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UNITED KINGDOM: COUNTRY REPORT ON PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE

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Chapter 1

Introduction to UK and its Agricultural Sector

The United Kingdom of Great Britain and Northern Ireland (UK) constitutes the greater part of the British Isles. The largest of the islands is Great Britain which comprises England, Wales and Scotland. With an area of 242,000 km², the UK is just under 1,000 km in length from the south coast of England to the extreme north of Scotland and just under 500 km across in the widest part. It has a population of 61.4 million[1].

England is predominantly a lowland country although there are uplands in the north (the Pennine Chain, the Cumbrian Mountains and the Yorkshire moorlands) and in the south west in Cornwall, Devon and Somerset. Central southern England has the downs - low chalk hill ranges. Wales is a country of hills and mountains, the highest of which are in Snowdonia in the North West; the tallest peak is Snowdon (1,085 m). More than half of Scotland consists of the sparsely populated highlands and islands of the north. Scotland contains the majority of the UK's highest mountains - nearly 300 peaks over 913m[2]. Northern Ireland is at its nearest point 21 km from Scotland. At its centre lies Lough Neagh, the UK's largest freshwater lake (381 km).

The UK's climate is generally mild and temperate. It is subject to frequent changes but few extremes of temperature. It is rarely above 32ºC or below -10ºC. The average annual rainfall is more than 1,600 mm in the mountainous areas of the west and north but less than 800 mm over central and eastern parts. Rain is fairly well distributed throughout the year.

Agriculture occupies 77% of the UK land, and forestry about 10%. The rest is mainly urban land, on which around three quarters of the UK population live. A wide variety of agricultural systems has evolved over the centuries to match local environments. An advanced infrastructure to support the resulting production has also developed. The efficiency of UK agriculture has been increasing over a long period. This has led to greatly increased food production, although in recent years, it has manifested itself as reduced inputs rather than increased output: the 26% increase in efficiency since 1985 comprises a 0.3% increase in output and a 20% reduction in resources used[3].

The industry contributed nearly £6.8 billion to the UK Gross Domestic Product (GDP) in 2008[4]. Self-sufficiency in those foodstuffs which can be produced in the UK rose

[1] ONS, 27 August 2009, http://www.statistics.gov.uk

[2] Any peak over 3000ft (913m) high is known as a 'Munro'

[3] *Agriculture in the United Kingdom 2008*, Defra, https://statistics.defra.gov.uk/esg/publications/auk/2008/AUK2008.pdf

[4] *Agriculture in the United Kingdom 2008*, Defra, pp. 88-89,

from 60% in 1970 to around 87% in the late 1980s but has since fallen to around 73%[5]. The condition of the land remains dependent on the farmers who work it and whose predecessors have shaped it over the centuries. Since the 1950s, agricultural productivity has increased markedly - as evidenced by a three-quarter reduction in the agricultural labour force. Over 0.5 million people remain directly employed in agriculture today, around 1.7% of the total work force, although this has much greater importance in some rural areas. Many other jobs in the supply trade and food manufacturing industries are dependent on agriculture. Moreover, agriculture's role in providing an attractive and varied countryside makes a significant contribution not only to quality of life, but also to rural economic activity, particularly tourism.

The trends in recent years which have affected or which will affect agricultural production include: the drive for increased food production during and following the Second World War; the level of support under the European Union's Common Agricultural Policy (CAP) which has encouraged a further intensification of production; and CAP reform. CAP reform has involved a change of emphasis towards the market place and environmentally sound farming (1992), the introduction of a rural development policy (1999), the decoupling of the majority of payments from production (2003), and the modernisation, simplification and streamlining of the CAP including removal of some restrictions on farmers (2008)[6]. For the future, the UK government will encourage, and will work for further CAP reform towards a sustainable model of European agriculture, which is internationally competitive without reliance on subsidy or protection; rewarded by the market for its outputs, and by the taxpayer only for producing societal benefits that the market cannot deliver; environmentally-sensitive, maintaining and enhancing landscape and wildlife and tackling pollution; socially responsive to the needs of rural communities; producing to high levels of animal health and welfare; and non-distorting of international trade and the world economy.

In 2007, there were some 323,900 farm holdings in the UK (excluding minor holdings), with an average size of 53.6 ha. About two-thirds of all agricultural land is owner-occupied.[7] Within the relatively small area of the UK there is great diversity of farming types (summarised in Tables 1 and 2 below), reflecting a wide variety of climate, geology, soils and local traditions. Each farming type makes its own contribution to biodiversity, and many habitats and species depend upon traditional agricultural practices for their survival.

[5] *Agriculture in the United Kingdom 2008*, Defra, p. 68

[6] *http://ec.europa.eu/agriculture/healthcheck/index_en.htm*; *http://ec.europa.eu/agriculture/capexplained/change/index_en.htm*

[7] June Survey of Agriculture and Horticulture 2009: England Provisional Results

Table 1 Total area on agricultural holdings[8]

	Percentage of total		
Land Usage	**1991**	**2006**	**2008**
Grassland over 5 years old	30.4%	31.8%	32.3%
Crops	28.8%	23.5%	25.3%
Sole right rough grazing	27.2%	23.9%	23.3%
Grassland under 5 years old	9.1%	6.1%	6.1%
All other land including bare fallow	4.1%	8.8%	6.8%

Table 2 Percentage of crops grown

	Percentage of total		
Land Usage	**1991**	**2006**	**2008**
Wheat	40.0%	41.6%	43.9%
Barley	28.1%	20.0%	21.8%
Oilseed rape	8.9%	12.9%	12.6%
Peas and beans	4.1%	5.2%	3.1%
Sugar beet	3.9%	2.9%	2.5%
Horticulture	4.0%	3.8%	3.6%
Other crops	10.9%	13.7%	12.5%

The policies of successive governments over the past 70 years have increased forest cover from 5% to 14%. The main strands of present policies are aimed at the protection of the very few surviving ancient and semi-natural woodlands, the sustainable management of all existing woodlands and forests, and a steady expansion of tree cover in harmony with the environment.

[8] *Agriculture in the United Kingdom 2008*, Defra, p. 17

Chapter 2

Indigenous PGR

The indigenous PGR of the UK may be sub-divided into three categories: landraces, crop wild relatives and wild plant species resources.

2.1 Primitive forms of cultivated plants and landrace resources

Landraces are dynamic populations of crops that have historical origin, distinct identity and generally lack formal crop improvement. In addition, they are often genetically diverse, locally adapted and associated with traditional farming systems. Within the UK, landraces and old cultivars are still maintained by a significant number of growers and amateur gardeners throughout the country. Recent inventories indicate that extensive landrace diversity exists for cereals, forage crops, and fruit and vegetables and is also likely to exist for other non-surveyed crop groups (see Scholten *et al.*, 2003; Kell *et al.*, 2009). Landraces are not commonly cultivated by commercial farmers. They tend to be cultivated for niche market or in marginal agricultural conditions (e.g. *Bere* barley for milling and malting in the Scottish islands). Overall the number of farmers growing them and the area grown continues to decline – the average age of those maintaining landraces is over 65 years.

