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TRAINING ACTIVITIES AND TRAINING REQUIREMENTS IN THE FIELDS OF PLANT GENETIC RESOURCES, PLANT BREEDING AND SEED PRODUCTION

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I. INTRODUCTION

1. Developing countries' manpower needs are directly and closely linked to overall agricultural development. High priority is therefore given by FAO to agricultural education and training to meet the requirements for more and more trained and qualified personnel in all aspects of agricultural development.

2. The Twenty-second session of the Conference, I Article 6 of Resolution 8/83 urged that international cooperation be directed towards "Establishing or strengthening the capabilities of developing countries, where appropriate, on a national or sub-regional basis, with respect to plant genetic resources activities, including plant survey and identification, plant breeding and seed multiplication and distribution, with the aim of enabling all countries to make full use of plant genetic resources for the benefit of their agricultural development."

3. The present paper concerns training programmes related to the intensification of activities leading to the supply of improved seed and plant material. The objective is the training of managerial, scientific and technical staff to serve the chain of activities which starts with the collection and maintenance of plant genetic material, is followed by the breeding of crop varieties suitable for certain ranges of conditions and concludes with the propagation and distribution of seed and vegetative planting material for crop production.

4. The paper consists of three main sections. The first looks at the existing manpower situation and future requirements. Reference is made to estimates prepared in the studies for "AT 2000" and "Trained Agricultural Manpower Assessment in Africa", and indications given of the more detailed studies required to establish manpower needs in the three fields under consideration.

5. Section two presents examples of the wide range of post-graduate and in-service training activities of developing countries, and assistance given for training by FAO and international and national institutions. It concludes that in spite of the considerable progress made in training activities in the fields of plant genetic resources and seed production during the last 15 years, the supply of experienced plant breeders in developing countries is still unsatisfactory.

6. The third suggests strategies and action programmes for development of scientific and technical manpower, with the aim of enabling all countries to make full use of plant genetic resources for the benefit of their agricultural development. The need for closer co-ordination of training activities in plant genetic resources, crop breeding and seed production is discussed and a review is made of the co-operation of train} activities between FAO, national universities and research institutes and the IARCs,[1/] both with regard to formal and in-service courses.

7. In the absence of a comprehensive survey of training activities and training needs, and because of the lack of data, the preliminary nature of this review should be recognized.

II. SCIENTIFIC AND TECHNICAL MANPOWER REQUIREMENTS

8. Forecasting training needs must be based on an assessment of trained manpower requirements. Medium- to long-term estimates are based on optimum manpower needs over a 10 to 25-year period, assuming that targets for the use of improved seed and planting material are reached. Short-term estimates refer to trained manpower required over the next six to ten years for existing operations and institutional infrastructures, for which resources have been committed.

(i) Estimates of Medium- to Long-Term Trained Manpower Requirements

9. FAO's planning study "Agriculture: Toward 2000" provides estimates of total trained manpower requirements at the "professional" and "technical" levels for countries in the four developing regions "Africa", "Latin America", "Near East", and "Far East". They were based on the number of farm families calculated from statistics of rural popu-

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1/ International Agricultural Research Centres

lations. Estimates were made of the number of farm families that can be serviced by one Field Extension Worker (FEW) using different ratios for rainfed and irrigated areas as well as for the use of inputs. These figures, increased by 20 percent for senior professional personnel, were then used to calculate total trained manpower requirements and training requirements (ref. Annex 1).

10. More detailed calculations on the same general basis were made, country-by-country, for the African Region in FAO's study on "Trained Agricultural Manpower Assessment in Africa", prepared for the 13th FAO Regional Conference for Africa held in Harare, Zimbabwe, from 16-21 July 1984. It contains information, for 46 African countries, on

(a) trained agricultural personnel by occupational level (i.e.: professional, technical and vocational) and educational background;

(b) estimated minimum requirements for trained agricultural personnel by the year 2000; and

(c) estimated annual training output needed to reach minimum targets.

