

RESEARCHABLE CONSTRAINTS IN THE SEED SECTOR IN DEVELOPING COUNTRIES

(PREPARED FOR THE ODA SUPPORTED CROP POST-HARVEST PROGRAMME)



RESEARCHABLE CONSTRAINTS IN THE SEED SECTOR IN DEVELOPING COUNTRIES

(PREPARED FOR THE ODA SUPPORTED CROP POST-HARVEST PROGRAMME)

MARK WRIGHT

AUGUST 1996



Central Avenue
Chatham Maritime
Kent ME4 4TB
United Kingdom

Foreword

Format of the report

The seed sector is addressed in its widest possible sense and aspects that have been considered in compiling this report are outlined in part A. This section also details potential areas for support and researchable constraints on a thematic, rather than a country by country, basis, in a way that reflects a logical division of the seed sector. A Priority for Support section is structured differently in summarising the most important, and developmentally significant, constraints as a focus for future discussion and action.

A broad range of topics are covered that all have a bearing on the seed sector. However, this document does not claim to be a definitive guide to closely related issues, such as plant breeding, biodiversity and intellectual property rights. In this report the term seed is used to refer to true seed. In general, plants that are vegetatively propagated have not been included because their needs are different to those of plants with seed propagation (even though this is an extremely important sector). Each of the discrete points raised reflects the fact that it was mentioned by at least one respondent. To avoid repetition, the topics are not attributed to source in the body of the text. However, in the Priority for Support section the inclusion of topics as priority areas is justified with an indication of which institutions supported their inclusion.

The views expressed are derived from responses to the postal information requests as well as detailed discussions with the following groups: the ODA Bangladesh Agricultural Support Services project and USC Bangladesh (an NGO); vegetable breeders from the Asian SAVERNET network; ICARDA (Syria); ICRISAT (India); FAO and IPGRI (Rome); and ODI, the University of Edinburgh, Kew Gardens and ACTIONAID in the UK. Colleagues at NRI also helped in formulating ideas for the report which represents the common perceptions of workers currently active in the seed sector; it is not meant to be a review of the literature.

Part B gives an overview of UK institutions active in the seed sector based on a postal request for information sent to 35 individuals and groups. Recipients, with addresses, are listed in Appendix 1. Part C gives an overview of world-wide institutions active in the seed sector based on a postal request for information sent to 70 individuals and groups. Recipients, with addresses, are listed in Appendix 2.

This publication is an output from a research project (A0486) funded by the Overseas Development Administration of the United Kingdom. However, the Overseas Development Administration can accept no responsibility for any information provided or views expressed. Short extracts of this report may be reproduced in any non-advertising, non-profit-making context provided that the source is acknowledged.

© Natural Resources Institute, 1996

The cover photo is used with the kind permission of Kamas Westrup.

Acronyms used in the text

APSA - Asian and Pacific Seed Association
AVRDC - Asian Vegetable Research and Development Centre
CARICOM - Caribbean Community
CAZS - Centre for Arid Zone Studies
CGIAR - Consultative Group for International Agricultural Research
CIAT - International Centre for Tropical Agriculture
CLADES - Latin American Consortium for Agroecology and Development
DUS - Distinctness, Uniformity, Stability
ENDA - Environment and Development Activities (Zimbabwe)
FAO - Food and Agriculture Organisation of the UN
GIS - Geographical Information System
GTZ - Deutsche Gesellschaft für Technische Zusammenarbeit
ICARDA - International Centre for Agricultural Research in the Dry Areas
ICRISAT - International Crops Research Institute for the Semi-Arid Tropics
IPGRI - International Plant Genetic Resources Institute
IPR - Intellectual Property Rights
IRRI - International Rice Research Institute
MASIPAG - Farmers-Scientists Partnership for Agricultural Development
NGO - Non-Governmental Organisation
NRI - Natural Resources Institute
ODA - Overseas Development Administration
ODI - Overseas Development Institute
PBR - Plant Breeders Rights
PGR - Plant Genetic Resources
SADC - Southern Africa Development Community
SAVERNET - South Asia Vegetable Research Network
SEARICE - South East Asian Regional Institute for Community Education
UNCED - United Nations Conference on Environment and Development
UPOV - International Union for the Protection of New Varieties of Plants
USC - Unitarian Service Committee of Canada
WANA - West Asia and North Africa

Introduction

1. In the developing world, the majority of people are engaged in agriculture as their primary activity both to feed their own families and as a source of family income. Seed is a fundamental prerequisite for these activities.

2. The importance of good seed can not be overstated. Nearly all agriculture and forestry world-wide relies on seed (except in a few specialised cases such as *in vitro* propagation), or vegetative components, as the basis of planting material.

3. ODA has long realised the importance of the seed sector and has invested accordingly to support it. The level of investment is presented in Tables 1 and 2 showing projects completed since 1984 and those still active in 1996. It can be seen that a total of £11 million has been committed to projects devoted to seed activities and a further £16.8 million on projects having a significant seeds component. In addition, it should be noted that a further £15.4 million has been allocated from emergency funds, since 1991, to support programmes having a strong seed component (ODA Natural Resources Policy and Advisory Department, pers. comm.). These emergency funds are largely channelled through the British NGO network.

4. Historically, much of the programmed assistance to the seed sector has been targeted at seed production activities, normally through the relevant government agencies, and support to forestry programmes. The purpose of this document is to determine whether other aspects of the seed sector may warrant support by outlining those areas which are currently under-researched or under-resourced but for which researchers in the field agree are priority topics. The document also identifies topics which are being adequately addressed by other agencies or which are not considered priority topics and thus aims to maximise impact in a cost effective and responsive way.

5. ODA priority areas are outlined in three strategy papers for Sustainable Agriculture, Biodiversity and Forestry. Those that have a potential bearing on the seed sector are:

- policy and institutional reform;
- sustainable resource management;
- research and technology transfer;
- identification and promotion of relevant technologies;
- facilitation of the private sector;
- commissioning studies / research on biodiversity.

Table 1. FINANCIAL VALUE OF COMPLETED ODA FUNDED SEED PROJECTS SINCE 1984

REGION	YEARS OF PROJECT	PROJECT WITH SEED ACTIVITIES ONLY / £	PROJECT HAVING SEED COMPONENT / £	PROJECT TYPE
Africa	1987-90		93,884	Research - resistance to bruchids in beans
Africa	1990-93	35,000		Tree and shrub seed production
Africa - Cameroon	1990-92		188,880	Seed production - use of inoculum in legumes
Africa - Côte d'Ivoire	1986-89	unknown		Seed sector development
Africa - Côte d'Ivoire	1987-91	610,835		Seed production
Africa - Côte d'Ivoire	1987-92	3,150,000		Seed production through estate rehabilitation
Africa - E & S Africa	1990-92	61,295		Policy - seed sectoral study
Africa - Ethiopia	1989-?	172,222		Small scale seed production
Africa - Ethiopia	not recorded	3,997		Infrastructure - National Seed Corporation
Africa - Gambia	1988-92	2,679		Sesame seed study
Africa - Gambia	not recorded	unknown		Research
Africa - Ghana, Malawi & Tanzania	1992-95	120,894		On-farm seed storage
Africa - Kenya	1985-88		1,825,000	Infrastructure - parastatal seed production
Africa - Kenya	1986-91		400,000	Seed multiplication
Africa - Malawi	1994	66,000		Seed multiplication and distribution project development
Africa - Namibia	1992-93	47,555		Equipment for seed production
Africa - Sudan	1986-89		41,531	Research - control of <i>Aspergillus</i> in onions
Africa - Sudan	1993		unknown	Tools and seeds programme
Africa - Tanzania	? - 1990	72,000		Infrastructure - seed multiplication centre
Africa - Uganda	1991-94		146,261	Research - tree seed dispersal by primates
Asia - India	1987-94	583,000		Seed certification and seed packaging support
Asia - India & Nepal	1994-95	82,607		Policy - small farmer seed supply
Asia - Malaysia	1991-94		70,646	Research - tree seed ecology (Dipterocarpaceae)
Asia - Malaysia	1991-94		39,663	Seed health - <i>Colletotrichum</i> in forest trees

Asia - Nepal	1989-92	280,000		Infrastructure - tree seed production and distribution system
Asia - Nepal	1990-?		592,700	Seed production
Asia - Philippines	1992-93	52,679		Research - rice seed production and genebank longevity
Asia - Russia	1991		3,500	Project proposal assessment
Asia - Russia	1992-94	150,000		Seed potato production
Asia - Russia	1992-94		250,000	Seed production
Asia - Thailand	1991-94	285,874		Research - tree seed storage (Dipterocarpaceae, Araucariaceae and Meliaceae)
C America - Guatemala & Honduras	1989-92		195,290	Tree improvement - <i>Gliricidia</i> sp.
C America & Brazil	1990-93		210,983	Tree seed collection - <i>Calliandra</i> sp.
Europe - Albania	1994	unknown		Training
Europe - Poland	1990	unknown		Training
Europe - Romania	1992-93		182,450	Training
Global	1988-91	175,877		Research - tree seed storage (Dipterocarpaceae and Meliaceae)
Global	1991-92	19,874		Policy - institutional linkages in local seed supply
Global	1991-93	168,740		Research - seed health testing in maize
Pacific - Solomon Islands	1990-91		unknown	Tree seeds - production of silvicultural manual
S America & Costa Rica	1991-94	266,479		Tree genetic resources - <i>Inga</i> sp.
S America - Chile	1990-91	4,090		Training
S America - Peru	1990-93		160,535	Seed health - bacterial wilt of potatoes
UK	1984-90	129,531		True potato seed production
UK	1990-93	187,905		Tree seed trial management procedures
UK	1991-94	30,849		Research - recalcitrant seeds (tea, cocoa and jackfruit)
UK	1993-94	19,777		Research - tree seed storage (<i>Acacia</i> and <i>Leucaena</i>)
TOTAL / £		6,779,759	4,401,323	

Source: ODA Natural Resources Policy and Advisory Department

Table 2. FINANCIAL VALUE OF CURRENT ODA FUNDED SEED PROJECTS *

REGION	YEARS OF PROJECT	PROJECT WITH SEED ACTIVITIES ONLY / £	PROJECT HAVING SEED COMPONENT / £	PROJECT TYPE
Africa	1993-?		unknown	Grants to NGOs
Africa	1995-96	59,790		Research - reduction of seed losses
Africa - Botswana & Tanzania	1992-96	160,959		Research - seed physiology
Africa - Ethiopia	1992-96		260,846	Seed multiplication & storage
Africa - Ghana & Zambia	1994-97	230,421		Farmer seed security
Africa - Malawi	1992-95	375,000		Seed distribution
Africa - Mali	1993-?	unknown		Onion seed banks
Africa - Nigeria	1992-96	195,290		Seed health - yam tubers
Africa - Tanzania	1992-97		196,342	Seed production - trees
Africa - Tanzania	1993-96	131,765		Research - seed bed studies and effect on emergence
Africa - West Africa	1993-96		378,000	Network for evaluation of rice genetic resources
Asia	1994-97	201,529		Seed health - fungal pathogens of rice
Asia - Bangladesh	1991-?		8,300,000	Seed production
Asia - Indonesia	1991-96		2,644,000	Research - tree seed physiology
Asia - Indonesia	1992-95	31,936		Seed production - trees (<i>Gliricidia</i> sp.)
Asia - Nepal	1992-95		76,980	Seed health - vegetables
Asia - Nepal	1993-96	1,054,000		Seed production - vegetables
Asia - Russia	1995-96	160,000		Training
C America	1990-95		251,459	Tree genetic resources - <i>Leucaena</i> sp.
C America - Belize	1989-?		80,000	Tree seed distribution - <i>Annatto</i> sp.
C America - Costa Rica	1992-95		210,500	Tree improvement - timber and multipurpose species
Global	1993-96	173,422		Economics of true potato seed
Global	1994-95	77,745		Information network - tree seed
Global	1995	6,287		Training

Global	1995-96	237,623		Policy - small farmer seed supply
Global	1995-98	69,312		Research - cryopreservation for long term seed storage
UK	1991-95	865,000		Storage of vegetative material
UK	1993-95	206,382		Research - seed heat tolerance using genetic markers
UK	1995-96	22,915		Development of ODA seed strategy
TOTAL / £		4,259,376	12,398,127	

Source: ODA Natural Resources Policy and Advisory Department

* Although some of these projects appear to have been completed already, they are included in this table either because there are plans to extend them or because final reports have not yet been submitted.

A - Components of the seed sector

6. Constraints are considered under the following headings (although in many cases there is considerable overlap between categories) with an indication of needs, either support and / or research based, relating to each topic.

Target crops

- food crops (primary and secondary)
- non-food crops (e.g. pasture crops and medicinal plants)
- tree crops

Geographical / ecological zones

Social aspects

- role of men and women in seed activities
- farmer preference
- seed issue awareness
- seed security

Germplasm factors

- *in situ* and *ex situ* conservation
- genebank procedures / techniques
- maintenance of biodiversity (food crop and non-food crop)
- plant breeding and its appropriateness
- plant collecting missions

Research

- seed physiology
- biotechnology

Institutional & policy

- seed certification / legislation
- varietal release mechanisms
- intellectual property rights
- quality control
- seed packaging
- seed marketing
- public sector / private sector
- role of NGOs
- seed banks
- economics of seed production / distribution
- seed replacement following crisis (drought, war)

Information needs

- training of farmers / extension staff / others
- networking and information interchange

Target crops

7. Although world-wide some 7000 species of plants are used in agriculture, only 30 of these provide 90% of the world's calorific intake. These major crops, whether seed propagated (e.g. wheat, rice, maize and the grain legumes) or vegetatively propagated (e.g.

cassava, potato, banana and yam), come under the mandate of the CGIAR centres and have been well studied, particularly with regard to plant breeding aspects.

8. Secondary food crops and utility crops including traditional vegetables, minor cereals, herbs and spices, aromatic plants, medicinal plants and pasture crops, are very poorly researched. Little, if anything, is known of their seed physiology, optimal planting rates and seed storage requirements. Despite having had a lower priority in national programmes, many of these crops play an important role at community level, for example, in traditional medicine, cooking and local trade. There is a real need to support their continued use for dietary variation, strengthening local economies, protecting biodiversity and the traditional knowledge bound up with their use.

9. Some programmes have already been initiated to address the problem of these neglected crops. IPGRI are funding monographs and networks for 25 crops including t'eff, bambarra groundnut and breadfruit. A huge amount of information still needs to be collected for the many other secondary crops that are important in the tropics including not just food crops but also those which have utility uses. Basic storage data are required to ensure seeds can be handled and kept under optimal conditions, in order to optimise successful propagation, and to support their preservation as part of a wider biodiversity conservation strategy.