Although there has been a resurgence of interest in growing traditional varieties, due to increasing interests in organic production and local food, the remaining wealth of UK landrace diversity is highly geographically localized and critically threatened with extinction. The latter in the UK as elsewhere in Europe is due largely to (a) diffusion of modern cultivars into all sectors, (b) rigorous implementation of variety and seed certification legislation, (c) reduction in rural populations, (d) necessary simplification of productive processes due to high manpower costs, (e) increasing age of maintainers and (f) unsuccessful transition and passage of information from one generation to the next (see Vetelainen *et al.*, 2009).

Associated with the increasing loss of landrace varieties, there is anecdotal evidence to suggest that there is an ongoing decline in the genetic diversity within those landraces and old cultivars that remain. However, landraces are being actively conserved *ex situ* in gene banks by some UK-based institutions such as Science and Advice for Scottish Agriculture (SASA), Warwick Horticulture Research International (WHRI), the John Innes Centre (JIC) and privately funded organisations such as National Council for the Conservation of Plants and Gardens (NCCPG) and Garden Organic's Heritage Seed Library (HSL); *ex situ* in field gene banks by the National Fruit Collection (NFC), Brogdale and East Malling Research (EMR); and *in situ* on-farm or in home garden environments by some enthusiastic growers and amateur gardeners. Old cultivars of top fruit such as apples are still widely grown commercially in the UK. The Government supports conservation of top fruit via the Countryside Stewardship Traditional Orchard Scheme, and the National Trust and

Natural England are currently undertaking a survey of top fruit holdings and promoting increased recognition and use of these resources. Annex 1 contains further details of *ex situ* collections and their current holdings.

The presence of significant crop landrace material still being grown in the UK was highlighted in a Department for the Environment, Food and Rural Affairs (Defra) funded study (Scholten *et al.*, 2003) to develop a UK National Inventory of Plant Genetic Resources, which focused on crop wild relatives and landrace assessments particularly in the cereals and fruit sectors. The latter element of the initial study indicated that there remained a significant wealth of landrace diversity in the UK, but that it is often highly geographically localized and critically threatened with extinction. A further project focused on developing a vegetable landrace inventory for England and Wales (Kell *et al.*, 2009) and recognised that the full range of English and Welsh vegetable landrace diversity already conserved in *ex situ* collections is unrecognised because it is often not identified as such in gene bank information management systems. The study also identified a number of key *in situ* maintainers of English and Welsh vegetable landrace diversity, including small-scale commercial seed companies, non-governmental organizations, individual farmers, allotment holders and home gardeners. This exercise has provided a useful baseline of information for further research and evaluation.

An exciting new initiative in Scotland is focusing on landraces and traditional varieties of small grain cereals, potatoes, forage grass and Shetland cabbage are being conserved under the Scottish Landrace Protection Scheme (SLPS) which was launched by Scottish Advice for Scottish Agriculture (SASA) in August 2006. This scheme provides a safety net for the continued use of landraces by storing seed produced by each grower each year. In the event of a poor harvest, a grower can request some of the seed already deposited and stored at SASA. With the consent of the donor, the remaining seed can be made available for research, breeding and education. For further information of this initiative see Green *et al.* (2009).

Currently in the UK there is no full inventory of indigenous landrace diversity, though a partial inventory is available via the UK GRFA Portal at *http://grfa.org.uk/search/plants/index.html*.

2.2 Crop Wild Relative (CWR) resources

Crop wild relatives are wild plant species that have indirect use derived from their relatively close genetic relationship to a crop. They are possible crop progenitors, and are also reservoirs of potentially useful traits that could be transferred to crops. Although the majority of UK commercially cultivated plants are derived from non-native species, there are a significant number of UK CWR species. A list of some of the more commonly known UK native CWR of current or potentially important commercial or agricultural benefit that may be found in the wild is provided in Table 3.

Table 3. List of Native UK CWR Species.

Species	Common name	Species	Common name
Allium ampeloprasum var. *babingtonii*	Wild leek	*Ribes nigrum*	Blackcurrant
Allium sphaerocephalon	Round headed leek	*Ribes rubrum*	Redcurrant
Apium repens	Creeping marshwort	*Ribes uva-crispa*	Gooseberry
Artemisia campestris	Field wormwood	*Rubus caesius*	Dewberry
Asparagus officinalis subsp. *Prostrates*	Wild asparagus	*Rubus chamaemorus*	Cloudberry
Berberis vulgaris	Barberry	*Rubus fruticosus*	Blackberry
Beta maritima	Sea Beet	*Rubus idaeus*	Raspberry
Brassica nigra	Black Mustard	*Rumex rupestris*	Shore dock
Brassica oleracea	Wild Cabbage	*Ruscus aculeatus*	Butcher's broom
Brassica rapa	Wild Turnip	*Sambucus nigra*	Elder
Bromus interruptus	Interrupted brome	*Trifolium arvense*	Haresfoot Clover
Corylus avellana	Hazelnut	*Trifolium bocconei*	Twin-flowered Clover
Crambe maritima	Sea Kale	*Trifolium campestre*	Hop Trefoil
Dactylis glomerata	Cocksfoot	*Trifolium dubium*	LesserYellow Trefoil
Daucus carota	Wild Carrot	*Trifolium fragferum*	Strawberry Clover
Empetrum nigrum	Crowberry	*Trifolium glomeratum*	Clustered Clover
Fragaria vesca	Strawberry	*Trifolium incarnatum* subsp. *molinerii*	Crimson Clover
Lactuca saligna	Least lettuce	*Trifolium micranthum*	Slender Trefoil
Lactuca serriola	Wild lettuce	*Trifolium occidentale*	Western Clover
Lactuca virosa	Great lettuce	*Trifolium repens*	White Clover
Lathyrus tuberosus	Sea pea	*Trifolium scabrum*	Rough Clover
Linum perenne subsp. *Anglicum*	Perennial flax	*Trifolium squamosum*	Sea Clover
Lolium perrene	Rye Grass	*Trifolium striatum*	Knotted Clover
Malus sylvestris	Apple (crab)	*Trifolium strictum*	Upright Clover
Mentha pulegium	Pennyroyal	*Trifolium suffocatum*	Suffocated Clover
Prunus padus	Cherry	*Vaccinium myrtillus*	Bilberry
Prunus spinosa	Sloe	*Vaccinium oxycoccus*	Cranberry
Pyrus cordata	Plymouth Pear	*Vaccinium vitusidaea*	Cowberry

The UK national CWR inventory contains 413 genera and 1955 species, although not all of these are native taxa (Maxted *et al.*, 2007). Table 4 shows the numbers of CWRs associated with various forms of uses and Table 5 shows the major genera

containing CWR taxa. Approximately 78% of all native taxa are classified as a CWR, and hence there is a wide range of current statuses. Of these, 303 species were prioritised on the basis of agricultural or horticultural importance of their related crops. Thirteen of these prioritised CWR taxa are considered to be threatened within Great Britain using World Conservation Union (IUCN) Red List criteria (See Maxted *et al.*, 2007).