11. The calculations of training output were made for each of the major sub-sectors of agriculture, i.e. extension, research, training, production and protection, water and irrigation, home economics, mechanization, inputs and services, statistics and planning as well as for the sectors of forestry, fisheries and livestock.

12. Personnel included under the sub-sector plant production and protection were categorized as performing the following duties: support to crop production and protection, regulatory services, pest control, promotion of crop production, pasture development. The total number of trained personnel required in this sub-sector were estimated to reach 120,000, about 32,500 (27 percent) at professional and 87,500 (73 percent) at technical level.

13. However, while extension work and many essential technical and administrative services have a direct relation to the number of farm families, this is not necessarily the case for work connected with the production of improved seed and planting material, which is more directly related to the supply of improved material sown or planted annually, and thus potentially related to the total cropped area. While the above data cannot be used directly for estimating the requirements in the three fields under review, they are nevertheless useful for providing an overall framework of reference for more detailed studies of specific occupational groups.

14. An assessment of requirements of university level training (i.e. graduates) for the production of cereal seeds in developing countries, made by FAO in 1975, provides an example of a methodology better adapted to this particular field.

15. The calculations summarized in Table 1 below were based on target areas under "High Yielding Varieties", annual renewal rates for fresh seed, sowing rates and yield of seed crops, as well as the following estimates of staff/seed production ratios:

(a) One "Variety Evaluation and Release" staff - per 1,000 ha of seed produced.
(b) One "Seed Production and Harvesting" staff - per 500 ha of seed produced.
(c) One "Seed Processing and Storage" staff - per 500 tons of seed processed.
(d) One "Seed Marketing and Promotion" staff - per 500 tons of seed distributed.
(e) One "Seed Testing, Certification and Legislation" staff - per 250 ha of seed produced.

Table 1 - GRADUATE STAFF REQUIREMENTS FOR CEREAL SEED PRODUCTION IN DEVELOPING COUNTRIES: 1980 (ESTIMATED NUMBERS)

Region	Cereal Area (million ha)	Variety Evaluation and Release	Seed Production and harvesting	Processing and Storage	Marketing and Promotion	Testing Certification and Legislation	Total Graduate staff
Africa and Near East	72	184	368	758	758	734	2802
Latin America	45	74	142	363	363	296	1238
Far East (excluding China)	160	258	516	1367	1367	1034	4542
TOTAL	277	516	1026	2488	2488	2064	8582

16. FAO estimated that training requirements for technical level staff (with high school level diplomas) would be four to five times larger than for graduate level staff, i.e. between 30,000 and 40,000.

17. These estimates corresponded very well with the needs specified for ten Most Seriously Affected and Least Developed countries in 1975 as part of the "FAO Seed Review".

18. In view of the subsequent increases in population and food production, staff requirements in 1985 would probably be at least of the same order of magnitude, despite training efforts 1980-84.

19. Estimates of this type are only very approximate, but their application on a country-by-country basis could provide a useful guide for manpower planning in seed production.

20. Calculations need to be brought forward on the basis of FAO statistics and country-by-country enquiries. An order of magnitude can be derived from FAO's estimates of seed requirements in its study "AT 2000" (Ref. Annex 2).

21. Similar calculations for crop breeders would not be valid because of the great differences in the need for breeding activities as between different crops and regions. Estimates of long-term manpower requirements in this field have to be based on the following:

(a) the crops acreage and the economic importance of the major crops in a given country;
(b) the number of breeders and assistant technical staff presently employed for each major crop;
(c) the breeding requirements of each major crop in relation to problems of yield and quality, husbandry, resistance to pests and diseases, harvesting, and post-harvest constraints;
(d) existing regional or international institutions dealing with the crops important for the country concerned and their capability to support national programmes.