10. Pasture and forage crops are a special case because of the pressing need to regenerate degraded rangelands in many parts of the world. Pasture crops are those that are grazed by animals and self-regenerate in the farming system e.g. *Medicago* and *Trifolium*; forage crops are sown and harvested each year as animal feed e.g. *Vicia* and *Lathyrus*. For common rangelands to be sustainably managed, they must be sown with appropriate pasture species. Although CIAT previously carried out research on these crops, little is known of the means to ensure good plant establishment because the seed traits of the target species, such as how to overcome dormancy and optimal seed handling and storage parameters, are still poorly known.

11. Trees, particularly in the tropics, are poorly researched. Many species are now becoming important as sources of firewood, building material and for fruit and nut production. Many are candidates for managed plots, but lack of knowledge relating to seed requirements hinders this development. Recently, a lot of effort has gone into establishing the seed needs, for handling and storage, in some tropical species, particularly in the families Dipterocarpaceae and Meliaceae. The work in the Meliaceae is incomplete and other families in particular need of attention are the Sterculaceae and Guttiferae.

12. One specific problem, found particularly in the tropical tree species, is recalcitrance. This refers to seeds being intolerant of desiccation and impossible to store under traditional genebank conditions. This has been investigated to some extent, for example in Malaysia, by Horticulture Research International and by the University of Reading, but more work needs to be done. In addition, Reading has identified an intermediate category of seed storage behaviour, prevalent particularly in seeds of plantation crops, forest trees, and shrubs. Research on the required storage practices for this class of seeds is still limited. Another problem relating to tree seed is that of dormancy. Many live seeds, of both tropical and temperate species, fail to germinate with a consequent narrowing of the genetic

pool, simply because suitable dormancy breakage pre-treatments are unknown or relatively ineffective.

Geographical / ecological zones

13. Plant material kept as seed suffers the same biotic stresses as food grain stocks and, in addition, is particularly sensitive to abiotic stresses, notably high temperatures and humidities. Seeds being stored under these conditions are more prone to loss of viability - a situation which commonly arises in the hot humid tropic belt. Crops grown out of season, through use of irrigation for example, will often need to have their seeds stored through the rainy season thus exposing them to greater stresses.

14. Agro-biodiversity is an important aspect of subsistence farmers' strategies. The tropical rainforests are recognised centres of high levels of biodiversity and some attention is being paid to these areas. The drier zones, despite having a very pronounced diversity, have been far less studied, even though some 850 million people live in the arid and semi-arid areas.

15. Many discrete areas of the developing world have similar agro-ecological conditions. With the advances in geographical information systems (GIS) it is possible to map plant biodiversity by eco-zone. This would theoretically allow the identification of comparable zones in different countries and the crop varieties grown in each. This information could be used to supply varieties that are known to be the same as, or similar to in terms of agronomic needs, previously existing varieties in a given area thereby ensuring a greater chance of adoption by the community. The demand for farm-saved seed is often greatest in marginal or extreme environments, because of the specialised requirements of the crops grown, but these zones are also those where the chances of losing seed are high; a GIS system may therefore have greatest application in these areas. Whether such a system would be feasible and the extent of its potential utility is not yet clear.

16. It is evident that some areas of the developing world have better research and support infrastructures with regard to the seed sector. Many parts of Latin America and SE Asia have well developed NGO networks relating to seed issues (e.g. CLADES in South America and MASIPAG in the Philippines) in a way that Africa is only now beginning to develop. Those countries with no informal networks, coupled with a poor official infrastructure, have the greatest support requirements.

Social aspects

17. Although it is generally recognised that in many parts of the developing world it is the women who select and care for the seed stocks, the extent to which this is the case has not been properly documented. The criteria which farmers use in selecting seeds are also poorly understood. Studies of these topics will implicitly require a sensitivity towards gender issues. In the Fouta Djallon area of Guinea, for example, swamp rice is considered a man's crop amongst the Mandinka whilst it is regarded as a woman's crop by the Fulani.

18. The mechanisms by which farmers learn about the availability of new crops or plant types (be they improved or local varieties) either through the formal extension services or through informal contacts with other farmers have only been described from a few countries. Frequently, farmers state lack of availability of seed or non-awareness of availability as prime constraints to their adoption of new varieties. Mechanisms for improving information delivery to the end user could be investigated and supported. This could also include components outside the normal formal sector, e.g. rural radio, in order to maximise the potential audience.

19. Seed security will be enhanced at farmer and community level through increased awareness of seed availability and seed types coupled with awareness of appropriate seed storage techniques.

Germplasm factors

20. Germplasm factors encompass aspects of plant genetic conservation (through seed storage) as well as plant breeding by using these seeds as the source of genetic variability. The technical requirements for maintaining seed in good condition (primarily reduced temperatures and relative humidities) are well understood. However, different crops have different inherent characteristics, including the ability to store well. Crops with particular problems are those with a high oil content such as soya and groundnuts. These problems can become severe under the less than ideal climatic, institutional and management conditions found in many developing countries. It is estimated that some 80% of all seed used in developing countries is stored on-farm. Under these conditions seeds which store poorly are potentially problematic.

21. Approximately 500,000 accessions of crop and wild relative material are held under the auspices of the CGIAR network. A further 5.5 million accessions are kept by national programmes of material relevant to their own country or region. Generally, the CGIAR centres are active in regenerating material to maintain viability of stocks whilst at the same time documenting accession characteristics for reference by breeders. Many of the national programmes lack the financial and manpower resources to be able to undertake accession assessments which relegates them to the status of storage facility rather than a working genebank. A genebank is only really of use if the nature of the material being held is documented and available to interested parties. Many of the national programmes may therefore require institutional support to allow their genebanks to function in a useful manner.

22. Seeds stored in genebank conditions are under different regimes depending on the purpose of the storage:

- at approximately 4°C, for storage up to 25 years (active conditions);
- at minus 18/20°C, for storage up to 50 years (base conditions);
- in liquid nitrogen, for storage in excess of 100 years (though not yet widely used).

23. The use of refrigerated systems, which tend to be costly, assumes a certain level of infrastructure and constant power supplies not always available in developing countries. There is good potential for reducing the storage costs for national programmes. This could include assessment of ultra-drying of seeds which could then be stored under ambient temperatures, or the use of a decentralised system of seed storage such as is practised in Morocco and parts of China where a number of individual institutes keep small seed stocks in standard deep freezers.

24. Genebanks play a vital role in maintaining genetic diversity through seed storage. However, there are substantial financial and institutional problems relating to their functioning, including management by staff who may not be seed technologists. In addition, genebanks tend to concentrate on major crops which are propagated by true seed (e.g. the cereals and pulses). Minor crops, crops propagated through vegetative means (e.g. yam) and the close wild relatives of many of the crops tend to be poorly represented in formal genebanks. With the growing interest in biodiversity and the formal undertaking of many governments to work towards preserving genetic diversity (through the Convention on Biological Diversity presented at UNCED, 1992) it has become clear that initiatives need to be devised to reduce the threat of genetic erosion faced by many crop species. Genebanks will remain central to the preservation of genetic diversity but will need to be supplemented by other activities.

25. Since the bulk of seed planted by farmers is derived from their own saved stocks and most farmers in developing countries still plant a wide range of crop species and crop varieties, the potential for farmers to act as repositories of crop genetic material through *in situ* conservation is considerable. The mechanism by which a rational and sustainable *in situ* conservation programme could be implemented is unclear - although the basis for serious current debate. This is compounded by the fact that farmers who store their own seed are already practising *in situ* conservation but this is normally as a consequence of their farming system (because the seeds are not available anywhere else) rather than a conscious decision to preserve diversity. The scientific arguments are hampered by an almost total lack of understanding of what current farmer practices are, how successful those practices are and the constraints on seed storage and varietal selection at farmer level. This lack of basic knowledge needs to be addressed since without it, it will be impossible to devise a strategy acceptable to farmers. It seems likely that *in situ* conservation will have a more important role in the secondary crops, or those varieties of the major crops which are highly localised. IRRI, in accepting the need to understand farmer-managed diversity, have initiated a programme working with rice farmers in Vietnam and the Philippines. Crop varieties that are widespread or locally significant could readily be maintained under an *ex situ* regime. As part of any investigation into the practicalities of an *in situ* system, the role played by home gardens should figure prominently. These gardens, which tend to be planted close to the house, serve to provide small quantities of prized crops. The extent of the diversity within these gardens and the way that diversity changes over time (at genotypic, varietal and species levels), has been little studied, although IPGRI is currently proposing a programme to address these issues.

26. Other major initiatives have already been started under the auspices of the Global Environment Facility (e.g. *in situ* conservation of genetic diversity in Turkey; a farmer-based approach to the conservation of plant genetic resources in Ethiopia) or are under

consideration by the Community Biodiversity Development and Conservation Programme that aim to address the problems of *in situ* conservation and the role that farmers can play in maintaining agro-biodiversity.

27. Although the last few years have seen a shift in plant breeding methodology to allow more of an input from farmers, there is still a need to ensure common goals between farmers and breeders. This could be manifested in several ways.

- Farmer risk aversion strategies and varietal preferences should be documented and incorporated into breeding programmes.
- Farmers could be brought into the varietal selection process at a much earlier stage so that they can view, for example, 20 promising lines rather than 3–4 breeder selected lines. Allowing farmers access to these segregating and early generation materials should result in better local adaptation of the final material. This would be particularly appropriate for breeders working in marginal environments where a large number of agro-ecological niches occur. On-farm crop improvement activities (participatory breeding) should be recognised as a valid plant breeding philosophy and current farmer initiatives should be documented and supported as required with complementary investigations to establish under what conditions farmers still prefer to use landraces and why.
- Breeding should be for farming system as well as for yield. Farmers may require varieties suitable for intercropping rather than for monoculture, or a quick-maturing variety with some yield to tide them over the hungry season rather than long-maturing high yielding types.
- The sites chosen for variety testing prior to variety release should match closely the target environments (which is not always the case at present).

28. Although the CGIAR centres have extensive collections of germplasm for the principal crops, and adequate funds for continued collecting, the minor and localised crops such as the traditional vegetables are very poorly represented in genebanks. Since these crops play a significant role in community nutrition, there is the need to collect the range of diversity found in these species, both to safeguard the existing germplasm and also to allow landrace enhancement activities in the future.

29. It should be noted that a potential danger of enhancing landrace material through breeding is that the wide range of diversity currently residing in the local populations may be eroded as the ‘improved’ varieties become available and are adopted by the farmers. Project planners must be aware of this likelihood and ensure that safeguards are in place so that this genetic diversity is not lost.

30. An area closely related to germplasm collections, and one which is receiving an increasing amount of attention, is that of access to genetic material. Traditionally plant breeders had ‘plant breeders’ rights’ (PBR) which allowed free interchange of germplasm for variety enhancement. Much of the material used in plant breeding is derived from landraces or wild relatives and there is now a move, on the part of many developing countries, to initiate a system that allows some of the financial benefits that accrue from the

use of landrace material to be repatriated to the country from which the landrace material was sourced. This has prompted a world-wide debate on the relative merits of International Property Rights (IPR), plant patenting legislation and changes to the PBR system. This debate, although important to plant genetic resources, is being seriously addressed by FAO, the World Trade Organisation and UPOV (who have responsibility for PBR procedures) and will not be dealt with further here.

Research

31. The principles for successful seed storage are well established. There is an extensive literature on seed biology and seed physiology which includes viability and seed dormancy studies. Some gaps still exist, largely in the understanding of dormancy-breaking techniques for the minor crops, forage and pasture species, and tree crops. In many of these species dormancy has not been bred out as it has been in the major crop species. The problems with forage and pasture crops are particularly acute. Developing countries are home to an increasing area of degraded rangeland. The problem is how best to re-seed these areas to allow regeneration and continued grazing. The private sector has no interest in producing these seeds, nor in carrying out the basic research, because the profits are too small and the market too variable. Systems need to be developed that allow sufficient seed to be produced, often in the form of a mixture of species, and to allow areas to be seeded in a way that is sustainable. ICARDA are developing a pilot system that would use seed pods of *Medicago* species, containing seeds with naturally variable dormancy periods, to re-stock pasture land. More initiatives and studies of this kind, that capitalise on seeds natural patterns of behaviour, are urgently needed and are likely to rely solely on public sector funding.

32. Recalcitrance in seeds has already been mentioned in another context. At present there is no way of telling whether seed of a given plant is recalcitrant or orthodox in its storage characteristics. Although typically, the larger the seed the greater the tendency to be recalcitrant, and it is known that some storage traits are shared at family or generic level, these cannot be considered diagnostic. The only way of establishing storage needs is through extensive laboratory studies. If markers could be established to predict storage type this would speed up the process considerably. Preliminary findings from work at Kew and The University of Reading have shown a potential link between high molecular weight polysaccharides and desiccation tolerance. This work needs to be consolidated.

33. A different problem relating to variability is that seeds from a single tree, as well as different trees of the same species, will have a wide range of inherent viability depending on the stage of maturity that the seed has reached. Since the seeds all look physically the same it is impossible to visually select those with the greatest germination potential. The development of a field technique that allows collectors or farmers to preferentially harvest seeds with the highest germination would be very beneficial. Corollary studies could investigate the relationship between maturity of seeds and their longevity in storage (which in some species e.g. foxglove has been shown to be greatest at a time significantly after the time of maximum seed mass). These studies have practical applications. For example, in many forage crops the plants are cut and left in windrows just prior to maturity. This prevents loss of seed after maturity, as a result of pod shattering, but allows the seed to continue maturing within the pod so that its storage longevity is enhanced.

34. In many of the major crops, dormancy has been selectively bred out of the seed. However, it is unknown whether there are any genetic linkages between dormancy and other, agronomically desirable, traits. This may have particular application to trees where breeding efforts to 'domesticate' species are currently underway.

35. Current procedures for seed performance testing rely on laboratory based viability or germination tests. Viability indicates the number of dead and living seeds; the more informative germination tests show the maximum potential germination of a seedlot. It is sometimes argued that to make these germination figures of more practical use, studies elucidating the relationship between laboratory and field germination should be extended. However, it may be more pragmatic to accept the objectives and limitations of laboratory testing and simply educate the users of seed test results how best to interpret them.

36. Many of the oilseed crops inherently store poorly. A further problem arises amongst some plantation crops and certain forest trees and shrubs (coffee, oil-palm, papaya and neem) in that they show freezing stress at the standard genebank storage temperature of -20°C. This occurs even when the seeds are dried to below 10% moisture content. This class of seeds needs further attention to establish the optimal long-term storage regime.

37. Seed borne diseases cause significant losses in viability and subsequent damage to the growing plant. In many cases, the factors affecting transmission of the pathogen to and from the plant to its seed are poorly understood. At present almost all seed pathology work is being conducted by the Danish Government Institute of Seed Pathology.

38. There is a demand for applied research applicable to farmers who store their seed from one season to the next. IPGRI are currently funding work, based in Niamey, on the potential of sun-drying during seed conditioning. Seeds are sensitive to extremes of temperature and too rapid drying, and so the development of a drying protocol that maintains high seed viability would be very useful. Other areas that could be addressed are the potential for local admixtures (e.g. ash, botanicals) to prevent insect attack, identification of suitable storage containers and development of germination tests for use by small scale farmers.