Table 4. Use categories of UK native CWR Species.

Rank	Use Category	Major Families	Species Nos.
1	Indirect use	All families	490
2	Medicinal and aromatic	*Asteraceae, Apiaceae, Lamiaceae*	258
3	Ornamental	*Asteraceae, Liliaceae*	243
4	Technical	*Cyperaceae, Asteraceae, Lamiaceae*	159
5	General Food	See separately under 9,10,11 and 12	133
6	Functional tree / forestry	*Fabaceae, Pinaceae, Betulaceae*	102
7	Fodder / feed / forage	*Poaceae, Fabaceae*	100
8	Reclamation / soil improvement	*Poaceae, Pinaceae, Fabaceae*	72
9	Vegetable	*Apiaceae, Brassicaceae, Asteraceae*	71
10	Fruit	*Rosaceae, Ericaceae*	45
11	Starch / sugar	*Poaceae, Chenopodiaceae*	10
12	Oil	*Brassicaceae, Linaceae, Chenopodiaceae*	7

Table 5. Major UK agricultural crop wild relative families and genera (ornamentals excluded).

Family	Genera	Taxa	Genera with numbers of included species
Poaceae	15	113	*Agrostis* (6), *Alopecurus* (6), *Arrhenaterum* (1), *Avena* (3), *Bromus* (8), *Cynodon* (1), *Dactylis* (1), *Festuca* (13), *Festulolium* (5), *Hordeum* (3), *Lolium* (2), *Phalaris* (1), *Phleum* (5), *Poa* (15), *Trisetum* (1)
Fabaceae	6	59	*Trifolium* (23), *Vicia* (13), *Onobrychis* (1), *Medicago* (5), *Lotus* (5), *Lupinus* (2)
Rosaceae	5	29	*Fragaria* (2), *Malus* (2), *Prunus* (7), *Pyrus* (2), *Rubus* (7)
Brassicaceae	4	28	*Brassica* (3), *Sinapis* (2), *Rorippa* (8), *Raphanus* (1)
Apiaceae	7	22	*Apium* (4), *Anthriscus* (3), *Petroselinum* (2), *Carum* (2), *Foeniculum* (1), *Daucus* (1), *Pastinaca* (1)
Liliaceae	2	12	*Allium* (9), *Asparagus* (1)
Papaveraceae	1	11	*Papaver* (6)
Solanaceae	1	7	*Solanum* (5)
Grossulariaceae	1	6	*Ribes* (6)
Asteraceae	3	5	*Cichorium* (1), *Lactuca* (3), *Scorzonera* (1)
Valerianaceae	1	4	*Valerianella* (4)
Linaceae	1	3	*Linum* (3)
Chenopodiaceae	1	3	*Beta* (1)
Polygonaceae	1	1	*Rheum* (1 hybrid)
Cannabaceae	1	1	*Humulus* (1)
Totals	50	303	

Given that most UK native and archaeophyte taxa are classified as CWRs, trends derived from general plant surveillance activities are likely to provide a reasonable proxy for trends in CWRs. The UK's plant diversity indicators show continuing declines in species richness in woodland, grassland and boundary habitats, although plant species richness on arable land had increased between 1990 and 2007 (Defra, 2009). Data from the Countryside Survey are currently being analysed to obtain specific trends in CWRs. However, it should be noted that trends in richness, distribution and abundance do not necessarily reflect trends in genetic diversity.

A recent analysis of UK CWR diversity prioritised species on the basis of economic importance and relative threat and then attempted to identify CWR hotspots (Maxted *et al.*, 2007). The distribution of the highest priority 226 CWR were mapped and overlaid to identify the 17 top 10x10 km grid squares, nine of which contained Special

Areas for Conservation and eight of which contained Sites of Special Scientific Interest (see Figure 1). Natural England, together with the University of Birmingham, have undertaken a feasibility exercise concerning the possible establishment of the first genetic reserve for CWR in the UK within one of the sites identified in the Lizard, Cornwall.

Currently there is limited active use of CWRs in crop breeding in the UK, with the exception of *Lactuca serriola.* However, many current fodder/feed/forage varieties are selections from native *Poaceae* and *Fabaceae*, as are some fruit varieties from *Rosaceae* and *Ericaceae* species. In additional, many other CWR species possess pest and disease resistance traits which have not yet been characterised and are well adapted to local soil and climate, and thus have potential to be of use in crop breeding. Whilst not all of these plant species are relatives of economically important crops in the UK, some are of importance in other countries (for instance cranberry in the USA).

Figure 1. Seventeen UK CWR hotspots using the iterative method (total numbers of highest priority CWR taxa present in each shown, as well as additional CWR taxa in brackets).

Agricultural intensification over the last 50 years in the UK has been so effective at controlling arable 'weeds' that of the 30 species that have shown the greatest decline across Britain, 60% are found in arable and other cultivated land. A combination of improved seed cleaning, increased fertiliser use, high yielding crop varieties and the introduction of herbicides has all contributed to their decline. In response to these losses, Plantlife is running the Arable Plants Project in partnership with the Farming

and Wildlife Advisory Group (FWAG). The project targets farms which historically have had rich assemblages of arable species, encouraging the owners to choose the appropriate options when entering into new agri-environment schemes. Farmers enter into Entry Level and Higher Level Stewardship agreements with government agencies and help is provided to manage the farmland sustainably to maintain farm income while enhancing biodiversity benefit. As a result, many populations of rarer plant species not recorded from particular fields for decades or even centuries are now flourishing on these farms.

2.3 Wild species resources

The majority of UK agriculture relies on the cultivation of non-native species, yet there are a number of wild plants that are harvested commercially or for personal use. There are about 300 UK species of plant that are currently harvested from the wild for a variety of uses (Prendergast and Sanderson, 2004; Milliken and Bridgewater, 2005). Many of the species harvested from the wild are common and widespread. It is, however, difficult to obtain accurate information about the volumes of plant material being harvested and the numbers of people involved or the income made from these species.

It is clear from surveys being undertaken by a range of organisations that there is an increased interest in the traditional uses of UK plants leading to increased harvesting from the wild for some species, possibly stimulated initially by Food for Free (Mabey, 1972) and related initiatives. The diversity of plants being harvested has also increased with time and it would appear that the number of people involved in the development of products from these plants has increased. There has further been an increase in the diversity and volume of plant-derived products that contain UK species entering the market in the UK, although most of these species are being supplied from plants grown abroad.

If the use of some species increases then monitoring of the amount harvested from the wild may become necessary to ensure population levels and genetic diversity are not adversely impacted. Where necessary, more support would need to be given to cultivate material, in order to reduce pressures on wild populations.