22. For plant genetic resources activities estimates of long-term manpower requirements must be based on long-term plans for collection, maintenance, and evaluation. These, of course, will depend on the priority crops, on the quantity and variety of

genetic material involved, and on its location and dispersion. Such factors will have only an indirect relation to national or regional crop production of the species concerned.

(ii) Estimates of short-term manpower requirements

23. Trained manpower requirements on the short-term, both for seed production and plant genetic resources activities, depend directly on the plan of work for the period concerned i.e. on the number and output of seed processing stations, the number of plant collection missions and the needs of genebanks expected to be in operation.

24. Estimates of short-term manpower requirements in the crop breeding field would have to be made in an ad hoc manner, based on the evaluation of:

(a) the current urgent breeding problems for major crops in the areas concerned;
(b) the facilities that can be made available on both a regional and national basis within, say, a five-year term.

(iii) Calculation of training requirements

25. For in-service training the annual intake depends, obviously, on the number and variety of courses and their frequency and the proportion of staff to be admitted to courses each year. For national courses it is usually found convenient to establish a national in-service training centre, with a resident director and staff equipped to receive a wide variety of seminars and courses.

26. The annual intake of full-time students for formal university training level must be based on:

(a) the existing number of trained personnel;
(b) the annual increment in trained staff required;
(c) normal staff wastage due to retirement, transfer, and other reasons;
(d) the length of the training courses concerned.

27. The total capacity of the training institutions may be calculated from the annual intake of each particular course multiplied by the duration, in years of the courses concerned.

III. PAST TRAINING ACTIVITIES

28. FAO's support to the development of training institutions has primarily been at university, diploma and certificate levels. Since 1982, 56 agricultural education institutions (38 universities and 18 intermediate level schools and colleges) have received technical assistance from FAO. Among these, 21 institutions (15 universities and 6 schools/colleges) were specifically supported in the subject area agronomy/plant breeding.

29. In addition, FAO in collaboration with Member Countries, international and bilateral agencies and institutions as well as private foundations has organized a wide range of training activities in plant genetic resources, plant breeding and seed production.

30. The activities were focused on post-graduate studies, short courses and in-service training programmes. These training activities are briefly reviewed below:

(i) Formal Education

31. The main training activity of the preparatory academic type' has been the one-year post graduate course at Birmingham University, U.K., leading to a M.Sc. degree. It has been sponsored by IBPGR [1/] since 1974 and has received financial support from UNEP for the last nine years. The course has attracted 182 students from 50 member countries.

1/ International Board for Plant Genetic Resources (Rome, Italy)

32. FAO/SIDA have organized a series of University level training courses in breeding field crops from 1960 up to 1978. The courses were held at Svalov in Sweden and were attended by a total of 61 participants from African and Asian countries.

33. A series of 12-month courses on Systems of Dryland Farming were held annually at Roseworthy Agricultural College, South Australia, from 1976 to 1980. The programmes were supported by Saudi Arabia under FAO Trust Fund entitled "Strengthening National Institutes by Training Scientists in Field Food Crops".

34. A few universities offer B.Sc. and M.Sc programmes in seed technology. These are: Mississippi State and Oregon State Universities in USA, Unversity of Edinburgh in Scotland and Massey University in New Zealand. The programme of studies in these institutions are international in character. Similarly, universities in developing countries, such as Brazil, Costa Rica, India, Malaysia and Mexico have started degree programmes with emphasis on seed technology. In addition, an advanced level symposium on Tissue Culture Technology and Utilization was held in Norway in July 1984.

(ii) In-Service Training

35. Short courses at centres other than Birmingham have been sponsored by IBPGR since 1977 (short courses) and 1979 (study tours). The number of students attending the short courses averaged 54 per year from 1977-79 and 109 per year from 1980-83, and totaled 598 over the seven years 1977-83. The number of participants in study tours from 1979-82 has varied from six to eleven and totaled 39 over the four-year period, 1979-82. Students at the short courses came from 101 countries, and on study tours from 20 countries.