39. Biotechnology has an important role to play. Its use in producing new varieties through intra- and inter-specific crossing has great potential and is, to a large extent, covered through funding from the private sector. Biotechnology also has an important role in producing virus-free planting material for vegetatively produced crops through tissue culture e.g. with potatoes. This is covered by the private sector or CGIAR centres. There are a number of needs in this field, including the development of genetic markers for seed-borne disease resistance and the use of micro-propagation techniques. It is worth noting that biotechnology plays a far more significant role in crops that are vegetatively propagated (and are therefore clones), since this is an effective way of introducing genetic variation into the population.

Institutional and policy needs

40. Many developing countries have adopted seed legislation modelled on Europe. This includes procedures for seed certification, varietal release and quarantine of imported/exported material. In many cases, protocols developed for market-oriented, intensive, monoculture cropping systems supported by a strong infrastructural network that allows the procedures to be implemented, are not appropriate or are unrealistic in many developing countries where institutional support is less advanced.

41. Varietal testing and variety release procedures are normally very slow. Work by CAZS showed that varietal testing took from 3-9 years, with release procedures adding another 1-2, and result in the release of only a limited number of new varieties. Farmers, particularly those in marginal areas, exist in a highly variable environment necessitating a wide range of varieties. In many cases it would be more appropriate for larger numbers of less well defined varieties to be released allowing the farmers to be the arbiters of what constitutes a suitable variety. Suitable varieties will stand a greater chance of being adopted and spread; locally poor varieties may be abandoned. There is the potential to develop regional procedures allowing the release of a given variety if it has passed the release conditions in a second country with similar agro-ecological and socio-economic conditions. This would not only speed up the process of varietal testing and release, and reduce costs, but also give farmers quicker access to a wider range of seed material. However, national legislation and sovereignty will be key issues.

42. There is also the potential to facilitate regional seed trade development. As the seed sector liberalises, entrepreneurs will need to refer to economic studies detailing potential markets and to country regulations detailing seed activities in targeted countries.

43. The tight strictures of seed legislation may inhibit varietal adoption. Under conditions where seed is planted for family self sufficiency or for sale in local markets there is less need for the stringent purity requirements of certified seed. In the same way, seed which is exchanged locally is often of known provenance and so varietal characteristics are known. Germination is a potential problem, but within every community those farmers able to keep seed in good condition are often well known. It has been suggested that under subsistence conditions a germination percentage of 70% is probably adequate because farmers tend to plant more than one seed per station (which could be argued to be a waste of seed) and because they are prepared to replant in any gaps in the field that become apparent during plant establishment.

44. Certification tends only to relate to the major crops. This is because formally produced varieties have to conform to definitions of distinctness, uniformity and stability (DUS). Secondary crops, which are grown on a smaller and more localised scale with no input from the formal sector, have no legal requirements in terms of seed quality or varietal DUS. Support to the secondary crops should be promoted and this, inevitably, will lead to some varietal enhancement activities, such as the reduction of toxins in local *Solanum* species. Once this occurs and the farmer varieties become more identifiably distinct there may be moves to produce certified seed of these crops. Certification is extremely resource intensive and it is suggested that for these crops (and indeed for the major crops under most circumstances) a more appropriate methodology is that of 'quality declared seed' as

promoted by FAO or the 'truthful labelling system' as used in the USA, Brazil and India. Both of these systems put the principal onus for quality on the producer, freeing the National Seed Authorities to take on other activities.

45. As governments increasingly withdraw from seed production activities in favour of the private sector (which concentrates on the high value seeds such as hybrid maize and vegetables) there is an awareness that many crops and crop varieties will not be serviced by the formal sector. Farmers already produce seed as part of their production system and there is the realisation that there is good potential for the systematic involvement of the farming community in producing seeds of locally valued crops as a supplement to the activities of the private sector. A few initiatives are already underway: ENDA, a Zimbabwean NGO, has been working with sorghum farmers in western Zimbabwe; and GTZ have set up a project, also in Zimbabwe, to develop concepts for seed production by small scale farmers in southern Africa. In Malawi, the governmental Small Scale Seed Production programme has, since 1977, used farmers to produce certified seed of improved varieties. However, this programme suffered problems due to the logistical difficulties involved in the Seed Technology staff needing to visit a large number of small farming units. This programme is currently being revised. Learning from the experiences of these, and similar projects, particularly in view of the need to ensure financial sustainability, there is great scope for implementing on-farm seed programmes elsewhere if the problematic experiences can be overcome.

46. Quarantine laws are designed to prevent the ingress of harmful pests and pathogens into a country. Many existing sets of legislation are based heavily on those of developed countries which have a different pest spectrum. There is an urgent need to rationalise quarantine laws so that the proscribed pests and pathogens relate to the agricultural environment of the country concerned. This should help prevent delays in movement of germplasm between countries (which is the principal source of material for breeding improved lines).

47. Whilst there is a good case for having a seed certification process for the commercial sector where high quality seed and varietal purity are important, there is good potential to re-examine the needs of small scale farmers and to revise the legislation to ensure that they have access to the best possible seed type and quality with the minimum amount of bureaucracy. ODA's funding of a study of Seed Regulatory Frameworks, by ODI and CAZS goes some way towards addressing these issues.

48. With the move towards liberalisation, there is also the potential for economic studies to identify which sectors of the economy are best placed to produce what seed type, which crops, for which end users, in the most cost effective manner. These studies could include both seed production and distribution activities and examine the private and public sectors (including NGOs, farmer groups, and the university sector) in relation to their level of expertise in seed technology. ODI, with ODA funds, has already produced an overview of NGOs in the seed sector, including some case studies, that serves as an excellent starting point for future work.

49. Quality is a particular issue in the commercial sector. With the global move towards market liberalisation, there is an emerging private sector of seed producers and

entrepreneurs. The private sector tends to concentrate its efforts on the high value crops such as hybrid vegetables but frequently experiences difficulties with maintaining seed quality. The methods and requirements for maintaining quality are clearly understood from a technical standpoint. The problem in this case is one of training and of trying to maintain quality with limited resources. Support to the private sector has the potential to increase seed availability at the farmer level, to help the local economy and to free up the resources of the public sector establishments to concentrate on, or fund, the less commercially attractive, though still important, crops. One aspect to which particular attention must be paid is seed packaging - both in terms of package type and packet size. Packet size should reflect the likely quantities that a farmer would wish to buy in order to plant their plot, rather than the convenience of the manufacturer.

50. At community level, seed banks are sometimes promoted as a component of overall food security. However, the history of similar community food stores suggests that such seed banks may not prove to be successful and so their suitability, both economically and socially, needs to be evaluated at an early stage.

51. Agricultural crises, as a result of natural calamity or political strife, are still common in many parts of the world and can lead to serious loss of local seed stocks. It is important that in replacing seed during emergency responses, appropriate seed is used, so that the plants are physiologically adapted to the local environment and that the food stuffs are acceptable to the community. The international response to the Rwandan crisis, through the Seeds of Hope initiative, was successful because seeds of stocks of Rwanda's six most important food crops were being held in national and international genebanks and could be multiplied in neighbouring countries and returned to Rwanda for farmers' use. This laudable and highly effective response highlighted the general problem that no well developed framework for action exists to allow rapid response to other similar crises. For such a framework to be developed the following actions would need to be taken.

a) A clear understanding should be developed of the current seed supply networks (both formal and informal).

b) An appraisal and documentation should be made of the range of diversity existing in each of the agro-ecological zones (bearing in mind that the marginal areas may house the greatest biodiversity and may therefore be affected to the greatest extent during a crisis).

c) Links should be established with local institutions (both formal and informal) that are capable of multiplying seed material or carrying out landrace enhancement. These groups may be in the NGO sector, for example SEARICE in the Philippines is very active in promoting the use of traditional rice varieties and is able to supply farmers with seed material.

52. Response to crises such as drought or war falls under the general heading of national seed security. Some proposals have been put forward to examine the problems of rationalising response to these crises, for example the FAO seed security project which anticipates contracting the private sector to multiply seed; the ICARDA proposal to establish national carry-over seed stocks, regional seed security reserves, community based

seed banks and strategic areas seed reserves; and the IPGRI suggestion to take the Seeds of Hope model but to incorporate social and political factors into the methodology.

Information needs

53. Training is a key area and yet seed technology rarely plays a major role in the curricula of extension staff. The potential knock-on effect of better staff training (leading to a deeper appreciation of the constraints) in terms of farmer-saved seed quality, with resultant improved seed vigour, would undoubtedly be beneficial. The private sector also has a great need for assistance in seed marketing, with obvious benefits for farmers in terms of increased seed availability. Particular training is required in forecasting, costing, transport and logistics as well as in the technical aspects.

54. NGO staff, particularly those involved in emergency responses involving seed inputs, could usefully be trained in the technical requirements of seed storage and in the role and value of diversity at farmer level. This should reduce the chances of inappropriate seeds being offered to communities. A rational dialogue with NGOs may help to dissuade the more radical groups from their stance of, for example, refusing to use 'new' varieties on political grounds.

55. Training networks are currently being developed by IPGRI for dissemination over the internet. Although available to a limited audience at present, as computers become more widely available in developing countries, these focal points for information will become invaluable. Current emphasis is on providing the necessary backbone information for the running of a Plant Genetic Resource Conservation and Use course and the outline curriculum can be found under Training Materials at <http://www.cgiar.org:80/ipgri/>. Topics directly relevant to seed include *in situ* and *ex situ* conservation, germplasm use and germplasm health.

56. Formal courses, in the UK, suitable for senior staff include:

- MSc / Diploma in Seed Technology - University of Edinburgh;
- MSc / Diploma in Conservation and Utilisation of Plant Genetic Resources - University of Birmingham with the Royal Botanic Gardens, Kew.
- MPhil in Plant Breeding and Crop Improvement - University of Reading with the University of Birmingham

Ad hoc and short courses are also provided by the National Institute of Agricultural Botany and by the Forestry Commission.

57. Some intra-regional seed information networks exist. Examples are the FAO funded, but now primarily commercial, Asian and Pacific Seed Association (APSA) in Bangkok; the SADC Plant Genetic Resources Centre (SPGRC) in Zambia with the remit of establishing a regional centre in Lusaka plus national centres for plant genetic resources in each member country over a 20 year period; the SADC Tree Seed Centre Network; the WANA (West Asia and North Africa) network, coordinated by the WANANET Steering

Committee whose Secretariat are based at ICARDA, Syria, covers 18 countries and acts as a forum for exchange of information on all aspects of the seed sector (seed policy, seed health, training needs etc.) as well as initiating proposals that have a regional focus. A similar network is to start in West Africa in mid-1996 with GTZ funds and the success of the WANA network suggests that it could also be appropriately extended to other areas of the world.

58. Regions that appear under-resourced in terms of networking are East Africa and the Caribbean (although FAO does have a project for the English speaking countries in the latter - Improved Seed Production in the CARICOM Countries). The Caribbean poses particular challenges because of the range of languages spoken.

PRIORITIES FOR SUPPORT

The preceding analysis has outlined areas of the seed sector that appear to warrant support and have been highlighted by respondents either in conversation or in response to the postal request for views. In this section, only those topics that were raised by a number of the respondents are given. These topics are divided in terms of ODA's own strategy objectives given in paragraph 5. An indication is given for each topic as to the support it received from the respondents. It is not considered useful to give a numerical ranking of the topics, in terms of the number of times the topic was suggested, because the institutes contacted often had specialised interests and were unable to comment on the wider issues. The list represents the author's interpretation from these sources. Those topics which are of immediate priority are marked below with a hollow square (□).

a) Policy and institutional reform

- Harmonisation and rationalisation of seed certification, seed quarantine and varietal testing and release procedures at regional or sub-regional levels. This was considered extremely important by the World Bank, the CGIAR centres and bilateral donors like GTZ as well as groups such as CAZS.
- The development of framework procedures that would allow the international community to respond to seed needs in the wake of natural or political disaster. The NGO sector, FAO, the CGIAR centres and some academics felt that this was highly desirable.

b) Sustainable resource management

- Support to basic research on, and promotion of, the secondary food crops that will allow their seeds to be stored, multiplied and distributed. This includes the minor cereals, traditional vegetables and medicinal crops. This is very high priority on the grounds of improving local nutrition, maintaining biodiversity at farm level and for, potentially, diversifying local trade. This is supported by the CGIAR centres, Kew, NRI and the NGOs.
- Support to pasture crops. Basic and strategic research on the changes in seed quality that occur during seed development and maturation are essential for these species, given that the need to reduce seed loss through shattering results in so many compromises during seed multiplication. The research should also establish seed storage requirements, and devise techniques for re-seeding of degraded rangelands. This was universally highlighted as an important shortfall area with need for early attention.
- The tropical tree sector needs substantial support, again at a basic research level, to allow seeds to be collected, stored, tested, pre-treated and subsequently established. This requires an understanding of seed physiology and germination requirements, which is currently lacking. This will include research on the storage of seeds showing recalcitrant and intermediate seed storage behaviour, dormancy breakage, laboratory testing, and optimal techniques for de-pulping fleshy seeds. This requirement was particularly supported by the CGIAR centres and Kew but also widely supported by other respondents

such as the UK Forestry Commission, GTZ, the Dutch genebank and the International Seed Testing Association.

c) Research and technology transfer

□ Training of NGO staff involved in seed handling and distribution, to develop a sounder technical basis for their decision making and to engender a deeper understanding of the need for appropriateness in seed supply. This was an acknowledged need amongst the NGO community and was also raised by members of the international community.

Support to seed information exchange systems either through networks, such as the WANA network, or through the propagation of teaching material such as the pioneering curriculum development work of IPGRI on the internet. This has great potential over the long term although access to the system may limit its use in the short term.

d) Identification and promotion of relevant technologies

□ Cost-effective techniques for long term maintenance of genebank material e.g. the potential of ultra drying and sun drying techniques. This was considered important by all the CGIAR centres contacted and by Kew.

□ Support to participatory breeding initiatives that allow farmers to become involved in development of new varieties, through access to seeds of segregating material, at an earlier stage. This topic was widely supported as a way of making breeding more responsive to farmers' needs.

e) Facilitation of the private sector

□ Training of the private sector in aspects of seed quality maintenance and appropriate packaging as well as in marketing skills e.g. logistics, forecasting and costings. This should also include training in basic seed technology and seed production techniques for entrepreneur farmers who emerge as liberalisation progresses. This was identified by bilateral donors, some of the CGIAR centres and those involved in seed development projects as important.

f) Commissioning studies / research on biodiversity

□ Support to *in situ* conservation initiatives including baseline studies to determine current farmer seed handling and storage practices; farmer criteria for adoption / non-adoption of new varieties; local seed supply systems; determination of how agro-biodiversity changes over time at given localities. These studies are particularly needed in marginal areas and those prone to natural (or political) calamity. This was universally highlighted as being of prime importance.