Information derived from:

Defra, (2009a). *UK Biodiversity Indicators in Your Pocket 2009*. Defra, London.
Defra, (2009b). *Fourth National Report to the United Nations Convention on Biological Diversity: United Kingdom*, 2009. Defra, London.
Green, N., Campbell, G., Tulloch, R. and Scholten, M.A., (2009). Scottish Landrace Protection Scheme. In: *European Landraces: On-farm conservation, Management and Use* (eds. Vetelainen, Negri and Maxted). Technical Bulletin 15. Pp. 172-181. Bioversity International, Rome, Italy.
Kell, S., Maxted, N., Astley, D., Allender, C., Ford-Lloyd B.V. and Contributors, (2009). *Vegetable landrace inventory of England and Wales*. Defra project code IF0164. University of Birmingham.
Mabey, R., (1972). *Food for free*. Harper-Collins, London.
Maxted, N., Scholten, M., Codd, R. & Ford-Lloyd, B., (2007). Creation and use of a national inventory of crop wild relatives. *Biological Conservation* 140: 142-159.

Milliken, W. and Bridgewater, S., (2005). *Flora Celtica*, Birlinn, Edinburgh.
Prendergast, H.D.V. and Sanderson, H., (2004). *Britain's wild harvest*, Royal Botanic Gardens, Kew.
Scholten, M.A., Maxted, N. and Ford-Lloyd, B.V. (2003). *UK National Inventory of Plant Genetic Resources for Food and Agriculture*. Defra project code GCO134. University of Birmingham.
Vetelainen, M., Negri, V. and Maxted, N., (2009). *European Landraces: On-farm conservation, Management and Use*. Technical Bulletin 15. Bioversity International, Rome, Italy.

Chapter 3

National Conservation Activities

3.1 *In Situ* Conservation Activities

Many plants have widely dispersed populations. Some require the retention of features traditionally located in the countryside, such as hedges, copses, ponds and flushes. Sympathetic land management is important to the conservation of these widely dispersed species.

Rare and vulnerable species may require more specific action. The Wildlife and Countryside Act gives specific protection to 151 species of plants in Great Britain. Strict protection is relevant when human exploitation or destruction is the main threat. Additionally, the UK Biodiversity Action Plan has prioritised action on 334 species of plants, which also appear on statutory lists. This action can focus on a range of threats.

3.1.1 Protected Areas

While protected species remain important, there is increasing emphasis towards a strategy designed to ensure that as wide a range of species as possible survives throughout their natural range. The cornerstone of *in situ* conservation in the UK is a system of protection for areas notified as being of special scientific interest because of their biological or geological features.

Particularly vulnerable and precious habitats and species are being further protected through the designation of Special Areas of Conservation (SACs) under the EU Habitats and Species Directive. By the end of March 2008, the UK had a total 6,823 designated Sites of Special Scientific Interest (SSSIs) and Areas of Special Scientific Interest (ASSIs). These represent 2.4 Mha or 10% of the total land area. A further million hectares of inshore coastal habitats is also protected. The different site types overlap; in total about 3.5 Mha is protected by European or National designation. Although as yet there are no protected areas in the UK where the genetic diversity of crop wild relative species is actively conserved. Natural England, together with the University of Birmingham, have undertaken a feasibility exercise concerning the possible establishment of the first genetic reserve for CWR in the UK within one of the sites identified in the Lizard, Cornwall.

Outside these formally and informally protected areas, environmentally beneficial management of farmland is encouraged through a number of schemes introduced under Council Regulation (EC) No 1698/2005 of 20 September 2005 on support for rural development by the European Agricultural Fund for Rural Development (EAFRD). Separate schemes are run in each of the countries of the United Kingdom. The schemes operate by multi-annual voluntary paid agreement between farmers

and the relevant government authority. In addition to support for organic farming, the schemes variously aim to maintain and restore semi natural habitat and introduce wildlife friendly management onto more intensively managed farmland. In 2008, UK farms covering c.8.7m ha were included in the schemes.

Rural Development Departments and government agencies are also operating farm capital grant and farm woodland schemes that provide funding for specific environmentally-beneficial measures.

3.2 *Ex situ* conservation

Part of the plan for the plants listed in the Wildlife and Countryside Act is to conserve them off site (*ex situ*) in the seed banks such as the Millennium Seed Bank at the Royal Botanical Gardens (RBG), Kew (Wakehurst Place), which now holds population samples from the majority of UK native seed-bearing species. Similar arrangements are developing with Scottish Natural Heritage and the Countryside Council for Wales. *Ex situ* collections held in the UK exist not as a single national gene bank but as a decentralised network of collections of varying size and specialisation. Many plants are conserved in botanical gardens, arboreta, and agricultural and horticultural institutions. These collections of growing plants are carefully maintained either out in the open or under glass. Clones, varieties and cultivars of particular species are kept to maintain stocks of genetic diversity. PlantNetwork co-ordinate a rich variety of living germplasm in more than 50 botanic gardens and arboreta in the UK (and Eire). A list of some of the larger gene banks held in the UK is presented in Annex II. The collections are closely linked to active research on the species and often share the same site. Maintaining active collections in this way is the best way of ensuring the closest links between genetic resources and the main scientific beneficiaries.

Botanical Gardens Conservation International (BGCI), an international botanic garden network headquartered in the UK, maintains an extensive computer database monitoring and coordinating the collections of rare and endangered plants in cultivation in British and other botanic gardens and arboreta worldwide. Data is exchanged electronically between BGCI and many botanic gardens by means of an agreed international standard, the International Transfer Format for Botanic Garden Plant Records (ITF).

In 2004, the UK Government adopted a policy relating to Genetic Resources for Food and Agriculture which recognised the importance of key *ex situ* plant genetic resources and the need for their longer term maintenance.

The UK Government is a member of the Governing Body of the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) and is in active negotiations with PGR collections within the UK with respect to designation of resources into the Multilateral System of the ITPGRFA.

The UK Government funds a number of *ex situ* plant genetic resource collections.

- The National Fruit Collection, at Brogdale comprises top fruit and some soft fruit. Its collection of apples is one of the largest in the world. Material is supplied to fruit breeders in the UK and overseas under the terms of the SMTA to ITPGRFA, and is used for research.

- The Vegetable Gene Bank at Warwick HRI, Wellesbourne covers in particular varieties of onions (*Allium*), carrot (*Daucus*) and *Brassicas*, all stored as seed. Material is made widely available, both nationally and internationally. The collection is designated as a base collection by Bioversity International.

- The Millennium Seed Bank at the Royal Botanic Gardens, Kew (Wakehurst Place) contains over 50,000 accessions, comprising 27,650 species from 341 plant families. This is the largest seed bank collection of wild species in the world and results from the international Millennium Seed Bank partnership led by Kew involving 123 institutes in 54 countries. Additionally, Kew leads the EU-funded ENSCONET (European Native Seed Conservation Network) which co-ordinates wild species seed conservation across Europe.

- The Nottingham Arabidopsis Stock Centre at the University of Nottingham is wholly supported by the Biotechnology and Biological Sciences Research Council (BBSRC) and is a national and international resource maintaining and distributing plant material and information in support of research in all aspects of plant molecular biology and genetics.