36. Seven-month duration courses on wheat improvement were organized periodically by FAO/Rockefeller Foundation from 1961 to 1972. The courses were held at CIMMYT, Mexico.

37. From 1971 to 1984, FAO with the support of SIDA has organized a series of six-month training courses on maize, sorghum and millet production. The training programmes were held at the Indian Agricultural Research Institute, New Delhi and Hyderabad, and were attended by 57 trainees from African and Near Eastern countries.

38. FAO/DANIDA organized a 4-month training course on improvement of food legumes. The programme was held at the Seed and Plant Improvement Institute, Karaj, Iran in 1975 and attended by 16 students from African and Near Eastern countries.

39. A series of 7 month training courses on improvement in nutritional quality of barley and spring wheat were organized by FAO/SIDA/SAREC and held at Svalov, Sweden. The courses were conducted in 1977 and 1978 and attended by 12 participants from six countries.

40. From 1974 to 1977, FAO with assistance from the Italian Government has organized a series of seven-month courses on improvement of durum wheat. The programmes were held at the Italian Cereal Research Institute, Rome, and were attended by 11 students from nine countries.

41. In 1981 FAO has organized a training course on the Methodology of Training in Transfer of Improved Crop Production Technology. The three-weeks course was held at Islamabad, Pakistan, and attended by 17 participants from the Near Eastern countries.

42. From 1980 to 1984, FAO has organized a series of short courses in food legume production through the Regional Office for Latin America and the Caribbean. These courses dealt with production techniques at various technical levels and also covered varietal selection. During the five years concerned, 20 courses were held in 12 countries of the region and were attended by a total of 562 trainees. The programmes were organized in cooperation with the national ministries, research institutes or universities and the assistance of technical agencies, including CIAT and INTSOY.

43. FAO has organized a series of training courses in seed production and technology. These courses, usually lasting 1-2 weeks, have been held on a regional basis in various countries in Africa, Asia, Near East and Latin America. They were largely supported by the Swedish International Development Authority (SIDA) and the Norwegian Agency for International Development (NORAD). The recent FAO/SIDA training course in seed technology was held in Jamaica in 1982 and was attended by 19 participants from seven Caribbean countries.

44. FAO with the support of the French Government has organized a training course on maize seed production for African and Asian countries. The programme was held in Montpellier, France, in 1983. Similarly, in collaboration with the Spanish Government, FAO has organized a training course in seed technology for Latin American countries. The programme was held in Madrid and Sevilla, Spain in 1982, and was attended by 21 participants from 15 countries.

45. National short courses and training programmes in selected seed technology subjects are being organized since 1974 and have become regular annual events in many countries. They are organized by national institutions and universities, with the help of FAO and, in sane cases, financial assistance from donor countries. They are usually of 1-2 weeks' duration and train from 10 to 30 intermediate and field level staff. In addition, FAO has also organized a number of 1-3 week seminars and workshops for discussions and exchange of experiences between technical workers in seed production and specialists in seed technology. A number of development agencies of European governments have provided both technical and financial support.

(iii) Activities of the CGIAR Centres and Institutions

46. IARCs with mandates for plant crops are carrying on some genetic resources activities, particularly the stocking, maintenance and evaluation of working collections; i.e. CIAT[1/] (cassava, beans, tropical pastures), CIMMYT[2/] (wheat, maize, triticale), CIP[3/] (potatoes), ICARDA[4/] (faba beans, lentils, durum wheat, barley), ICRISAT[5/] (millet, sorghum, chickpea, pigeon pea, groundnut., IITA[6/] (cowpeas, sweet potatoes, yams, and for Africa cassava, maize and rice) and IRRI[7/] (rice). Their collections are part of the international network promoted by IBPGR.