Development of a GIS eco-zoning system. This would have two functions:

- (i) to allow plant varieties to be related to their appropriate agro-environment, and
- (ii) to gain a better understanding of the relationship between seed quality development and environment (particularly temperature).

This could have important long term value but its feasibility and utility need to be examined first. It was suggested by some of the CGIAR network, Kew and The University of Reading as being useful.

B - Synopses of UK organisations, active in the seed sector, who responded to the request for information

ACTIONAID

Centre for Arid Zone Studies (CAZS)

Forestry Commission

Henry Doubleday Research Association (HDRA)

Horticulture Research International (HRI)

Institute of Grassland and Environmental Research (IGER)

John Innes Centre

National Institute of Agricultural Botany (NIAB)

Natural History Museum

Natural Resources Institute (NRI)

Overseas Development Institute (ODI)

Oxford Forestry Institute (OFI)

Plant Testing Station - Northern Ireland

Royal Botanic Gardens, Kew

Scottish Agricultural Science Agency

Silsoe College

UK Agricultural Supply Trade Association (UKASTA)

University College London

University of Aberdeen

University of Edinburgh

University of Reading

World Vision

ACTIONAID

ACTIONAID is a London based development NGO, formed in 1972. **ACTIONAID** works in 20 countries with some of the world's poorest communities to enable them to alleviate their poverty and secure lasting improvements to their quality of life. **ACTIONAID**'s long-term development programmes are designed to tackle the problems of poverty, including food production and environmental damage.

Seed related activities

The main focus of the seeds work has been in Africa and has ranged from emergency interventions to the development of small-scale seed enterprises within the overall strategy of improving household food security.

Seed distribution schemes have formed part of production support and rehabilitation programmes in Malawi, Ghana and Mozambique and the experience gained from these is in the process of being documented by the agency. Local level seed availability and distribution are being addressed by programmes in The Gambia, Ethiopia and Malawi, where a national level project to increase the supply of appropriate, high quality seed and planting materials for food crops through the establishment of seed producer groups is in its first season.

Several country programmes are also working on seed storage losses, community seed stores and revolving seed credit activities to improve the quantity and quality of farmer-saved seed.

Geographical focus

ACTIONAID works in 20 countries of Africa, Latin America and Asia.

Principal staff

Ms Laura Kelly - Natural Resources Adviser

Ms M Buchanan Smith - Head of Emergencies Unit

Centre for Arid Zone Studies (CAZS)

CAZS was formed in 1984 and functions as a self-financing and semi-autonomous unit of the University of Wales, Bangor. The centre was established primarily to promote sustainable agricultural and forestry development in arid and semi-arid lands.

Seed related activities

CAZS manages the ODA Plant Sciences Research Programme which has an annual budget of £1.6 million. The principal focus of this programme is in the use of biotechnology to help breed improved crop varieties. The main components are the use of molecular markers to tag economically important genes and genetic engineering to produce resistant varieties. The programme is also supporting projects on participatory plant breeding in Nepal, and on-farm seed priming in India and Zimbabwe.

CAZS are also involved in farmer participatory plant breeding (Nepal) and participatory varietal selection (India). With ODI, the centre has a project for 'Small farmer seed supply: reforming regulatory frameworks for testing, release and dissemination'. Case studies from India and Nepal have been completed; Pakistan, Philippines, Kenya, Zimbabwe, Bolivia and Colombia, have been included in Phase II. CAZS is concerned with assessing the appropriateness of pre-release varietal testing sites and methods.

Geographical focus

World-wide

Principal staff

Dr John Witcombe - Participatory plant breeding and varietal selection, seed regulatory frameworks, genetic resources and biodiversity, varietal popularisation, small farmer seed supply.

Dr D S Virk - Participatory varietal selection, seed regulatory frameworks, participatory plant breeding.

Dr J Gorham - Pre-breeding identification of resistance traits.

Dr P A Hollington - Seed production of forage legumes, participatory varietal popularisation.

Dr D Harris - Seedling establishment, on-farm seed priming.

Forestry Commission

The Forestry Commission carries out applied and, to a lesser extent, strategic research on tree seed within its Plant Production and Tree Improvement branches.

Seed related activities

The principal aims of the seed research programme are to improve quality and performance of tree seed, which are often poor and unpredictable. It also aims to improve the forecasting accuracy of laboratory seed tests. This information is increasingly applied to the topics of seed ecology, natural regeneration and *ex situ* conservation.

Nursery research concentrates on improving husbandry methods for bare root and container seedlings, plus developing methods for vegetatively propagating selected genotypes of broad-leaved trees.

The Plant Production branch also acts as the British Official and Advisory Testing Station for tree and shrub seeds.

Geographical focus

Mainly UK and temperate although contracts have been carried out on Mediterranean, tropical and sub-tropical species.

Principal staff

Dr Peter Gosling - seed storage, testing, dormancy, pre-treatment and germination.
Currently chairman of ISTA Forest Tree and Shrub Seed Committee.

Dr S Jones - seed dormancy, pre-treatment and germination

Mrs Y Samuel - seed testing

Mr W Brown - seed orchard establishment and management

Dr S Lee - progeny and clonal testing

Dr C Samuel - seed origin, provenance and gene conservation

Henry Doubleday Research Association (HDRA)

HDRA was given charitable status in 1958 and is well known for its work on organic farming. Of particular relevance to the seed sector are the International Research Department and the Genetic Resources Department.

Seed related activities

HDRA has a particular interest in the seed sector relating to its activities in conservation and distribution of crop varieties, vegetable variety testing and agroforestry. HDRA manage including the collection and distribution of potentially useful drought-resistant, multipurpose tree species in parts of Africa and Asia. In India, HDRA has also given advice on tree species choice for agroforestry together with assistance on purchasing and supply of high quality seed.

HDRA has also been involved in the micropropagation of the Andean tuber crops oca, *Oxalis tuberosa* and melloca, *Ullucus tuberosus*.

Geographical focus

UK with projects undertaken in Cape Verde, India, Oman, South Africa and China.

Principal staff

Dr Philip Harris - Head of International Research Dept.

Dr Jeremy Cherfas - Head of Genetic Resources Dept.

Dr Elna Lennartsson - Head of Temperate Research

Horticulture Research International (HRI)

HRI was established in 1990 to serve the R&D needs of the horticultural industry. It is managed by a non-executive Board of Directors and is funded through contracts and commissions from MAFF, the Office of Science and Technology and from horticultural growers.

Seed related activities

HRI is involved in a wide range of seed related research both at its Wellesbourne site and through UK and international collaborations. Over the past five years seed activities have been focused on the following topics:

- 1) Physiology of farm-woodland and forestry seeds (dormancy and recalcitrance) to provide a basis for improving seed viability and longevity.
- 2) The physiological and biochemical basis of seed vigour.
- 3) The techniques and management practices of medium and long term seed storage for genetic resources conservation.
- 4) Physiological studies on tomato seed production, development and germination.
- 5) The importance of factors in the pre-emergence phase influencing seedling establishment.
- 6) Priming techniques for the production of germinated seed and its separation from non-germinated seed.
- 7) Seed quality in bedding plants.
- 8) Timing irrigation during vegetable crop establishment.
- 9) Minimising insecticide use (through seed treatment and film coating techniques).
- 10) Application of biocontrol agents to seeds.
- 11) Quantification of seed germination characteristics of important weeds in vegetable crops.
- 12) Process engineering of seeds (large scale priming and film coating technologies).
- 13) The nature of recalcitrant seed behaviour.

Geographical focus

UK and world-wide

Principal staff

Dr W E Finch-Savage - physiology and biochemistry of recalcitrant and orthodox seeds, seed technology, crop establishment

Dr D Gray - vegetable seed crop production, seed treatment, seed physiology

Dr M Bettey - seed biochemistry and molecular biology

Dr A Grundy - seed physiology and ecology

Dr D Astley - genetic conservation (vegetable gene bank)

Dr R Maude - seed pathology and seed treatment

Mr D Suett - seed treatment technology

Mr G Petch - seed technology

Dr H R Rowse - seed technology

Institute of Grassland and Environmental Research (IGER)

IGER is one of the institutes supported by the Biotechnology and Biological Sciences Research Council. It has four broad research themes: genetics and plant improvement; basic plant and microbial science; environmental and land management research; ruminant nutrition research.

Seed related activities

Seed issues are particularly addressed by the Genetic Resources Unit and the Herbage Seed Research Unit. The Genetic unit was formed in 1964 with the main objective of collecting and characterising forage grasses to provide contrasting material for studies of population genetics, cytogenetics and plant physiology. In addition, elite populations are provided for variety production. The Unit manages a genebank with over 7600 accessions, mainly of temperate forage grasses and legumes and includes advanced cultivars, breeding material, landraces ecotypes and wild populations. There is particular emphasis on *Lolium* and *Trifolium* species.

The Herbage Seed unit is involved in a wide range of research from the physiological processes involved in seed production through to the agronomic practices necessary for seed production of forage grasses and legumes. Genetic differences are studied with particular emphasis on fertilisation and seed development. Research by the breeding groups is put into practice via links with commercial partners and into industry.

Geographical focus

Mainly Europe

Principal staff

Genetic Resources Unit

Dr N R Sackville Hamilton - Head of Biodiversity Group

Ken Chorlton - Genebank management, plant collection, seed multiplication

Ian Thomas - Genebank management, plant collection, documentation

Herbage Seed Research Unit

D Hides - Head of Plant breeding Department, Head of Grass Breeding Group

Dr A Marshall

John Innes Centre

The Centre has a staff of over 600 scientists involved in a range of fundamental, strategic and applied research. There is also a strong training element at the Centre with a particularly strong post-graduate training system supporting in excess of 130 students.

Seed related activities

These take place within the Genetic Resources Unit which maintains a number of important germplasm collections. The collections are all working collections housed in a purpose built facility maintained at 1.5°C and 7%RH with some 600m³ of storage capacity. Extensive characterisation data on large parts of the collection collected over many years has also been computerised and is available upon written request. All accessions are available free of charge subject to availability. The following collections are maintained:

1. BBSRC Cereals Collections.

These collections are the largest and most authoritative in the UK and are very comprehensive in material bred and trialed in the UK and Western Europe. In addition, they also contain a large body of land races from different parts of the world. Summary statistics for the collections are as follows:

Triticum (wheat) - 9000 accessions; *Hordeum* (barley) - 10560 accessions; *Avena* (oats) - 3000 accessions.

2. Collection of Triticeae species.

Includes representatives of all wild and cultivated wheat species, of all species of the closely related genus *Aegilops*, cultivated and wild ryes plus examples of other genera in the tribe Triticeae including *Haynaldia* and *Hordeum*. Also included is the Watkins collection of approximately 850 hexaploid and 350 tetraploid wheats.

3 Precise Genetic Stock Collections.

These collections were mostly developed under the auspices of the European Wheat Aneuploid Co-operative (EWAC) which was initiated and coordinated by the Department. Together the collection constitutes the world's largest and most comprehensive collection of cytogenetic stocks of wheat and related species.

4. The John Innes *Pisum* Collection.

This is a broad based collection, of some 3000 accessions, comprising a wide range of wild and semi-cultivated material. In 1993 the collection became the International genetic stocks centre for the species in collaboration with the Nordic Gene Bank.

5. *Vicia faba* collection.

Comprises 270 accessions, primarily cultivars and breeders lines, built up around the breeding programme run at the former Plant Breeding Institute in the UK.

Principal staff

Mike Ambrose - Genetic Resources Unit

National Institute of Agricultural Botany (NIAB)

NIAB was founded in 1919. Specialising in agriculture, horticulture and food it supplies consultancy, training, information and contract research to governments, supra-governmental agencies, agribusiness and farmers. The Official Seed Testing Station for England forms one of the departments of NIAB.

Seed related activities

NIAB have considerable expertise in the following areas that relate to seed:

- Distinctness, Uniformity and Stability tests for National lists and for Plant Breeders' Rights.
- Seed certification.
- Training for Crop Inspectors and for seed testing, seed sampling and seed technology.

NIAB undertake consultancy work overseas and have been particularly active in Eastern and Central Europe on the operation of National Seeds Schemes, the implementation of Plant Breeders' Rights and Quality assurance of certified seed. More recently work has been undertaken in Russia and China.

Advice has been given to other countries in Latin America and Asia.

Geographical focus

UK and world-wide

Principal staff

Dr Simon Draper - Deputy Director

Dr Mike Wray - Head of Seeds Department

The Natural History Museum

The Natural History Museum in London is one of the world's foremost institutes for the study and classification of animals, plants and minerals. Its unrivalled collections and library contain a wealth of information that supports research in systematic biology and against which ecological and geological change can be measured.

Seed related activities

Seed activities are concentrated in two of the five departments, Botany and Entomology. Staff in Botany specialise in seed morphology and systematics, tropical seed germination, and soil seed banks. Entomological activities concern the systematics, identification and ecology of seed predators and their parasitoids. Identification of unknown seeds, seed predators or their host plants is carried out using the extensive collection material. The museum has over 3 million specimens of higher plants, specialist seed collections

The Museum supports a research station in Belize to facilitate access to tropical forests for seed collection and long-term studies of seed ecology.

Teaching is mostly at PhD level with students registered at various British institutions. The Museum also runs a MSc course 'Advanced methods in Taxonomy and Biodiversity' in conjunction with Imperial College and contributes towards several other Masters level courses.

Geographical focus

World-wide

Principal staff

Botany

Dr N Garwood - seed morphology of neotropical families, tropical seed identification guides, ecology of tropical seed germination, dormancy and seed banks

Dr C Adams - seed morphology and systematics of Spermaceae (Rubiaceae)

Dr C Humphries - seed morphology and systematics of Anthemidae (Compositae)

Dr C Jarvis - nomenclatural advice to ISTA

N Robson - seed morphology and systematics of Guttiferae and Hypericaceae

S Knapp - seed morphology and systematics of Solanaceae

R Vickery - general seed identification, folklore and identification of drift seeds

Entomology

Dr C Lyal - morphology, systematics and ecology of seed feeding weevils

J Ghazoul - reproductive ecology of Dipterocarpaceae with reference to impact of insect seed predators and pollinators

L Cervantes Peredo - seed feeding insects of Guyanese forests

Natural Resources Institute (NRI)

NRI is a scientific institute within the University of Greenwich, and is an internationally recognised centre of expertise in applied research and consultancy in the environment and natural resources sector. Its principal aim is to increase the productivity of renewable natural resources in developing countries in a sustainable way by promoting development through science. NRI has some 250 professional staff from a wide range of scientific, technical and social science backgrounds.

NRI's capability rests on its: interdisciplinary approach to problem solving; dynamic link between technology generation and technology transfer; practical understanding of the development process from socio-economic, environmental and institutional perspectives; and excellent links with the development and scientific communities.

