the problem of productivity. The question is one of will and of commitment. It is about time that it became not merely a commitment on the part of Government. I am quite convinced that the transformation of

India cannot be allowed to remain, an exclusive responsibility of Government. It can only be done by voluntary getting togeth er of all people towards this task. I was, therefore, rather excited with the prospect that no University Degree—that was what I understood it to mean—no High School Certificate, no Diploma in 1976 would be conferred unless a person comes with a certificate—not a false one—that he has planted at least two trees and promises to keep it green for the year. What is the difficulty in this ? It can surely be done. but it has not been done so far. One could go on elaborating ideas whereby man's own volition can transform the face of our country. There are vast resources. One has merely to look at energy potential which is locked up in the Himalayan snows and flows perenially through the Gangetic plain.

These are the kinds of tasks, if we are to carry forward the national transformation and thc social transformation and finally the economic transformation. Even while, we are procceeding with the intensive agricultural development strategy, we have to adapt ourselves to the concrete and specific problems of linear growth rates. A linear growth rate might be a function of water, fertiliser and seed. But there are other things to be done to which you, Mr President, have rightly invited attention—the problem of storage, of optimization in the use of water by the conjunctive use of ground and surface water, of seeds, of salination etc. All these things have to be done. Even as all these things have to be done in the entire country, let us address ourselves to the task of transformation of Bihar and Eastern U.P., Madhya Pradesh, Orissa and West Bengal. I suggest the rest of India can look after itself, if we can make an impact in 1976-77 on one district of Bihar. I ask you, Mr President, to adopt that one District on behalf of the whole Science Congress and the scientific community. I, from the Planning Commission, commit myself to total cooperation, in this task. If India were to consist merely of Haryana, Punjab, Western U.P. and of south of India, we have no great problem of economic development. We have growth rates in this country which are far superior to any of the growth rates established anywhere else in the world. I know gross national product is a God which has failed. Therefore, the problem of economic development and social transformation is not a simple function of incremental economics, it is an all round problem, involving great social, psychological, cultural problems, attitudinal problems, value systems etc. So I wish to leave the thought with you : why not make 1976-77 a year not merely of elaborating Integrated Rural Development in a generalised way, but adopt one district where the Universities and the scientific establishments in India can demonstrate concretely what we can do in one year to transform one of the more backward areas of our country. One of the advantages of this would be that we shall cease to theorise ; we shall have to address ourselves not to the generalities of the 363 districts of India, but to the concrete problems of one district of India in an obviously a backward State. If it can be done in Bihar, it can de done in U.P. ; it can be done in Madhya Pradesh, if only we address ourselves to this task in a very specific, in a very concrete and in a time bound manner. Mr Chairman, I offer you my whole-hearted cooperation and the cooperation of Planning Commission in this task.

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