47. Most of the above IARCs accept a limited number of persons for practical training in their genetic resources units, and in sane cases include candidates for M.Sc. degrees who do their research in these units. IRRI has run annually a 4-month course on Genetic Evaluation and Utilization since 1975; 324 persons (mainly "in-service") from developing countries participated in this course. A UNDP project now in phase II provides for training courses on root and tuber crops with particular emphasis on breeding and germplasm selection, propagation and tissue culture techniques, germplasm exchange and quarantine. CIAT, CIP and IITA are doing the training, mainly by course work.

48. Plant breeding is a major objective and activity of all the Centres with crop mandates. The Centres have, soon after their establishment offered training courses in "production" (oriented to the contribution research can make) and "improvement (or "breeding") of their mandate crops. These courses were mainly for "in-service" persons from developing countries, and a conservative estimate of the total number of participants to date would be 12,000 at the locations or stations of the Centres, and 20,000 if in-country courses are included.

49. Training specifically in seed technology and technical aspects of seed industry operations has been offered at only one Centre so far, namely CIAT. Short courses run since 1978, have found overwhelming demand from developing countries, and have had more than 300 participants, mainly Latin Americans of the in-service type. A few candidates for M.Sc. degrees have done their research in CIAT's seed unit. Other Centres which have offered courses on seed production on handling include ICARDA, ICRISAT and IITA. CIP has a special "thrust", which includes training, related to development of a technology for potato production from botanical seed (true potato seed), and has long included training on tuber seed potatoes in its activities.

50. All of the Centres have offered research opportunities that are part of universities' requirements for higher degrees. The total output to the end of 1983 has been more than 1,800 M.Sc. and Ph.D. degrees. In addition the Centres have offered a

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1/ Centro Internacional de Agricultura Tropical - (Cali, Colombia)
2/ Centro Internacional de Mejoramiento de Maiz y Trigo (Mexico)
3/ Centro Internacional de la Papa - (Lima, Peru)
4/ International Center for Agricultural Research in Dry Areas (Aleppo, Syria)
5/ International Crops Research Institute for the Semi-Arid Trops (Patancheru, India)
6/ International Institute for Tropical Agriculture (Ibadan, Nigeria)
7/ International Rice Research Institute (Los Banos, Philippines)

total of 565 postdoctoral fellowships. It is not possible to state the proportion falling into fields of plant genetic resources and plant breeding, but they are bound to be very substantial.

IV. FUTURE DEVELOPMENT AND ACTION

51. Undoubtedly education and training have considerably developed over the last fifteen years in developing countries as a whole but with varying standards between countries. Many countries have developed and strengthened their national universities and other institutes of higher learning. Furthermore, programmes are underway to provide facilities for an increased output of post-graduates in selected institutes, including regional institutions which assist in the development of curricula for undergraduates and post-graduate training. However, in many of the least developed countries, where the need for trained manpower is most acute, higher education is still a rare privilege.

52. National efforts in developing countries have been supported through bilateral cooperation by developed countries in many ways and training in particular ranks high in bilateral technical assistance programmes. FAO and other international organizations have contributed in enhancing national efforts to build and strengthen agricultural universities and training facilities, to arrange for formal and specialized training abroad and to develop national capabilities in research and support services.

53. One indication for these developments is for example the growth rate in the number of research staff in developing countries between 1975 and 1980 of close to 7 percent per annum.[1/] Yet the number of research workers or technical personnel does not give a satisfactory indication of the manpower situation and there are no reliable figures available for many countries of those trained and actively engaged in plant breeding, seed development and genetic resources.

54. Moreover the level of training, specific research or technical experience and management skills will determine the efficiency of available manpower in operating the crop improvement system in a country. Post graduates and in-service training programmes are playing a crucial role in this respect to develop the necessary expertise.

55. Finally, well-trained manpower might be wasted if a country's institutional facilities, including post and career structure and financial support, are too weak to permit the experience and skills gained to be used.

56. The shortage of manpower in a number of countries might be more severe among trained laboratory and field technicians than among academically trained personnel. Consequently, the lack of support personnel can become a main hinderance for the development of well-functioning plant breeding and seed development services.