Seed related activities

NRI's expertise centres around extensive on-farm experience and institutional capacity building. NRI have carried out farm-level surveys of farmer practices for seed handling, conditioning and storage. Qualitative studies have been carried out to determine the most successful farmer techniques in order to develop a portfolio of best practices for small-scale farmers.

Current work includes enhancement of landrace vegetable material in Ghana, further studies on effectiveness of farmer seed saving strategies and the development of training material relating to seeds to be incorporated into extension worker and graduate training packages.

Geographical focus

World-wide

Principal staff

Dr Mark Wright - on-farm seed storage

Mr David Walker - on-farm seed storage

Mr Rudy Schippers - vegetable seed production and seed legislation

Overseas Development Institute (ODI)

ODI was founded, in London, in 1960 as an independent non-governmental centre for development research and a forum for discussion of the problems facing developing countries. The Institute's strengths lie in having a broad-based capacity in practical policy research; considerable experience in working at the interface between technology and policy; and capacity to analyse and interpret farm-level information. Within ODI there is a seeds and biodiversity programme which coordinates all seed work.

Seed related activities or key interests

The emphasis of the seeds and biodiversity programme is practical research and dissemination of information about relations between local and formal seed systems, seed policy including seed regulatory frameworks, and the economics and organisation of different seed systems. The programme combines economics and anthropology, and works in collaboration with technologists, in order to provide practical policy analysis capacity. It is linked to ODI's Agricultural Research and Extension Network (AGREN) of 900 field practitioners, which provides a channel for speedy flow of ideas and problems from the field, and the speedy dissemination of the programme's research results.

Geographical focus

World-wide

Principal staff

Ms Elizabeth Cromwell - structure and organisation of the formal seed sector, role of NGOs, local seed supply systems, on-farm conservation of plant genetic resources.

Dr Rob Tripp - indigenous variety development and maintenance, local seed supply systems, seed policy and seed regulatory frameworks, seed enterprise development.

Oxford Forestry Institute (OFI)

The OFI functions within Oxford University's Department of Plant Sciences, and has as its principal internal mission the pursuit of excellence in education and academic research. Its external mission is to maintain and enhance its role and reputation in training, strategic research, information and advice.

Seed related activities

The major seed activity is the collection of seed from a range of, mostly, leguminous trees, for evaluation in field trials.

Studies have been carried out to investigate the genetic diversity of several tree genera notably *Acacia*, *Faidherbia*, *Calliandra* and *Leucaena*.

Support has been given to local seed production for example of *Gliricidia* in Malawi, the Philippines and India.

Geographical focus

Tropics

Principal staff

A J Pottinger

Plant Testing Station - Northern Ireland

The Northern Ireland Plant Testing Station forms part of the Applied Plant Science Division of the Department of Agriculture. The station also incorporates the Northern Ireland Official Seed Testing Station.

Seed related activities

The main areas of work relate to:

- Seed testing
- Seed certification
- UK Plant Breeders' Rights
- UK National List trials
- Recommended Lists
- Research and University teaching

Geographical focus

UK

Principal staff

Dr T Gilliland - plant varieties and seeds

Dr E White - plant varieties and seeds

Royal Botanic Gardens

The Royal Botanic Gardens is split between two sites; Kew near London and Wakehurst Place in West Sussex.

Seed related activities

The principal seed activities are carried out at Wakehurst Place in the Seed Conservation Section. This section is a part of the Jodrell Laboratory based at Kew which specialises in research in anatomy, biological interactions, molecular systematics, cytogenetics and seed conservation. The Seed Conservation Section comprises a Seed Bank of international significance containing collections representing 10% of the world's genera and 53% of the world's plant families. Focusing on tropical dryland species, 30 plant families have been identified as primary targets for collection. Kew's Seed Bank is supported by a research group engaged in applied and strategic research aimed at maximising the storability of bank collections.

Seed Conservation staff contribute to various training courses:

- Plant conservation techniques course and Herbarium techniques course
- MSc in Conservation and Utilisation of Plant Genetic Resources (with University of Birmingham)
- Support to other courses e.g. on cryobiology at York, UK and Cincinnati, USA

Kew has been awarded a £21.6 million pound grant from the Millennium Commission to fund a Millennium Seed Bank. This will build on the existing Seed Bank and will aim to conserve seeds of the entire seed bearing British flora by the year 2000 and a further 10% of the world's flora, principally from the drylands, by the year 2010.

Kew also houses the Survey of Economic Plants for Arid and Semi-Arid Lands (SEPASAL) database. This is used widely by development organisations, aid agencies, and researchers who need to know which plants are most suited to particular purposes in the arid and semi-arid areas, for a wide range of uses such as new food sources to soil stabilisation. The database currently has information on 6000 dryland species and a bibliographic database of 150,000 references dealing with plants of economic value.

Geographical focus

World-wide

Principal staff

Mr Roger Smith - Head of Seed Conservation Section

Mr Simon Linington - Seed Bank Manager

Dr Michiel van Slageren - Seed collector (Africa / Middle East)

Mr Michael Way - Seed collector (Americas)

Dr Hugh Pritchard - seed germination, seed storage

Dr Robin Probert - supporting *ex situ* conservation of plant biodiversity

Dr Paul Tompsett - seed physiology, databasing of tropical tree seed research

Scottish Agricultural Science Agency (SASA)

SASA can trace its roots to 1913. It is now an agency of the Scottish Office Agriculture Environment and Fisheries Department. Its work is carried out in three main sectors: Plant varieties and Seeds; Potato and Plant health; Pesticides and Zoology.

Seed related activities

Seeds work is concentrated in the Plant Varieties and Seeds Division. This comprises several sections. The Official Seed Testing Station supervises all tests made for certification purposes in licensed seed testing stations as well as carrying out some of the tests themselves. The Cereals Section is responsible for the technical and administrative work associated with the certification of cereal seed in Scotland. The Herbage and Vegetable Crops Section is responsible for the certification of seed of species other than cereals and potatoes.

Training is an important part of the Division's work and courses in crop inspection, seed sampling and seed testing are regularly run for the UK agricultural industry and overseas scientists.

SASA is one of three groups world-wide developing a Machine Vision capability. This system uses a combination of video camera and micro-computer to automatically detect contaminant seed in certification samples. This will eventually allow high throughput rates with very high levels of accuracy.

Geographical focus

Mainly Scotland

Principal staff

Mr Simon Cooper - Deputy Director (Plant varieties and Seeds Division)

Mr Ron Don - Head of Official Seed Testing Station

Mr Jack Davidson - Head of Cereals Section

Mr Niall Green - Head of Herbage and Vegetables Section

Silsoe College

Silsoe College is part of the School of Agriculture, Food and Environment of Cranfield University. The group with closest ties to the seed sector is the Postharvest Technology Department. Silsoe has an extensive programme of pure and applied research and development both in the UK and overseas, including £4.5 million of contract work.

Seed related activities

Expertise within the Department relates to primary processing, handling, storage, and marketing of seeds. Current main research areas include: crop storage technology, effects of storage conditions on crop physiology, non-destructive assessment of crop quality, and processing techniques.

Specialised courses are run relating to seed. These can be tailor-made such as a five day seed treatment programme or more formal undergraduate and postgraduate courses. MSc courses with a seed component include:

- Postharvest Technology (with Crop market technology or Tropical crops options)
- Agricultural Engineering (with Tropical crop storage and processing option)

Geographical focus

World-wide

Principal staff

Dr Brian Clarke - seed cleaning and seed treatment

Mr M Paul Douglass - storage structures

Mr Brian Stenning - quality monitoring of seed

Dr Naresh Magan - seed diseases and mycotoxins

Dr Julia Aked - plant pathology

UK Agricultural Supply Trade Association (UKASTA)

UKASTA represents some 400 companies and cooperatives which are either manufacturers or agricultural merchants who sell inputs (including seeds) in the UK.

Seed related activities

UKASTA's main aims are to:

- achieve the most favourable economic conditions possible for members through effective lobbying;
- assist members to realise their maximum business potential by supplying timely and accurate information; and
- enhance public understanding of modern food and farming methods and the role played by the agricultural supply industry.

UKASTA is also the recognised Industry Training Organisation for the agricultural supply trade. As such it defines and monitors the sector's skill requirements, seeks to establish standards for key occupations and acts as a link with governmental departments and other bodies on training and vocational issues.

UKASTA also incorporates UKAFIS - the UK arm of the International Seed Trade organisation.

Geographical focus

UK

Principal staff

Mr Paul Rooke - Manager, Seeds

University College London - Department of Anthropology

The Department of Anthropology at UCL is the largest anthropology department of any UK university. The wide range of anthropological research carried out at UCL reflects the Department's commitment to a broad-based conception of the discipline and the many varied research interests of both staff and students. Work on the seed sector is currently undertaken by Professor Paul Richards and three post-graduate research students, Kate Longley, Sandra Squires and Dan Taylor.

Seed related activities and Principal staff

Paul Richards has been studying indigenous knowledge and informal seed systems in central Sierra Leone for over 15 years. His most recent work has focused on the impact of war on the formal (state-run) and informal (farmer-managed) seed sectors, and addresses the need for greater awareness of seed issues in relief and rehabilitation interventions. In Sierra Leone, he has worked with the various institutions of the National Agricultural Research System and a number of NGOs, most notably CARE and ACTIONAID. He is presently involved with the Community Biodiversity Development Conservation (CBDC) Programme in Sierra Leone.

Kate Longley is also involved with the CBDC Programme in Sierra Leone and has carried out her fieldwork in close association with the Rice Research Station at Rokupr and ACTIONAID-Sierra Leone. Her PhD project focuses on the seed management practices of semi-subsistence farmers and how these relate to social and cultural aspects of wealth. She is particularly interested in the role of farmers in local crop development and, through her association with the CBDC Programme, is involved in designing effective participatory plant breeding strategies.

Sandra Squires' research focuses on the social and cultural aspects of the institutional frameworks within which seed selection is carried out. She is presently undertaking a case study of public-sector institutions (Purdue University, Indiana, USA and the Institut de Recherches Agronomique at Maroua, Cameroon) involved in cowpea improvement and research. An essential element of Squires' research is the study of the patterns of engagement and channels of communication between farmer client groups and crop improvement researchers.

Dan Taylor's study examines the role of landraces and local knowledge of low-input farmers in agricultural development in KwaZulu, Natal, South Africa. His study of farmers' technologies and innovations is presented in relation to the recent political changes in South Africa, to the perceived social decay in the rural areas, to development strategies, and to discourses of modernity. In addition to his own PhD research, he is involved with the seed activities of agricultural development projects in Southern Africa organised through two NGOs: Find Your Feet (UK) and the Centre for Low Input Agricultural Research and Development (South Africa).

University of Aberdeen

The Department of Agriculture was founded in 1895. It runs various BSc and seven Masters level courses. Typically 180-200 undergraduates and 280 postgraduates are registered at any one time. About half of the postgraduate students are from overseas. The Department is a member of NATURA, the European Network of Universities active in Tropical Agriculture.

Seed related activities

Seed activities are largely concentrated in the Crop Science Group of the Department of Agriculture. Particular areas of research interest at present are the processes leading to seed production, the mechanisms of seed ageing particularly during storage, techniques for invigorating seeds, methods for assessing seed quality, germination and crop establishment.

Geographical focus

UK, Africa and Asia

Principal staff

Professor Robert Naylor - Temperate and tropical cereals. Seed production, crop establishment, cereal physiology, soil seed banks. Member of Editorial Committee of Seed Science and Technology.

Dr Alison Powell - Temperate and tropical grain legumes, small-seeded vegetables. Seed quality issues, seed treatments, seed production and storage, seed response to stress.

Dr S Matthews - Grain legumes, small-seeded vegetables, cereals. Crop establishment, seed production and storage, plant growth regulators.

Dr Barrie Seddon - Grain legumes, small-seeded vegetables. Biocontrol of diseases using Bacillus seed treatments

Dr Trevor Stuchbury - Grain legumes, small-seeded vegetables, cereals. Biochemical analysis of seed coats, metabolic changes in response to stress.

Dr I Bingham - Maize. Factors affecting post-germination growth, in particular the effect of seed ageing.

University of Edinburgh (Institute of Ecology and Resource Management)

The Institute of Ecology and Resource Management (IERM) was formed in 1990 by an amalgamation of the former Schools of Agriculture, Forestry and Ecological Sciences as part of a wider reorganisation of Biological Sciences within the University. Its teaching and research interests span both the utilisation and the conservation of renewable natural resources. The Institute offers a number of specialised postgraduate taught courses at Masters level, mostly organised in a modular format. Teaching resources of the Institute are greatly enhanced through close collaboration with the Scottish Agricultural College (SAC) which shares the same building.

Seed related activities

Teaching and study tours

The most important seed activity at Edinburgh is the Postgraduate Course in Seed Technology, a one year taught course leading to an MSc degree or Diploma. The course was established in 1976 and to date has received 250 students from 55 countries, mostly in the developing world. Many former students now occupy key positions in national programmes and commercial organisations. Collectively they provide a substantial network of contacts world-wide. The course has a clear objective to provide a comprehensive and integrated coverage of the subject required by senior staff such as technical managers and planners, with a strong orientation towards the needs of developing countries. Close links are maintained with commercial seed companies to show the managerial aspects while the regulatory context is well covered by the participation of staff from the Scottish Agricultural Science Agency (SASA). The course is unique in providing an intensive coverage of the subject leading to an MSc degree in one year.

Customised training programmes have been organised for many students, typically these last 2 - 4 months and incorporate some parts of the postgraduate course, supplemented by individual work relevant to the trainees needs. The most common focus of these programmes has been quality control of seeds and varieties, statutory requirements and management. Through its wide range of UK contacts, both academic and commercial, the Institute is well-placed to organise study tours for overseas visitors to provide an overview of seed industry activities.

Research and Consultancy

The Seed Technology Unit has provided technical coordination for two major research projects in recent years. One was a collaborative programme in Seed Science and Technology between the UK and India, financed by ODA. The other, executed with ACTIONAID, investigated the opportunities for small-scale seed enterprises in Africa. IERM also provides facilities for laboratory-based research projects in topics such as seed physiology and the characterisation of cultivars. Staff have carried out many consultancy assignments on behalf of UK and other development agencies. The Institute also has a continuing role in the seed component of the Agricultural Support Services Project (ASSP) in Bangladesh which is financed by ODA/World Bank.

Principal staff

Dr Michael Turner - seed industry development, policy issues, training, vegetable crops.
Mr G K Laverack - cultivar technology, variety maintenance, certification, training.
Dr W Spoor - Plant breeding, variety identification by laboratory techniques.

The University of Reading

Located within the Department of Agriculture the Seed Science Laboratory has been involved with seed research since 1969.

Seed related activities

The activities of the Seed Science Laboratory have centred on:

- seed storage and associated problems, especially those of long-term storage;
- seed production and seed quality development;
- physiological quality of seeds (seed vigour) and its effect on crop establishment, growth and yield; and
- seed dormancy, factors affecting its release and their implications for weed control.