- The Pea Gene Bank at the John Innes Centre in Norwich is a broad based collection used by many researchers and plant breeders. It is the second largest collection of pea germplasm in Europe and also acts as the International Centre for genetic stocks for the species.

- The BBSRC Cereal Collections (*Avena* spp., *Hordeum* spp. and *Triticum* spp.) at the John Innes Centre in Norwich are the UK reference collections for cereals. They are international working collections that are used in for both research and plant breeding programmes.

- The Grasses and Clover Collection at the Institute of Biological, Environmental and Rural Sciences (IBERS) includes a number of important collections such as oats, rye grasses, white clover, European forage germplasm and Triticale. The collections are used by plant breeders and for research.

- The Commonwealth Potato Collection at the Scottish Crop Research Institute (SCRI), Invergowrie consists of species belonging to Solanum section Petota. It has almost 1,500 accessions representing 83 Solanum species. Material is freely available to the scientific, breeding and knowledge transfer communities.

- SASA stores UK reference collections for National List and Plant Breeders' Rights testing for the UK and EU (potato, pea, turnip rape, swede and vegetables). In addition, SASA stores genetic resource collections containing

There are also a number of important privately owned or funded organisations which maintain specialist collections of plants. The Heritage Seed Library at Garden Organic Ryton for example, has large collections of old cultivars of garden plants and vegetables. Other collections are held by members of the many British National Societies for ornamental plants. Some 60,000 taxa of ornamental plants, mainly cultivars or species of exotic plants, are available through commercial nurseries in the UK. In addition over 600 National Collections of garden plants are cultivated in numerous UK public and private gardens and arboreta under the voluntary National Collections Scheme organised by NCCPG. Many UK Universities have small specialised collections of wild and cultivated plants of both native and exotic species which are used for research and training.

3.3 Details of storage facilities

For sexually reproducing plants, seed banks are the most efficient and effective method of long-term storage provided the seeds are 'orthodox'. Storage of seeds in UK national seed banks complies with international guidelines, such as those prescribed by the FAO. New or upgraded facilities have become operational at RBG Kew, Wakehurst Place (Millennium Seed Bank), Warwick HRI, SASA, SCRI and Henry Doubleday Research Association (GOR) since 2000. Cold storage (-10ºC to -20ºC) of dried seeds for some species increases long-term viability for at least 100 years, but for other species seed stores need to be replenished more regularly. Pollen can be stored in a similar way to seed, although there are thought to be very few collections based in the UK. *In vitro* preservation of parts of plants, such as meristem tips, buds or stem tips, is used infrequently in the UK and cryo-preservation is used to slow down growth rates of this material and enhance long-term conservation.

The Science and Advice for Scottish Agriculture (SASA) stores a partial duplicate collection for the Royal Botanic Gardens (RBG), Kew (Wakehurst Place). RBG, Kew holds duplicate accessions for all of the Millennium Seed Bank partnership members in addition to a number of older duplicate collections including those from the International Livestock Centre for Africa (ILCA), Ethiopia and the Land Stabilisation Collection for the FAO. Approximately 70% of Warwick HRI's Genetic Resources Unit (GRU) base collections are safety duplicated with the Centre for Genetic Resources (CGN), the Netherlands, under international standard base store conditions. Conversely, safety duplicates are maintained for CGN and a number of other international and national collections at Warwick HRI. The Commonwealth Potato Collection at SCRI has also exchanged duplicate collections with the potato collection at CGN, the Netherlands.

The UK National Inventory of PGRFA is managed by IBERS who act as the UK focal point. The database has recently undergone a second round of revision and now holds information relating to the majority of the major *ex situ* collections in the UK. This is an ongoing project and data on other collections within the UK are anticipated. The Inventory is accessible via the UK PGRFA portal (*http://grfa.org.uk/search/plants/index.html*).

3.4 Documentation

The majority of the larger seed banks have online searchable databases. For example, documentation at Warwick HRI, uses international descriptor standards with data stored using MS Access. The data relating to the International Plant Genetic Resources Institute (IPGRI) designated base collections form part of the European Cooperative Programme for Plant Genetic Resources (ECPGR) databases for *Allium* and *Brassica*. WHRI's GRU acts as the database manager for the ECPGR *Allium* database as a part of the agreed UK inputs-in-kind to the ECPGR. Collections are documented fully for passport and stock control data. Crop collections are characterised to varying degrees based on minimal descriptors defined for *Allium*, *Brassica*, *Daucus* and *Raphanus* by the ECPGR crop working groups and IPGRI. These data are valuable indicators for users looking for specific provenance or characteristics. The Institute of Biological, Environmental and Rural Sciences is responsible for collation and maintenance of the UK Nation Plant Inventory and the ECPGR European *Lolium* and *Trifolium repens* databases. As part of their role at the National Fruit Collections the University of Reading have taken responsibility for managing the ECPGR European *Malus* database.

3.5 Evaluation

The UK Governments support for key *ex situ* collections supports evaluation and characterisation which are crucial to improve the utilisation of PGR. This area has been significantly enhanced through the creation in 2004 of a series of Defra supported Crop Improvement Networks for wheat, pulse crops, oil seed rape and more recently one targeted on biomass for energy. These are based on the development of programmes of joint activities and resource development between the academic and commercial breeding sectors. Significant germplasm resources have been developed within these networks such as the UK public wheat mapping population and mutation resources in wheat and peas.

For some UK collections, such as Warwick HRI's GRU base collections, evaluation depends upon experts screening accessions and returning data for inclusion in the database. Warwick HRI's GRU has supported UK programmes screening for resistance to pests and diseases including carrot root fly, *Allium* white rot, *Pythium* in carrot, downy mildew in *Brassica*, *Beet Western Yellows Virus* in lettuce and *Crook Root* in Watercress. The strategic test collections are valuable reference standards which are being utilised increasingly in biotechnology.

Due to the relative cost of traditional characterisation and evaluation, increasingly within the UK, breeders and other users are looking to novel ways to identify desirable adaptive traits, such as marker assisted selection, high through-put genomic approaches and predictive characterisation.

3.6 Regeneration

Regeneration is routinely undertaken for the major collections in accordance with recognised procedures. Outbreeding taxa need to be regenerated in isolation, and

the equipment, resources and personnel required are significant. The majority of Warwick HRI's GRU, IBERS' collections and the Commonwealth Potato Collection at SCRI are outbreeders, and therefore it is necessary to prioritise which accessions within the collections will be regenerated on an annual basis. In some cases population size is constrained by the size of the isolation units.

Chapter 4

In-Country Uses of PGR

4.1 Use of PGR Collections

As stated earlier, *ex situ* collections exist as a decentralised network of collections of varying size and specialisation, and it is not therefore possible to quantify the number of times that each species has been supplied for use within the UK. With the main publicly supported collections located at scientific or higher education institutes, it is implicit that germplasm is primarily available for research, breeding, demonstration and training purposes.