57. The following actions should be considered to further improve the manpower situation in developing countries to effectively develop the staff capabilities in plant genetic resources, plant breeding and seed production. In all actions the participation of women should be taken fully into consideration.

(i) Manpower assessments at the national level should give recognition of the needs to develop and/or maintain an efficient system of plant breeding, including work on genetic resources and of seed development appropriate to the country's needs for a future period of at least one to two decades. Such assessment should be part of the study proposed in document CPGR:85/6 on the strength and weaknesses of plant breeding and seed development capabilities in developing countries.

The manpower assessment will provide guidance for the need in each country of the number and level of education and training required, which should be reflected in national policies.

(ii) Formal agricultural university education in developing countries should provide for a sufficient turn-out of graduates with a solid background in

1/ FAO, 1981: National Agricultural Research in Developing Countries Doc. C 81/26, Conference FAO.

botany, agronomy, genetics, plant pathology and plant breeding. While considerable progress has been made in a number of countries , others require assistance to reorient and upgrade their curricula and facilities. Such reorientation should include sufficient emphasis on seed technology and practical/technical aspects of plant breeding. FAO should mobilize such assistance including arrangements at an inter-country, regional or interregional basis to overcome shortcomings in formal education in some countries unable to support universities of sufficient quality standard.

In upgrading university education in developing countries, long-term twinning arrangements with universities in advanced countries had considerable impact in the past. Such arrangements should receive continued emphasis in bilateral assistance programmes with sufficient care for the actual priority needs of the respective developing country partner.

Post-graduate training is less well developed at universities of many developing countries. Fellowship programmes to provide such advanced specialized training should take into consideration the particular demand of developing countries in the three fields under consideration. FAO can assist in selecting relevant universities and institutes for post-graduate training.

The International Agricultural Research Centers (IARCs) of the CGIAR, so far as they have relevant arrangements with universities of their host countries, provide to sane extent possibilities for post-graduate training in plant breeding on their mandate crops. This applies also to the Joint FAO/IAEA Division in Vienna. The bulk of opportunities will however continue to be provided by universities in developed and developing countries, having well established post-graduate training programmes. There is need to regularly update directories for agricultural post-graduate training, including plant genetics and plant breeding with the expertise offered on particular crops and in seed technology.

Post-graduate training related to the various aspects of plant genetic resources is offered only by the University of Cambridge, U.K. There is need to identify in each region at least one university where such training could be developed, for which additional outside support might be necessary at least during the initial stages.

(iii) While the upgrading of the graduate and post-graduate education will provide for an increase in manpower with the formal education required for genetic resources, plant breeding and seed development, in-service training has to play a crucial role to improve specialized skills oriented to particular crops and crop environments and to various techniques required. FAO, the IARCs and IBPGR, but also regional plant breeding associations such as SABRAO and EUCARPIA play an important role in organizing and arranging such in-service training depending on increased donor support.

In plant genetic resources, short courses and workshops have been organized by IBPGR and relevant institutes including IARCs on aspects of techniques of exploration and collection, genebank management, seed physiology and storage, maintenance of vegetatively propagated species, in vitro conservations and information system. Such courses should continue and expand to particular crops and groups of crops. In collaboration with the relevant IARCs or relevant national or regional centres, a series of special workshops should be organized related to mandate crops, and oriented to the utilization of plant genetic resources in plant breeding, as already successfully started, supported by IBPGR and SABRAO. Additional resources would be required through FAO/IBPGR to support such expansion.

Possibilities for in-service training in plant breeding related to breeding methodology and special crop orientation need to be expanded to cater for the considerable need of developing countries. Again, the IARCs should resume a larger responsibility to offer such training on a crop-specific basis. The present TAC review of training activities of the IARCs is expected to give further guidance on this subject to the CGIAR and the centres it supports.