Considerable expertise exists relating to conservation of genetic resources. The main research topics relating to this area are:

- identification and classification of seed storage characteristics and methods to improve storage life of difficult (e.g. recalcitrant) seeds;
- the prediction of longevity of orthodox seeds;
- investigations into the accumulation of chromosome aberrations and genetic mutations which are associated with a resultant loss of seed viability;
- development of statistical procedures to monitor seed viability in storage;
- development of dormancy removal procedures; and
- development of engineering criteria and management procedures for medium and long-term stores.

The University offers a two year MPhil in Plant Breeding and Crop Improvement (together with the University of Birmingham).

Geographical focus

World-wide

Principal staff

Professor E Roberts - Seed storage for genetic conservation, effects of temperature and water potential on genetic damage and loss of viability. Factors controlling seed dormancy, especially relating to weed seed survival in the soil.

Professor R Ellis - Seed storage for genetic conservation, effects of temperature and water potential on genetic damage and loss of viability. Seed quality, crop establishment and yield. Seed development and seed production.

Dr A Murdoch - Ecology of weed and crop seed germination and dormancy. Biology of seeds of plant parasitic weeds. Weed-crop modelling.

Dr T Hong - Seed research for genetic conservation, dormancy and germination, ultra-dry seed storage, classification of seed storage behaviour, desiccation sensitivity in seeds, seed development and maturation, tree seed physiology.

World Vision

World Vision UK is a Christian relief and development agency. It is part of the international World Vision partnership which is at work in over 100 countries. The vast majority of World Vision's operations consist of long term community development projects focused upon a range of sectors with agriculture as an important component in a number of countries. The agency is also active in emergency relief and undertakes advocacy initiatives.

Seed related activities

Provision of seeds and tools to vulnerable families/groups as part of food security initiatives in emergency and rehabilitation contexts. Mozambique, Angola, Liberia, Southern Sudan and Zaire.

Rehabilitation of and support to agricultural technical and extension services. This has included the provision, testing and multiplication of new seed varieties in collaboration with local farmers. Mozambique and Angola.

Both the ODA and EC have provided valuable and substantial support to these initiatives in recent years.

Geographical focus

Africa (for seeds work)

Principal staff

Joe de Vries, Agriculture Co-ordinator Africa (for seeds expertise).
P.O. Box 1490, Kaneshi, Accra, Ghana

Tel 233-21-226643 Ext 259 Fax 233-21-230178

Lesley Sitch, Agriculture Programme Co-ordinator Mozambique.(for seeds expertise)
World Vision Mozambique, Caixa Postal 2531, Maputo, Mozambique.

Tel 258-1-426743 Fax 258-1-428624

Susan Barber, Manager Africa/Latin America.
World Vision UK, 599 Avebury Boulevard, Central Milton Keynes, MK9 3PG

Tel 01908-841000 Fax 01908-841015

C - Synopses of international organisations, active in the seed sector, who responded to the request for information

Asian Vegetable Research and Development Centre (AVRDC), Taiwan
Centre for Plant Breeding and Reproduction Research (CPRO-DLO), The Netherlands
Danish Government Institute of Seed Pathology, Denmark
Environment and Development Activities (ENDA), Zimbabwe
FAME Agricultural Centre, Nigeria
FAO, Italy
Gesellschaft für Technische Zusammenarbeit (GTZ), Germany
ICARDA, Syria
ICRISAT, India
International Plant Genetic Resources Institute (IPGRI), Italy
International Rice Research Institute (IRRI), The Philippines
International Seed Testing Association (ISTA), Switzerland
International Seed Trade Federation (FIS), Switzerland
International Union for the Protection of New Varieties of Plants (UPOV), Switzerland
M S Swaminathan Research Foundation, India
Rural Advancement Foundation International, Canada
Seed Control & Certification Institute, Zambia
Swedish University of Agricultural Sciences, Sweden
Unitarian Service Committee (USC), Canada
University of the Philippines at Los Baños, The Philippines
World Bank (Africa Technical Dept), USA
World Resources Institute, USA

Asian Vegetable Research and Development Centre (AVRDC), Taiwan

AVRDC was established in 1971 as a not-for-profit organisation for vegetable research, development, and training that is committed to the world's food security. The work is carried out within three programme: Crop improvement, Production systems and International cooperation. The Centre also has two regional offices for Asia (Thailand) and for Africa (Tanzania) which help to link the national programmes to headquarters in Taiwan. To achieve its mission, AVRDC has three major objectives: the conservation and characterisation of genetic resources and their use to develop improved varieties; generation of new knowledge and technological innovations for increased productivity of vegetables, with particular attention to sustainability and the prudent use of inputs; strengthening national vegetable research capacity in the developing countries through information services, training and collaborative research.

Seed related activities

Many of the seed activities fall within the Crop improvement programme which can call on the Centre's genebank of over 40,000 accessions which it uses to improve the genetic potential of key vegetables (notably Alliums, crucifers, eggplant, legumes, pepper and tomato).

Geographical focus

World-wide

Principal staff

Dr George Kuo - Director, Crop improvement programme

Centre for Plant Breeding and Reproduction Research (CPRO), The Netherlands

The CPRO is part of the Agricultural Research Department (DLO) of the Dutch Ministry of Agriculture, Nature Management and Fisheries. It aims to improve plants and plant production methods to ensure the success of the agricultural and processing industry through increased sustainability and profitability, whilst reducing any adverse effects on the environment.

Seed related activities

A wide variety of seed activities are carried out, although the emphasis is on research, policy and legislation, biodiversity and individual training. As part of the Wageningen Seed Centre¹ they also run short courses on plant breeding and seed technology, and MSc and PhD programmes.

The plant breeding programme concentrates on raising the genetic potential of target varieties either through traditional breeding techniques or, increasingly, through the use of biotechnology. The Dutch genebank is located at CPRO-DLO with 15,500 accessions allowing access to a wide range of genetic variability.

Seed technology research concentrates on all aspects of seed quality including seed health and vigour as well as coordinating all national seed testing activities.

Geographical focus

Particularly western Europe but also world-wide

Principal staff

J Hardon - genetic resources
G Langerak - seed health
W de Boef - participatory conservation strategies
N Louwaars - seed legislation and policy
F Krens - biotechnology
C Snijders - arable crops
G Grubben - vegetables and fruit

¹ The Wageningen Seed Centre is a collaborative body of five institutions: CPRO-DLO; the Departments of Plant Breeding, Agronomy and Plant Physiology of Wageningen Agricultural University; and the International Agricultural Centre.

Danish Government Institute of Seed Pathology for Developing Countries (DGISP),
Denmark

The DGISP was established in 1967 in recognition of the losses caused by seed-borne and seed-transmitted diseases and the significance of seed health in relation to food production. The Institute serves as a teaching, training cum research centre for countries eligible for Danish aid.

Seed related activities

DGISP's main functions are to:

- to train plant pathologists and seed technologists from developing countries in seed pathology including seed health testing;
- to conduct research on seed-borne diseases of the Third World both at the Institute and through cooperative projects in developing countries;
- to assist developing countries in introducing seed pathology courses and in implementing routine seed health testing in seed certification schemes and plant quarantine;
- to provide services and technical assistance in the field of seed pathology to countries eligible for Danish bilateral assistance.

The Institute runs annual diploma courses, of nine months duration, on Seed Pathology. In addition, the Institute also runs short (2-8 weeks) courses which are tailor made to recipients needs. These are run either in Denmark or in the host country.

Geographical focus

World-wide

Principal staff

Dr S Mathur - Director, mycology

Mr Henrik Jørskov Hansen - Deputy Director, mycology

Dr Hanne Wolffhechel - Assoc. Professor, mycology

Mr Sven Erik Albrechtsen - Assoc. Professor, virology

Dr Carmen Nieves Mortensen - Assoc. Professor, bacteriology

Environment and Development Activities (ENDA), Zimbabwe

ENDA is an NGO working, since 1983, with people in rural and urban areas striving to improve their lives and their resources in a sustainable way.

Seed related activities

Seeds fall under the Sustainable Natural Resources Management programme which has three components; seeds action, integrated grain storage and farm income generation. Seeds Action is a long-term project to identify indigenous small grains liked by farmers, for the farmers to improve the landraces, bulk them and to make them available as a gene bank and a germplasm resource tolerant to drought. The project aims to increase demand for indigenous seeds, to secure household food security and improve small scale farm incomes.

Geographical focus

Zimbabwe

Principal staff

Mr Takawira Ndiripo - Manager, Sustainable Natural Resources Management

Fame Agriculture Centre (Nigeria)

FAME is an NGO with the general objective of making significant contributions to agriculture and rural development, as well as land use planning and development in urban areas of Nigeria.

Seed related activities

Specific objectives relating to the seed sector include:

- to engage in programmes with a view to increasing and diversifying the food basket;
- to increase the raw material base in order to enhance the exploitation and utilisation of the industrial potentials of local plant resources
- to promote the training and development of local expertise in agroforestry and farm extension services

The Centre is particularly active in production of seedlings and grafted material of trees and shrubs. They also maintain a collection of 28 plants with medicinal properties and has a strong interest in the conservation of indigenous species in the Nigerian flora.

Geographical focus

SE Nigeria

Principal staff

Dr Jonathon Okafor - Managing Director

Seed related activities

Current FAO activities fall under different programmes, summarised as:

- Conservation and management of plant genetic resources (PGR)

1. *Commission on PGR*

The Commission is the inter-governmental body guiding and monitoring the implementation of the Global Plan of Action on PGR for food and agriculture, and it will focus on completing negotiations for the revision of the International Undertaking on PGR and its harmonisation with the Convention on Biological Diversity.

2. *Evaluation and sustainable use of PGR*

This element will include genetic diversity assessment, characterisation and evaluation, and assistance in defining priorities for PGR utilisation relative to crop improvement goals. Activities will relate policy to better reflect farmers' actual requirements for appropriate improved seed and planting material. This programme also covers the international network of *ex situ* collections held under the auspices of FAO. The *in situ* component will continue to promote activities for the on-farm conservation of farmers' varieties.

3. *World Information and Early Warning System on PGR (WIEWS/PGR)*

The system provides information on national research programmes on PGR conservation and use as well as details on *ex situ* and *in situ* collections and identifies and registers situations of possible genetic erosion. WIEWS/PGR also proposes programmes to prevent or minimise such erosion and technical support is given for the preparation of the periodic reports on the State of the World's PGR.

- Seed and planting material development

4. *Seed and planting material information and technology*

Priority is given to collecting, processing and dissemination of technical material on variety performance, seed sources and seed multiplication technologies, and distribution of samples of improved varieties for experimental purposes.

5. *Strengthening seed policies and programmes*

Activities aim to define criteria for the formulation and implementation of regional and national seed policies and programmes, including cooperation between developed and less developed countries.

6. *Improved on-farm seed production*

To aid smallholders and rural communities in marginal and remote areas to improve on-farm seed production and storage technologies, particularly through network promotion.

7. *Development of seed security*

To assist governments of member countries to develop regional and national strategies and programmes to overcome the disruption of seed availability due to recurrent natural and other calamities.

Geographical focus

World-wide

Principal staff

Dr U. Menini - Chief, Seed and Plant Genetic Resources Service (AGPS) .

Dr J. T. Esquinas-Alcazar - Secretary, Commission on Genetic Resources for Food and Agriculture, AGPS

Dr C. H. Rosell - Senior Officer, Seed Production Group, AGPS

Dr N. M. Anishetty - Senior Officer, Plant Genetic Resources Group, AGPS

Mr David Cooper - International Conference and programme for plant genetic resources

Gesellschaft für Technische Zusammenarbeit (GTZ), Germany

GTZ is a federal corporation with a development-policy mission: to improve the fundamentals of human existence in the South and East and to stabilise the natural conditions for life. It was set up in 1975 and is responsible for Technical Cooperation activities.

Seed related activities

GTZ considers seed programmes under four crop sector headings: food crops; industrial, plantation crops and renewable raw materials; fodder crops; horticulture and tree crops. The projects are divided according to thematic focus as follows:

- development adaptation and increased use of conventional and modern biotechnologies - particularly with reference to crops propagated by root and tubers
- genebanks - GTZ gives direct support to the genebanks in Ethiopia, Costa Rica and Kenya
- plant breeding, seed production, distribution and marketing - the greatest number of seed projects supported by GTZ are in the seed production sector
- seed certification and variety registration - GTZ currently supports programmes in Morocco and Egypt
- production of planting material for trees
- small-scale seed sector - support to on-farm seed initiatives is considered to be a priority area

Geographical focus

World-wide

Principal staff

Dr H Rudat - Senior planning officer
J Wadsack - Planning officer

International Centre for Agricultural Research in the Dry Areas (ICARDA), Syria

ICARDA is one of the 16 international research centres supported by the CGIAR network and was established in 1977. Headquartered in Syria, ICARDA works primarily on the following crops: barley, wheat, chickpea, lentil, pasture and forage crops.

Seed related activities

Most seed related activities are coordinated by the Seed Unit. This Unit, formed in 1985, has the overall objective of strengthening national seed production capabilities in West Asia and North Africa. The Unit is responsible for:

- training seed production staff;
- strengthening seed production infrastructure;
- producing limited quantities of high quality cereal, legume, and pasture and forage crops seed for distribution to national seed programmes;
- disseminating information and developing training manuals;
- conducting region-related seed technology research.

ICARDA also acts as the Secretariat of the WANA (West Asia / North Africa) regional seed network. This network promotes cooperation, exchange of information and standardises seed production and control procedures in its 18 member countries.

ICARDA holds over 100,000 accessions of its mandate crops in its genebank.

Geographical focus

The dry areas of the world

Principal staff

Dr A J G van Gastel - Head, Seed Unit (till mid 1996)

Mr Zewdie Bishaw - Seed Unit

International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), India

Established in 1972, ICRISAT is one of the 16 international research centres supported by the CGIAR network. Headquartered in India, ICRISAT also has major out-stations in Zimbabwe and Niger. ICRISAT is mandated to research five major crops (pearl millet, sorghum, chickpea, pigeonpea and groundnut).

Seed related activities

Research objectives relating to seed are:

- to develop cultivars resistant / tolerant to the major biotic and abiotic stresses and well adapted to the target production systems;
- to effectively deliver research products and disseminate information through training programmes, workshops, seminars, publications and field days;
- to monitor the adoption of new and existing technologies to ensure that research activities are accurately targeted, and are responsive to the needs of both farmers and the National Agricultural Systems;
- to ensure sustainable improvements in productivity, while conserving the natural resource base and improving the quality of the environment.

ICRISAT holds over 111,000 accessions of its mandate crops from 128 countries.

Geographical focus

World-wide

Principal staff

Dr K Anand Kumar - Director, Genetic enhancement division

Dr John Stenhouse - Director, Genetic resources division

Dr David Rohrbach - Director, Socio-economics and policy division

International Plant Genetic Resources Institute (IPGRI), Italy

IPGRI was established (as the International Board for Plant Genetic Resources) in 1974 and became an independent institute of the CGIAR network in 1994.