PGR collections often serve a range of uses depending on their composition which is in turn dependent on their history and development. These uses may be specific (registration collection, genetic stocks, related species) or may cover a number of uses with different emphases. For example, the BBSRC Cereals collection maintained at the John Innes Centre (JIC) at Norwich serves as the national reference collection for material bred and trialled in the UK. An agreement with the British Society of Plant Breeders (cereal section) requires samples of all lines entering the National Listing to be sent to the collection. After a three year period and registration of Plant Breeders Rights they are entered into the main collections and are available on request. The collections act as a reference collection for the future needs of plant breeders.

The majority of breeding companies use collections either for accessions for use as potential parents in breeding programmes or for information relating to pedigree, characterisation or known genetic traits. Close contacts with the breeders can be well developed. In some instances, collaborative characterisation work of mutual interest is done under a reciprocal arrangement i.e. stocks for data. Increased utilisation of PGR collections has come about through the wider adoption of molecular markers and the large scale genotyping of germplasm. The increasing availability of gene sequences is facilitating allele-mining of natural diversity within wider germplasm.

Germplasm may also be used as a pool of genetic variation which can form the basis of crop improvement strategies, whether by traditional plant breeding or genetic transformation techniques. Seed samples are being sent to an increasingly wide range of recipients, such as university departments, agricultural institutes and NGOs working both in the UK and overseas, particularly developing countries. Collections can be screened to identify species or plant varieties with specific disease resistances and resistance to biotic stresses such as heat, salt and drought, or for medicinal compounds. During the past few years, samples from the Millennium Seed Bank (RBG Kew at Wakehurst Place) have been used for a wide range of research

worldwide including counteracting salination, remedying heavy metal contamination and improvement of photosynthetic efficiency.

PGR collections may also serve as genetic stock collections. For example the *Pisum* collection at JIC, Norwich contains a large number of genetic lines and acts as the international centre for genetic mutation stocks for the species. The collection aims to cover all mutations that are available in *Pisum* and underpins a large proportion of the fundamental research in peas worldwide today. Genetic stocks are of considerable importance in genetic analysis and in the increasingly important area of molecular mapping.

Other types of genetic stocks held in PGR collections include near-isogenic lines, mapping populations and precise genetic stocks. These resources are vital in assisting researchers and breeders in quantifying the effects of single genes (near-isogenic lines) and in the mapping of complex traits where replication and field assessments may be required such as nitrogen and water use efficiency or yield. Precise genetic stocks are a further category of genetic stocks developed through chromosome manipulation techniques that can result in the loss or duplication of complete chromosomes or chromosomal segments. Maintaining such stocks often requires specialist cytological skills as they tend to be genetically unstable and therefore each generation needs to be checked.

New types of PGR collections have been developed to meet the demands of emerging technologies such as TILLING collections (Targeted Induced Local Lesions in Genomes). These are large collections (frequently of many thousand individual lines) created through chemical mutagenesis used as part of what is called a reverse genetics approach whereby once a gene has been identified, specific sequence motifs from the gene can be used to search for mismatches e.g. possible mutations that could lead to the identification of a novel adaptive phenotypic variation. These collections are being used by both the research and breeding communities in their search for useful variation in genes of interest. Examples of such resources are the TILLING populations of *Lotus, Medicago* and *Brassica* maintained at the John Innes Centre, wheat TILLING resource at Rothamsted and a barley resource at SCRI.

4.2 Crop improvement programmes and seed distribution

The material stored in national seed banks is available on request to *bona fide* researchers, subject to satisfactory arrangements regarding Intellectual Property Rights. All the major *ex situ* collections publicise the contents of their seed banks via searchable web databases in addition to their data being made available via the UK National Plant Inventory. RBG, Kew have helped lead the way on the development of material supply agreements for use by botanic gardens that control rights on behalf of the countries from which the material was collected.

The Government funds a number of programmes which aim to improve the understanding of the more fundamental aspects of plant biology. Many of these programmes rely on the ready availability of PGR located in UK seed banks. In addition PGR collections are often used directly in crop improvement programmes. In 2005 Defra initiated a series of Crop Genetic Improvement Networks that serve to bring together commercial breeders, producers and the academic community to

develop common programmes based on key priorities and challenges. These have resulted in the development of new PGR resources that are helping to underpin crop improvements in wheat, pulse crops, oil seed rape and bio-energy crops. The Government is working closely with both the providers of PGR and recipients, particularly commercial breeders, over the implementation of the ITPGRFA in the area of access and benefit sharing. The majority of the key *ex situ* collections now routinely use the Standards Material Transfer Agreement and the process of designating germplasm resources to the Multilateral System has begun.

4.3 Benefits of PGR Utilisation

At present the potential benefits outweigh actual returns. However, there has been some commercial spin off from PGR utilisation. For example, PGR utilisation has resulted in several new commercial varieties of crops that are of economic importance in the UK. Both the National Fruit Collection and WHRI are two of the many examples of government funded bodies which have provided the breeding industry both in the UK and worldwide with useful genotypes and gene combinations. Some of these have resulted in improved cultivars.

4.4 Improving PGR utilisation

Improved documentation and accessibility to data remain important objectives with the standardisation and computerisation of large quantities of historical records still being a priority target. The development of the UK Genetic Resources for Food and Agriculture (UKPGRFA) portal and the UK National Plant Inventory have been important developments in recent years in providing clearer access points to PGRFA information and resources.

In addition Defra has supported the development of databases of crop wild relatives (UK) and vegetable landraces (England and Wales), both co-ordinated by the University of Birmingham. These resources are also available via the UKPGRFA portal. Defra also support the development of the National Fruit Collections public access database by the University of Reading.

The creation of the Defra supported Crop Genetic Improvement Networks has brought a closer working relationship between a number of the core PGR collections and their stakeholder communities that has resulted in increasing awareness and dialogue and a broader uptake of resources.

Chapter 5

National Goals, Policies, Programmes and Legislation

5.1 *In situ* conservation

Following devolution and a number of other top-level drivers, a new strategic framework was published in 2007. Entitled '*Conserving Biodiversity – the UK approach*' it is based upon the twin principles of partnership and the ecosystem approach. Underpinning the UK framework are country strategies for biodiversity and environment in each of the four countries of the UK. These include further priorities and are supported by additional measures and indicators, reflecting the countries' different responsibilities, needs and views.

There are significant numbers of native UK species of economic value found in the wild, including many wild relatives of cultivated plants. Some may be protected by chance in nature reserves and through agri-environment schemes. However, these species are not monitored or recorded, except for one wild relative of asparagus which is a priority species under the BAP. As detailed in Chapter 2 above, Natural England has now begun investigating the establishment of the first genetic reserve for CWR in the UK within an existing protected area on the Lizard in Cornwall. If this process proves successful it is hoped that UK CWR will be systematically conserved *in situ* throughout the UK.

There are relatively limited examples of catalogued on-farm or home garden conservation of landraces and old varieties. Examples include ancient orchards, cultivated barley landraces and heritage vegetable varieties grown by enthusiasts.

England

A Biodiversity Strategy for England was launched in 2002[9]. The Strategy seeks to ensure biodiversity considerations become embedded in all main sectors of public policy and sets out a programme for the future to make the changes necessary to conserve, enhance and work with the grain of nature and ecosystems rather than against them. A report on the progress including biodiversity indicators was published in 2007.