Crop orientated in-service training organized by FAO needs also to be considerably expanded. While it should make full use of joint activities with IARCs, it must give particular attention to growing capabilities in national programmes of developing countries, which can be mobilized through the TCDC approach for training purposes. In this context particular attention should be given to important crops not supported by major international research efforts.

Special training courses organized by individual countries open for international participation and oriented to the needs of developing countries should be encouraged. The annual three months course on plant breeding at Wageningen, The Netherlands, are an important example, as are the International courses organized by the Maize Research Institute, Zemun Polje, Yugoslavia. International training on specialized and advanced technologies in plant breeding as provided by the FAO/IAEA Joint Division in Vienna, Austria, should be increased and expanded to include aspects of genetics and biotechnology.

In-service training in seed production has to be of practical nature, including systems and organization of seed production technology, seed processing and storage, seed testing and field quality control, seed certification and legislation and seed distribution and marketing. In line with the expansion of FAO's Seed Improvement and Development Programme to a larger number of countries, its training component should assist countries to establish national training programmes. Sub-regional training centres in countries with well-established seed programmes should be further encouraged and supported to assist national programmes. The cooperation which is developing between FAO and the IARCs can be of particular significance in this context. Where appropriate, the participation of the commercial seed industry in providing training should be explored and encouraged.

(iv) The training of support personnel for plant breeding and seed production needs particular attention in the development of relevant programmes. Special attention should be given to this aspect in manpower assessments at national level and in the study mentioned before on plant breeding and seed development capabilities in developing countries. Some countries provide particular courses, mostly of two years duration, for agricultural laboratory and field technicians either at professional schools or attached to universities. Others require to establish such courses at plant breeding or agronomy institutes. FAO could assist such courses through the development of training modules and training material, and encourage support to such training programmes in international or bilateral programmes of technical cooperation.

58. The actions proposed to reduce the gap of trained manpower in plant genetic resources, plant breeding and seed production require a strong and increased commitment and support of all Member Nations. Such support includes the mobilization of expertise and financial resources as well as increased flexibility to facilitate the exchange of experts and the clearance of trainees and experts to participate in or to provide training.

ANNEX 1

ESTIMATES OF SCIENTIFIC AND TECHNICAL MANPOWER
AND TRAINING REQUIREMENTS (From "AT 2000")

	Year	Africa	Latin America	Near East	Far East
Number of farm families per F.E.W.	1980	2 016	2 119	1 856	2 199
	1990	1 143	1 069	889	945
	2000	696	530	517	525
Total trained manpower requirements [1/]	1980	126 561	73 072	67 746	487 866
	1990	164 155	83 922	81 014	618 211
	2000	224 047	98 649	99 623	808 785
Required annual output of trained persons	1980	6 975	3 445	3 237	22 665
	1990	13 625	6 026	6 085	48 976
	2000	26 272	10 451	11 239	98 247
Required capacity of training system [2/]	1980	25 460	12 573	11 813	82 726
	1990	49 733	21 995	22 111	178 104
	2000	95 891	38 145	41 023	358 603

1/ Number of Field Extension (1 FEW/thouseand farm families rainfed Workers (FEW areas)
(1 FEW/500 farm families irrigated areas)
Total Trained manpower = (Plus adjustments according to inputs used)

2/ Annual output x 3.65, assuming 4 years' training senior personnel and 2.5 years' training remainder, with annual drop-out rate of 10% total student population.

ANNEX 2

SEED REQUIREMENT OF FOOD CROPS IN 2000 [1/]

Region	Total Requirement	Share of Improved Seed	Annujal Replacement of Improved Seed
	Million tons	%	Thousand tons
Africa	7.3	38	815
Far East	30.8	76	5590
Latin America	21.2	65	3305
Near East	5.1	67	945
90 developing Countries	64.4	67	10 655
Low income countries	27.1	72	5 070

1/ From "Seeds/Semences/Semillas", FAO Plant Production and Protection Paper No. 39, Rome, 1982.