Seed related activities

IPGRI's strategic plan, 'Diversity for Development', spells out four major objectives that form the basis of their activities:

- to assist countries, particularly in the developing world, to assess and meet their needs for the conservation of plant genetic resources and to strengthen links to users;
- to build international collaboration in the conservation and use of plant genetic resources, mainly through the encouragement of networks on both a crop and geographical basis;
- to develop and promote improved strategies and technologies for the conservation of plant genetic resources;
- to provide an information service to inform the world's genetic resources community of both the practical and scientific developments in the field.

IPGRI has funded the training of almost 2000 scientists and technicians in all aspects of genetic resources work and has been involved in collecting over 200,000 samples of crops in 120 countries.

Geographical focus

World-wide

Principal staff

Dr Jan Engels - Group Director, Germplasm maintenance and use

Dr Toby Hodgkin - Group Director, Genetic diversity group

Dr Florent Engelmann - Senior scientist, *in vitro* conservation

Dr Abdou-Salam Ouedraogo - Senior scientist, forest genetic resources

Dr Pablo Eyzaguirre - Senior scientist, anthropology and socio-economics

Dr Devra Jarvis - Scientist, *in situ* conservation

International Rice Research Institute (IRRI), The Philippines

IRRI is an autonomous, non-profit agricultural research and training centre, established in 1960, whose purpose is to increase total food production from rice-based farming systems. IRRI is a member of the CGIAR network.

Seed related activities

Plant breeding is a major focus of IRRI's work aiming to increase yields of the major rice types (irrigated; rainfed lowland; upland; flood-prone) as it has been since its success in producing the Green Revolution varieties in the 1960s. Much of this breeding work is carried out in collaboration with national programmes.

IRRI is also committed to conserving and promoting genetic diversity. It has a genebank housing 80,000 accessions of cultivated and wild rice types which are available to breeders world-wide. IRRI coordinates the International Network for the Genetic Evaluation of Rice (INGER) which promotes genetic diversity in rice crops throughout the world through exchange and evaluation of promising rice varieties.

IRRI also offers training opportunities in various aspects of rice production through short courses up to PhD programmes. To date about 8000 scientists have received training from IRRI.

Geographical focus

Rice producing areas of the world

Principal staff

Dr Michael T Jackson - Head, Genetic Resources Centre. Rice germplasm conservation, germplasm multiplication and regeneration.

Dr Twng-Wah Mew - Head, Entomology and Plant pathology Division and Head of Seed Health Unit. Seed health testing, plant quarantine.

International Seed Testing Association (ISTA), Switzerland

The ISTA was constituted in its current form in 1924. It is an intergovernmental association with a world-wide membership of 65 countries. In these countries there are 135 Official seed testing stations.

Seed related activities

The primary purpose of the Association is to develop, adopt and publish standard procedures for sampling and testing seeds and to promote uniform application of these procedures for evaluation of seeds moving in international trade. The secondary purposes are to actively promote research in all areas of seed science and technology (sampling, testing, storing, processing and distributing seeds), to encourage variety (cultivar) certification, to participate in conferences and training courses aimed at furthering these objectives, and to establish and maintain liaison with other organisations having common or related interests in seed.

The bulk of ISTA activities concerns:

- Technical committee of which the most important are germination, purity, vigour, forest tree and shrub seed, plant disease, variety
- Quality assurance which is achieved through accreditation protocols, referee testing, audit visits and the publication of handbooks

ISTA also organises triennial congresses which comprise preliminary technical committee meetings, a symposium for presentation of technical papers, and an ordinary meeting. ISTA also organises periodic workshops to ensure uniform application of the Rules and to keep senior seed testing officers and analysts informed of new developments.

Geographical focus

World-wide

Principal staff

Contact person: Heinz Schmid - Executive Officer

International Seed Trade Federation (FIS), Switzerland

FIS is a non-profit group of national associations as well as individual seed companies. It has members in 54 countries of the world and represents the mainstream of the world trade and serves as an international forum where the general problems of the seed industry are discussed.

Seed related activities

FIS represents the international seed trade, notably in the international governmental and non-governmental organisations. It maintains regular contact with these bodies to promote the viewpoint of the seed industry.

FIS organises an annual congress to act as a forum for business deals as well as to discuss issues relevant to the trade.

The Federation has issued trade rules and usages with a view to clarifying and standardising the contractual relations between buyers and sellers at international level. These rules are complemented by a code and a structure of arbitration for the settlement of international litigations.

FIS aims to promote the use of high quality seed, especially in developing countries. It has instituted a World Seed Prize which rewards those who have contributed to this purpose in an exceptional manner. It has also established a Seed Enterprise Development Programme, a modest but efficient effort by which trainees from developing countries can get acquainted with the most modern methods of seed technology in firms of developed countries.

Geographical focus

World-wide

Principal staff

Bernard Le Buanac - Secretary General

International Union for the Protection of New Varieties of Plants (UPOV), Switzerland

UPOV is an intergovernmental organisation of 30 member states to support the Convention for the Protection of New Varieties of Plants (1961 and revisions). The objective of the Convention is protection of new varieties by an intellectual property right.

Seed related activities

The purpose of the UPOV Convention is to ensure that the member states acknowledge the achievements of the breeders of new plant varieties by making available to them an exclusive property right. To be eligible for protection, varieties have to be

- distinct from existing, commonly known varieties; sufficiently homogeneous; stable (DUS criteria)
- new in the sense that they must not have been commercialised prior to certain dates established by reference to the date of the application for protection

The main activities of UPOV are concerned with promoting international harmonisation and cooperation, mainly amongst its member states, and with assisting countries in the introduction of plant variety protection legislation.

UPOV has established a detailed set of general principles for the conduct of the examination of plant varieties for distinctness, uniformity and stability and more specific guidelines for some 150 genera and species.

The most intense cooperation between member states allow the results from testing of varieties in one country to be accepted in another member country. Through such arrangements countries are able to minimise the cost of operating their own protection systems and breeders are able to get protection in several countries at a relatively low cost.

[At the Uruguay Round of the GATT negotiations, an agreement was reached on Trade Related aspects of Intellectual Property Protection (TRIPS). The agreement obliges all 114 members of the World Trade Organisation to protect plant varieties either by patent or by a *sui generis* system of protection, or a combination of both. The accepted international norm for a *sui generis* system is the UPOV system of plant variety protection. Article 67 of the TRIPS agreement also imposes upon developed countries an obligation to provide the technical assistance and training necessary to enable developing countries to fulfil their obligations under the TRIPS agreement].

Geographical focus

World-wide

Principal staff

Mr Barry Greengrass - Vice Secretary-General

M S Swaminathan Research Foundation, India

The M. S. Swaminathan Research Foundation (MSSRF) was established in 1988 as a non-profit and non-political Trust committed to harnessing science and technology for environmentally sustainable and socially equitable development. The Foundation has 162 full-time scientific and support staff, based in Madras. MSSRF's programmes seek to link ecological security to livelihood security. The Centre for Research on Sustainable Agriculture and Rural Development (CRSARD) was launched in 1990 to carry out MSSRF's research and training goals.

MSSRF's activities promote a pro-nature, pro-poor and pro-woman orientation to technology development and dissemination.

Seed related activities

To convert these concepts into field level action programmes, CRSARD works in the following areas:

- to train women belonging to landless and marginal farmer families in techniques relating to hybrid seed production;
- to promote partnerships between the corporate sector and seed growers;
- to provide small farm families with the benefits of scale in seed production and marketing;
- to increase the availability of good quality seeds and planting material;
- to create awareness about tissue cultured plants;
- to create awareness about Intellectual Property Rights with regard to local and commercial varieties;
- to organise workshops and meetings on women, seed and biodiversity in collaboration with the National Commission for women;
- networking with other NGOs who are interested in replicating or promoting these activities.

Such steps will also help MSSRF to implement effectively the provisions of the Global Biodiversity Convention relating to *in situ* conservation of landraces and will help rural women to derive benefits from the forthcoming 'Plants Varieties Act'.

Geographical focus

India

Principal staff

Dr. M. S. Swaminathan - Chairman, M. S. Swaminathan Research Foundation
Dr. K. Balasubramanian, Project Director, J.R.D. Tata Eco-technology Centre, MSSRF, Madras.

Rural Advancement Foundation International, Canada

RAFI is an international non-governmental organisation dedicated to the conservation and sustainable improvement of agricultural biodiversity and to the socially responsible development of technologies useful to rural societies. RAFI is concerned about the loss of genetic diversity - especially in agriculture - and about the impact of intellectual property rights on agriculture and world food security.

Seed related activities

RAFI's activities tend to fall under one of four headings:

- Biodiversity - food security and genetic resources
- Biotechnology
- Bio-piracy - checking the exploitation of indigenous knowledge
- Bio-policy - strengthening the multilateral framework

RAFI produce a wide range of dissemination materials to alert workers in the field and policy makers to issues that impinge on farmers in developing countries. They are also very active and influential in a range of multilateral fora, both governmental and non-governmental, dedicated to maintaining agro-biodiversity.

Geographical focus

World-wide

Principal staff

Pat Mooney - Executive Director
Jean Christie - Director of International Liaison
Hope Shand - Director of Research
Edward Hammond - Researcher

NB RAFI publications can be accessed on the Internet at:
<http://www.charm.net/~rafi/rafihome.html>

Seed Control and Certification Institute (SCCI), Zambia

The SCCI is a department in the Ministry of Agriculture, Food and Fisheries responsible for all Official Seed Quality Control.

Seed related activities

SCCI comprises the following units: Official Seed Testing Unit; Official Seed Inspection Unit; Seed Research and Development Unit; Seed Training Unit; Administration and Support Unit.

The work programme revolves around:

- routine seed quality testing;
- testing of new varieties to determine their suitability to the Zambian situation;
- training in all aspects of seed technology. Since 1991, with SADC funding, SCCI have run Seed production and technology courses for nationals from SADC countries;
- development and supervision of policy and legislation (e.g. Seed Laws of Zambia, 1966).

Geographical focus

Zambia

Principal staff

Dr Stephen Muliokela - Director (currently on sabbatical to help set up the Golden Valley Agricultural Research Trust in Zambia)

Mr W Silwimba - Assistant Director

Mr E Zulu - Head, Seed research and development

Mrs M Chipili - Head, Seed testing station

Mrs R Mukanda - Head, Seed training

Swedish University of Agricultural Sciences, Sweden

The Swedish University of Agricultural Sciences is the only agricultural university in Sweden.

Seed related activities

There are limited seed related activities and these take place in the Departments of Crop Production Science and of Plant breeding and genetics.

However, Professor Bengtsson has an extensive involvement in the seed sector, particularly as former Director General of the Swedish Agency for Research Cooperation with Developing Countries (SAREC). He was a member of the Keystone Dialogue on Plant Genetic Resources panel up until its final report in 1991. Since 1994 he has been a member of the CGIAR Genetic Resources Policy Committee which is particularly concerned with policy issues.

Current interests include policy issues relating to genetic resources and access to them, IPR, biotechnology, capacity building and international negotiations (FAO Commission on PGR, Convention on Biological Diversity), PBR and farmers rights.

Geographical focus

World-wide

Principal staff

Professor Bo Bengtsson

Unitarian Service Committee of Canada (USC), Canada

USC is a non-denominational, non-profit international development organisation, founded in 1945. USC's programmes cover a wide range of activities including agriculture, vocational training, small business development, health, education and environmental conservation.

Seed related activities

USC's main input to the seed sector is through its Seed of Survival (SoS) Programme in Ethiopia. Begun in 1988, in collaboration with the Plant Genetic Resources Centre, the project works with farmers to help them achieve long term food security. SoS supports farmer-based conservation, multiplication and utilisation of plant genetic diversity of major food crops in stress prone areas of Ethiopia. Activities include:

- seed multiplication of wheat, sorghum, maize, chickpea, fenugreek and vetch by 4680 farmers;
- technical support through landrace enhancement and evaluation and by studies of local storage methods;
- training workshops on Conservation, Utilisation and Enhancement of Plant Genetic Resources.

The USC Bangladesh office have recently initiated a programme with a local research organisation (UBINIG) to campaign for, and promote, biodiversity under small scale farmer conditions.

Geographical focus

Africa and Asia

Principal staff

Mr John Martin - Chief Executive Officer, Canada

Mr Tatek Samare Zarou - Programme coordinator, Ethiopia

Mr M A Zaman - Country director, Bangladesh

University of the Philippines at Los Baños, The Philippines

Seed related activities

The Department of Agronomy, which contains the Seed Science and Technology Division, spearheads the sustainable agriculture movement in the University. The Seed Science Division uses the subject of seed and genetic conservation as a venue to promote sustainability. The division has good contacts with local NGOs and People's Organisations as well as international NGOs, and their teaching, research and extension / training reflects this bias for the informal sector.

The group is also active in the area of IPR advocacy and they actively promote Indigenous Knowledge Systems in relevant aspects of their work.

The Division ran, until 1994, the Agroforestry Seed Information Clearing-house which developed resource materials related to sustainable agriculture and agroforestry, seed and genetic conservation in the Filipino context but which have a regional and international utility. Information is available detailing primary and secondary research results (including farmers and network members) and also practical advice on seed handling and storage.

A regular short course and *ad hoc* courses are held utilising participatory approaches and using the sustainable agriculture framework.

Geographical focus

The Philippines

Principal staff

Pamela Fernandez - Head, Seed Science and Technology Division

World Bank (Africa Technical Dept), USA

The World Bank is a multilateral development institution whose purpose is to assist its developing member countries further their economic and social progress. The term World Bank refers to two legally and financially distinct entities: the International Bank for Reconstruction and Development (IBRD) and the International Development Association (IDA). These two groupings have three related functions: to lend funds, to provide economic advice and technical assistance, and to serve as a catalyst to investment by others.

Seed related activities

The World Bank projects tend to address those problems requiring substantial funding. Programmes typically revolve around the commercialisation of the seed sector so that the seed sector functions via efficient, self sustained commercial enterprises in an increasingly market-oriented and competitive agricultural economy.

Project components tend to include:

- policy reform - deregulation of pricing, introduction of PBR, improvements to seed certification schemes etc.
- seed company commercialisation - through training of private sector companies in improved management and marketing, modernisation of facilities etc.
- institutional strengthening - upgrading of seed certification enterprises, development of seed technology training institutes etc.

In addition to support to the formal sector, there is a growing awareness of the need to support the informal sector. For example, in a project proposal for Ethiopia, the Seed Systems Development Project, both sectors are highlighted as important and so both are targeted for support.

Geographical focus

The World Bank has a world-wide remit

Principal staff

Mr V Venkatesan - Environmentally Sustainable Development Division

World Resources Institute (WRI), USA

WRI is a policy research centre created in 1982 to help governments, international organisations and private businesses to address the question: How can societies meet basic human needs and nurture economic growth without undermining the natural resources and environmental integrity on which life, economic vitality and international security depend?