[9] Working with the grain of nature: A biodiversity strategy for England, Defra, 2002

http://www.defra.gov.uk/wildlife-countryside/pdf/biodiversity/biostrategy.pdf

Scotland

The Scottish Government's strategy for the conservation and enhancement of biodiversity, published in 2004[10] aims to halt the loss of biodiversity and continue to reverse previous losses through targeted action for species and habitats. This process is supported by the Scottish Biodiversity Forum, a working partnership of Government, its agencies, sponsored bodies, non-government organisations, businesses, private organisations and individuals.

Wales

Within Wales responsibility for implementation of the UK Biodiversity Action Plan rests with many different players, with the overall steer and coordination provided by the Wales Biodiversity Partnership (WBP). This group brings together all sectors in a partnership supported by the work of people, groups and organisations locally and nationally. The Environment Strategy for Wales was produced in 2006[11].

Northern Ireland

Within Northern Ireland, the Biodiversity Unit in the Northern Ireland Environment Agency (NIEA) is responsible for implementing the policies designed to protect Northern Ireland's Biodiversity. By working with landowners, groups with a vested interest, conservation organisations, delivery groups and other government agencies, the Unit produces action plans and oversees the work of the Local Biodiversity Officers. A strategy was produced in 2002[12].

5.2 *Ex situ* Conservation

The UK has made national and international commitments for the conservation, characterisation and utilisation of Plant Genetic Resources. These are necessary to enable plant breeders to respond to any changes in climate, agriculture practices, market requirements, plant diseases and plant pests that cannot be accommodated by the current commercial plant varieties. Although public and private seed banks are a primary method for the *ex situ* conservation, the important role of botanic gardens, *arboreta* and other living collections is recognised, as is the complementary activities of a number of non-governmental organisations.

Other national bodies have a role in PGR, for instance, the UK Plant Genetic Resources Group (UKPGRG) has a wide technical base including groups

[10] Scotland's Biodiversity, It's In Your Hands; A Strategy for the Conservation and Enhancement of Biodiversity in Scotland, Scottish Executive, 2004

http://www.scotland.gov.uk/Resource/Doc/25954/0014583.pdf

[11] Environment Strategy for Wales, Welsh Assembly Government, 2006

http://wales.gov.uk/topics/environmentcountryside/epq/envstratforwales/;jsessionid=vN4dJ6BLw6whgdhWdGmYnx2vZpbmNgyKT7y1nvhzy1zMljfGxrGk!2101391267?lang=en

[12] Northern Ireland Biodiversity Strategy, Northern Ireland Biodiversity Group, 2002 *http://www.ehsni.gov.uk/nibs2002.pdf*.

representing both *in situ* and *ex situ* interests, as well as conservation bodies, ecological groups, and commercial representatives. The Group regularly offers advice to Government departments on issues relating to PGR.

Currently some 50 *ex situ* collections in the UK are publicly funded in whole or part. Although most of these are funded directly by Government departments, a significant number are funded indirectly, through Research Councils, universities and agricultural colleges. The majority of Government funding in this area is directed to the collections referred to at section 3.2 above. Most botanic gardens are funded in the main by local authorities and universities, with the notable exception of the Royal Botanic Gardens, Kew and Edinburgh, which are grant funded by Defra and Scottish Government respectively.

Funding from Defra is currently provided for the cost of maintaining certain core collections such as the Vegetable Gene Bank (Warwick HRI, Wellesbourne), the National Fruit Collection (Brogdale) and the Pea Gene Bank at the John Innes Centre, Norwich; the acquisition and multiplication of new material; the maintenance of collections to approved standards; characterisation; the establishment and maintenance of databases and the provision of information and material. Defra also contributes funding towards the Millennium Seed Bank (RBG Kew, Wakehurst Place).

Funding from the Scottish Government is currently provided to cover the cost of maintaining, extending and characterising certain core collections. Two of the most notable are the Commonwealth Potato Collection, and a Rubus collection, both of which are housed at the SCRI, Invergowrie. The Scottish Government's funding of the Royal Botanic Garden, Edinburgh, includes a significant contribution to the internationally important conifer conservation project, sites for which have been established throughout the UK.

The institutes supported by BBSRC house a number of core collections that are funded at least in part from the Government's science budget, most notably those located at the John Innes Centre (small grain cereals, wheat and related species, *Hordeum spontaneum*, *peas* and *field beans* and TILLING collections in *Lotus Medicago* and *Brassica*) and the collections at the Institute of Biological, Environmental and Rural Sciences, IBERS (oats, rye-grasses, white clover, European forage germplasm and Triticale). The Arabidopsis Stock Centre at the University of Nottingham is wholly supported by BBSRC at present and is a national and international resource maintaining and distributing plant material and information in support of research in all aspects of plant molecular biology and genetics.

5.2.1 Botanic Gardens and other living collections

With the notable exceptions of some botanic gardens such as RBG, Kew, most botanic gardens have only relatively limited links with seed banks. However, they constitute an important germplasm resource, have an important role to play in *ex situ* conservation of non-crop species, and offer considerable potential for species, rehabilitation and biotechnological research. Unlike seed banks which tend to focus

on a particular plant species or group, botanic gardens have historically collected a wider range of plants, from within a given geographical region.

5.3 Training

Training in PGR techniques is currently undertaken at a number of Higher Education Institutes and at several institutes holding germplasm collections. For example, the University of Reading provides training for higher degree students in *ex situ* conservation by seed storage, including in seed production for accession regeneration. RBG, Kew holds a series of international courses on plant conservation techniques (including seed conservation techniques), environmental education and botanic garden management. These courses are organised with the help of BGCI. The University of Birmingham still offers the only international post-graduate degree course in PGR techniques, the MRes in Conservation and Utilisation of Plant Genetic Resources. The University also offers a range of taught short courses internationally, covering such topics as: Conservation Data Management and Analysis; Plant Exploration and Conservation Strategies; *in situ* Conservation; Plant Identification; Plant Systematics; Seed Conservation and gene bank Management; Biotechnology and *in vitro* Conservation and Quantitative Plant Breeding, as well as bespoke PGR vocational training for PGR technicians to directors.

On a national level genetic and plant sciences feature in the school science curriculum. Many of the seed banks have open days to encourage an interest and understanding in the work of the collections (for example the Pea Seed Bank at the John Innes Centre, Norwich) and many gene banks offer field days where landraces are grown-up for inspection by potential growers.

5.4 National Legislation

The following section details those aspects of UK legislation that may have an effect on PGR conservation. *In situ* conservation programmes such as the SSSI and Environmentally Sensitive Area (ESA) systems have been described elsewhere.