Seed related activities

WRI's research is aimed at providing accurate information about global resources, identifying emerging issues and developing politically and economically workable proposals.

The Institute's current areas of policy research include forests, biological diversity, sustainable agriculture, economic incentives for sustainable development, and resource and environmental information. They are actively researching legislation regulating access to genetic resources from within their Programme for Biological Resources.

Geographical focus

World-wide

Principal staff

Dr Charles Barber - Senior Associate, Programme in Biological Resources

Appendix 1 UK recipients of request for information

Title	First name	Last Name	Post / Company	Address 1	Address 2	Address 3	Address 4	PostalCode
Mr	Mike	Ambrose	John Innes Centre	Norwich Research Park	Colney Lane	Norwich		NR4 7UH
Dr	Stephen	Blackmore	Dept of Botany	The Natural History Museum	Cromwell Road	London		SW7 5BD
Ms	Anne	Bradley	Forestry Research Programme	University of Oxford	Halifax House	6 South Parks Road	Oxford	OX1 3UB
Professor	Hugh	Bunting	University of Reading	Earley Gate	Whiteknights Road	Reading	Berks	RG6 2AR
Dr	Michael	Camlin	Plant Testing Station - DANI	50 Houston Road	Crossnacreevy	Castlereagh	Belfast	BT6 9SH
Dr	Brian	Clarke	Postharvest Technology Dept	Silsoe College	Cranfield University	Silsoe	Bedford	MK45 4DT
Mr	Simon	Cooper	Scottish Agricultural Science Agency	East Craigs	Edinburgh			EH12 8NJ
Ms	Elizabeth	Cromwell	Overseas Development Institute	Regent's College	Inner Circle	Regent's Park	London	NW1 4NS
Mr	Simon	Croxtton	ITDG	Myson House	Railway Terrace	Rugby		CV21 3HT
Dr	Simon	Draper	National Institute of Agricultural Botany	Huntingdon Road	Cambridge			CB3 0LE
Professor	Richard	Ellis	Dept of Agriculture	University of Reading	Earley Gate	PO Box 236	Reading	RG6 2AT
Dr	W E	Finch-Savage	Horticulture Research International	Wellesbourne	Warwick			CV35 9EF
Dr	Peter	Gosling	Forestry Commission	Forest Research Station	Alice Holt Lodge	Wrecclesham	Farnham	GU10 4LH
Professor	M	Haines	University College of Wales	Welsh Institute of Rural Studies	Penglais	Aberystwyth		SY23 3DD
Dr	Philip	Harris	HDRA	Ryton Organic Gardens	Ryton-on-Dunsmore	Coventry		CV8 3LG
Mr	A M	Hayter	Managing Director	ZENECA Seeds UK Ltd	Station Road	Docking, King's Lynn	Norfolk	PE31 8LS
Ms	Laura	Kelly	ACTIONAID	Hamlyn House	MacDonald Road	Archway	London	N19 5PG
Dr	Jonathon	Kydd	Wye College	University of London	Ashford	Kent		TN25 5AH

Title	First name	Last Name	Post / Company	Address 1	Address 2	Address 3	Address 4	PostalCode
Professor	Michael	Lipton	Dept of African and Asian Studies	University of Sussex	Falmer	Brighton	E Sussex	BN1 9QN
Ms	Catherine	Longley	Research Associate	University College of London	Dept of Anthropology	Gower Street	London	WC1E 6BT
Professor	Robert	Naylor	University of Aberdeen	Department of Agriculture	581 King Street	Aberdeen		AB9 1UD
Mr	Alan	Pottinger	Oxford Forestry Institute	Dept of Plant Sciences	University of Oxford	South Parks Road	Oxford	OX1 3RB
Dr	Wayne	Powell	Scottish Crops Research Institute	Mylnefield	Invergowrie	Dundee		DD2 5DA
Dr	Jules	Pretty	IIED	3 Endsleigh Street	London			WC1H 0DD
Mr	Paul	Rooke	Manager - Seeds	UKASTA / UKAFIS	3 Whitehall Court	London		SW1A 2EQ
Mr	John	Rowley	OXFAM	274 Banbury Road	Oxford			OX2 7DZ
Dr	Rory	Sackville-Hamilton	Institute of Grassland and Environmental Research	Plas Gogerddan	Aberystwyth	Dyfed		SY23 3EB
Ms	Rosemary	Simpson	Centre for Economic Botany	Royal Botanic Gardens	Kew	Richmond	Surrey	TW9 3AB
Mr	Roger	Smith	Head of Seed Conservation Section	Royal Botanic Gardens Wakehurst Place	Ardingley,	Nr Hayward's Heath	West Sussex	RH17 6TN
Mr	Peter	Thomas	World Vision	World Vision House	599 Avebury Boulevard	Central Milton Keynes		MK9 3PG
Dr	Michael	Turner	Institute of Ecology & Resource Management	School of Agriculture Building	West Mains Road	Edinburgh		EH9 3JG
Professor	T A	Villiers	Dept of Biological Sciences	Peel Building	University of Salford	The Crescent	Manchester	M5 4WT
Dr	P	Whitfield	Division of Life Sciences	King's College London	University of London	Campden Hill Road	London	W8 7AH
Dr	John	Witcombe	ODA Plant Sciences Research Programme	Centre for Arid Zone Studies	University of Wales	Bangor	Gwynedd	LL57 2UW
Dr	Mark	Wright	Food Security Dept	Natural Resources Institute	Central Avenue	Chatham	Kent	ME4 4TB
Ms	June	Wyer	Christian Aid	Inter-Church House	35 Lower Marsh	London		SE1 7RL

Appendix 2 Overseas recipients of request for information

Title	First Name	Last Name	Post / Company	Address 1	Address 2	Address 3	Address 4	PostalCode	Country
Information Officer			AGROMISA	Postbus 41	NL 6700 AA Wageningen				The Netherlands
The Documentalist			CARDI	University of the West Indies Campus	St Augustine				Trinidad and Tobago
Centro de Informacion			CATIE	7170 Turrialba					Costa Rica
Information Officer			ENDA	BP 3370	Dakar				Senegal
Information Officer			German Appropriate Technology Exchange	Sustainable Agricultural Division	c/o GTZ	Postfach 5180	D - 6236	Eschborn	Germany
Information Officer			International Agricultural Centre	PO Box 88	6700 AB Wageningen				The Netherlands
Information Officer			NORAGRIC	PO Box 2	N - 1432 Aas/NLH				Norway
Information Officer			North African Seed Bank	c/o ALECSO	Mohammed V Street	PO Box 1120	Tunis		Tunisia
Information Officer			People and Plants Initiative	c/o Man and the Biosphere Programme	UNESCO	Division of Ecological Sciences	7 Place de Fontenoy	F - 75352 Paris CEDEX 07	France
The Director			Seed Technology Laboratory	Mississippi State University	Mississippi State	MS 39762			USA
Information Officer			USAID	2201 C Street NW	Washington DC 20523				USA
Mr	Nitz	Abergas	MASIPAG	9379 Lopez Avenue	Los Baños	Laguna 4030			Philippines
Ms	Conny	Almekinders	Development Research Centre (IVO)	PO Box 90153	5000 LE	Tilburg			The Netherlands

Title	First Name	Last Name	Post / Company	Address 1	Address 2	Address 3	Address 4	PostalCode	Country
Dr	Charles	Barber	Program in Biological Resources	World Resources Institute	1709 New York Avenue, NW	Washington DC 20006			USA
Professor	Bo	Bengtsson	Dept of Crop Production Science	Swedish University of Agricultural Sciences	Box 7043	S-750 07 Uppsala			Sweden
Mr	K	Budathoki	Lumle Agricultural Research Station	PO Box 1	Pokhara	Kaski District			Nepal
Dr	Joel	Cohen	Intermediary Biotechnology Service	ISNAR	PO Box 93375	2509 AJ Den Haag			The Netherlands
Mr	David	Cooper	Plant Genetic Resources Officer	Room B-752	FAO	Viale delle Terme di Caracalla	00100 Rome		Italy
Dr	Ruperto	Donato	Director	Bureau of Plant Industry	692 Faw Andres Street	Malate	Manila		The Philippines
Dr	Jan	Engels	Germplasm Maintenance & Use Group	IPGRI	Via delle Sette Chiese 142	00145 Rome			Italy
Mr	J M	Fayemi	Sustainable Agriculture Coordinator	Environment Liaison Centre International (ELCI)	PO Box 72461	Nairobi			Kenya
Dr	Pamela	Fernandez	University of the Philippines at Los Banos	College of Agriculture	Department of Agronomy	Laguna 4031			The Philippines
Dr	R A	Fischer	Research Programme Coordinator	ACIAR	GPO Box 1571	Canberra ACT 2601			Australia
Mr	Esbern	Friis Hansen	Centre for Development Research	Ny Kongensgade 9	DK-1472 Copenhagen K				Denmark

Title	First Name	Last Name	Post / Company	Address 1	Address 2	Address 3	Address 4	PostalCode	Country
Dr	Eduardo	Fuentes	Principal Technical Adviser	Biodiversity Management	UNDP	Room FF- 1086	One United Nations Plaza	New York NY 10017	USA
Mr	Andrea	Gaifami	Coordinator for the Agricultural Sector	Centro Internazional CROCEVIA	Via Ferraironi 88/G	00172 Rome			Italy
Sr	Francisco	Gómez	CITESGRAIN	Escuela Agricola Panamericana	PO Box 93	Tegucigalpa			Honduras
Dr	Barry	Greengrass	UPOV	34 Chemin des Colombettes	CH -1211 Geneva 20				Switzerland
Mr	Henrik	Hansen	Danish Government Institute of Seed Pathology	for Developing countries	PO Box 34	Ryvangs Allé 78	DK - 2900 Hellerup	Copenhagen	Denmark
Mr	Jaap	Hardon	Centre for Genetic Resources	(CPRO-DLO)	PO Box 16	NL 6700 AA Wageningen			The Netherlands
Mr	Tiff	Harris	Information Services	CIMMYT	Lisboa 27, Colonia Juarez	Apdo. Postal 6-641	06600 México, DF		Mexico
Mr	Robert	Havener	Winrock International	Route 3	Box 376	Morrilton	AR 72110- 9537		USA
Mr	Bertus	Haverkort	COMPAS	c/o ETC Foundation	PO Box 64	3830 AB Leusden			The Netherlands
Mr	Henk	Hobbelink	GRAIN	Girona 25, pral.	E-08010 Barcelona				Spain
Dr	R W	Huggan	IRRI Information Centre	IRRI	PO Box 933	1099 Manila			Philippines
Mr	Calestous	Juma	African Centre for Technology Studies	PO Box 45917	Nairobi				Kenya
Mr	R	Khanal	Chief Seed Technologist	Pakhribas Agricultural Centre	Dhankuta	c/o BAPSO	PO Box 106	Kathmandu	Nepal
Dr	George	Kuo	Director, Crop Improvement Programme	AVRDC	PO Box 42	Shanhua, Tainan	74199 Taiwan		China

Title	First Name	Last Name	Post / Company	Address 1	Address 2	Address 3	Address 4	PostalCode	Country
Dr	Bernard	Le Buanec	Secretary General	International Seed Trade Federation	Chemin du Reposoir 7	CH-1260 Nyon			Switzerland
Dr	M T	Lesnick	Senior Vice President	The Keystone Center	PO Box 8606	0175 Summit County Road 8	Keystone	Colorado 80435-7998	USA
Mr	R M H	Manurung	Project Director	Palawija Seed Project	Jalan AUP No.3 Pasar Minggu	PO Box 7227 / Jkpsm	Jakarta 12072		Indonesia
Mr	John	Martin	USC Canada	56 Sparks Street	Ottawa	Ontario		K1P 5B1	Canada
Mr	Hailu	Mekbib	Biodiversity Institute	PO Box 30726	Addis Ababa				Ethiopia
Dr	Umberto	Menini	Chief	AGPS	FAO	Viale delle Terme di Caracalla	00100 Rome		Italy
Dr	Godwin	Mkamunga	SADC Plant Genetic Resources Centre	Chalimbana Research Station	Private Bag CH6	153 02 Lusaka			Zambia
Mr	Pat	Mooney	RAFI	Suite 504	71 Bank Street	Ottawa	Ontario	K1P 5N2	Canada
Dr	Stephen	Muliokela	Mount Makulu	Seed Control and Certification Institute	PO Box 350199	Chilanga 13201			Zambia
Mr	T A	Mushita	COMMUTECH	PO Box 7232	Harare				Zimbabwe
Mr	Takawira	Ndiripo	ENDA	14 Belvedere Rd	PO Box 3492	Harare			Zimbabwe
Dr	N	Nkouka	IAPSC	PO Box 4170	N'longkak	Yaoundé			Cameroon
Dr	J	Okafor	FAME Agricultural Centre	3 Kingsway Road	PO Box 3856	Enugu			Nigeria
Dr	David	Rohrbach	Socioeconomics and Policy Division	ICRISAT - Regional Programme	Matopos Research Station	PO Box 776	Bulawayo		Zimbabwe
Ms	Elisabeth	Rubaihay	c/o Kawanda Agricultural Research Institute	PO Box 7065	Kampala				Uganda
Dr	H	Rudat	Senior Planning Officer	GTZ	Postfach 5180	65726	Eschborn		Germany

Title	First Name	Last Name	Post / Company	Address 1	Address 2	Address 3	Address 4	PostalCode	Country
Mr	Nathan	Russell	CIAT	Communications Unit	Apartado Aereo 6713	Cali			Colombia
Mr	Rene	Salazar	SEARICE	Unit 332	Eagle Court Condominium	26 Matalino Street	Diliman	Quezon	Philippines
Dr	Virginia	Sandoval	Environment Studies Board	College Eight	University of California	Santa Cruz	CA 95064		USA
Mr	Heinz	Schmid	Reckonholz	International Seed Testing Association	PO Box 412	CH - 8046	Zurich		Switzerland
Ms	Vandana	Shiva	Research Foundation for Science, Technology	and Natural Resource Policy	105 Rajpur Road	Dehra Dun 248 001	Uttar Pradesh		India
Dr	John	Stenhouse	Genetic Enhancement Division	ICRISAT	Patancheru 502 324	Andhra Pradesh			India
Professor	M S	Swaminathan	M S Swaminathan Research Foundation	3rd Cross Street	Taramani Institutional Area	Madras - 600 113			India
Professor	J	Uzo	Res. 48 Adelabu Street	Office Block B Rm 20	Ministry of Agriculture	Enugu			Nigeria
Dr	A J G	van Gastel	ICARDA	PO Box 5466	Aleppo				Syria
Dr	Saskia	van Oosterhout	DRSS	Agricultural Research Institute	PO Box 8108	Causeway	Harare		Zimbabwe
Mr	V	Venkatesan	Africa Technical Department	The World Bank	1818 H Street, NW	Washington DC 20433			USA