5.4.1 Plant Health Regulations (The Plant Passport system)

Within the EU Single Market, plant health checks are focused on the place of production. There are no border checks for plants and plant products travelling between EU Member States, although spot checks may take place anywhere in the trade chain. A limited range of material which hosts the most serious 'quarantine' pests and diseases requires a plant passport to facilitate its movement. Any business which wishes to be involved in the movement of passportable material within the EU or the import of material into the EU for commercial reasons, is required to register with the relevant authority in the relevant Devolved Administration. For example, in England and Wales, this is the Food and Environment Research Agency (FERA) which inspects business premises and provides the requisite authority to issue plant passports for their material. Registration is free with no time limit. Authorisation will be granted annually on the basis of an official inspection of the plants during the growing season and a check on record keeping. These official inspections are chargeable.

Where a country or region within the EU can prove that it is free from a particular quarantine pest or disease which is established elsewhere in the Community, it can seek Protected Zone status. Material entering such protected zones must be free of the relevant pest or disease, with this being clearly indicated on the plant passport, where one is required. Where required, a passport is needed both for movements within and between Member States, and additional requirements apply for movements into and within Protected Zones.

When marketed within the EU plant material of ornamental and certain fruit and vegetable genera must satisfy minimum quality standards. Such material must be accompanied by a supplier's document when marketed. With some exceptions those supplying material must be registered and, in the case of fruit and vegetable genera, accredited, by FERA. In England and Wales, inspections of production premises are carried out by the FERA inspectors. No charges are made.

5.4.2 Sale, distribution and marketing of seeds

All aspects of production and marketing of seeds of the main agricultural species are prescribed in EU Seed Marketing Directives. The Directives prescribe minimum quality standards for certified seed, to ensure that purchasers are assured of receiving seed of a reasonable and uniform quality, and require checks to be made on varietal and analytical purity and germination. The Directives also place restrictions on the number of generations of seed, to preserve the integrity of the product, and prescribe conditions and procedures for the official examination of crops and testing of seeds. A recently adopted Commission Directive (2008/62/EC) which provides a legislative framework for the national listing and marketing of conservation varieties and landraces of agricultural plant species and seed potatoes threatened with genetic erosion came into force in the UK on 30 June 2009. Similar proposals for conservation varieties of certain other vegetable plant species have recently been adopted at a European Commission Seeds Standing Committee.

Council Directives 2002/54/EC, 66/401/EEC, 66/402/EEC, 2002/56/EC, 2002/57/EC, 2002/55/EC and 2002/53/EC set out the EU's legislation on the marketing of beet seed, fodder plant seed, cereal seed, seed potatoes, seed of oil and fibre plants, vegetable seed and on the common catalogue of varieties of agricultural plant species.

Seed of the main agricultural and vegetable species may only be marketed if it has been certified in accordance with the requirements of the appropriate Directives and if the variety in question appears on the National List of a Member State or on the EU Common Catalogue. To achieve listing status, all varieties must undergo tests for Distinctness, Uniformity and Stability (DUS). With the exception of vegetable species and amenity grasses they must also undergo trials to evaluate their Value for Cultivation and Use (VCU). The UK Government continues to argue that, other than for seed potatoes, the directive requirements should apply to commercial rather than amateur use and that the 'small packet' market used by gardeners for vegetable seed species should be exempted from these provisions.

Species covered by the Seed Marketing Directives can only be marketed legally if they comply with EU listing and certification requirements. However, farmers may in certain circumstances be permitted to save home produced seed of a listed variety for re-planting on their own farms (farm saved seed) providing that they pay appropriate royalties to the holder of plant breeders' rights. The royalty rate for farm saved seed is currently set at 50% of the rate for certified seed.

Farm saved seed may not be marketed or traded between farms.

5.4.3 Intellectual Property Rights (IPR)

The UK has a comprehensive IPR legislative programme. Both patents and Plant Variety Rights have an indirect and beneficial effect on PGR conservation, by encouraging investment in new technologies and the development of new varieties, and affording a route through ownership/ licensing agreements for owners of genetic resources to be recompensed when material is developed and exploited commercially. There are currently no plans to amend our IPR legislation as a consequence of General Agreement on Tariffs and Trade (GATT). The UK Government fully understands the implications of the IPR legislation for genetic resources.

Chapter 6

International Collaboration

6.1 International Commitments

Since the adoption of the Convention on Biological Diversity, a number of voluntary and legally binding agreements have been adopted or are under discussion. Significant agreements affecting conservation and sustainable use of genetic resources for food and agriculture (GRFA) are:

- The Convention on Biological Diversity (CBD)
- The International Treaty on Plant Genetic Resources for Food and Agriculture (IT)
- The Global Plan of Action for the Conservation and Sustainable Utilisation of Plant Genetic Resources for Food and Agriculture (GPA)

Convention on Biological Diversity

The main obligations relevant to the conservation and sustainable use of PGRFA relate to:

- Identification and monitoring of genetic resources important for their conservation and sustainable use (Article 7) – "paying particular attention to those which offer the greatest potential for sustainable use."
- *In situ* conservation (Article 8);
- *Ex situ* conservation (Article 9);
- Sustainable use of genetic resources (Article 10); and
- Research and training (Article 12).

The UK's Darwin Initiative assists countries that are rich in biodiversity but poor in financial resources to meet their objectives under one or more of the three major biodiversity Conventions including the Convention on Biological Diversity (CBD) and the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES). The initiative has been running since 1992 and has sponsored a number of projects supporting Plant Genetic Resources for Agriculture, for example, a project in Costa Rica to raise awareness about the conservation and sustainable use of agro-biodiversity and plant genetic resources among local and indigenous communities, farmers and their organisations, and other stakeholders, as well as raising awareness about the value and importance of their traditional knowledge (project ref: EIDPJ003).

International Treaty on Plant Genetic Resources for Agriculture (IT)

The objectives of the IT are the conservation and sustainable use of plant GRFA and the fair and equitable sharing of benefits with the aim of achieving sustainable agriculture and world food security. The main UK sponsored gene banks are now

using the Standard Material Transfer Agreement (SMTA) for annex 1 crops, and are encouraged to use the SMTA for further crops which can be exchanged without restriction.

The Global Plan of Action for the Conservation and Sustainable Utilisation of Plant GRFA (GPA)

The GPA has 20 priority activity areas covering *in situ* conservation and development, *ex situ* conservation, utilisation of plant GRFA and institutions and capacity building. Priorities particularly relevant to a Defra policy on GRFA are:

- surveying plant GRFA and updating inventories
- developing new markets for local varieties and diversity-rich products
- building strong national programmes
- constructing comprehensive information systems for plant GRFA.

The Department for International Development (DFID) is responsible for the UK Government's official Aid Programme. It provides assistance for conservation and research into PGR of value to developing countries in order to further its overall mission of promoting sustainable economic and social development and the welfare of people in developing countries.

In pursuit of these objectives, DFID supports programmes of research, conservation and management in Renewable Natural Resources (RNR) at UK institutions, through multilateral organisations and in developing countries.

6.2 International Agricultural Research Centres

The DFID aims to promote sustainable economic and social development and welfare of people in developing countries. In pursuit of this objective, the UK was a founder member of the Consultative Group on International Agricultural Research (CGIAR), an informal association of over 65 countries, international and regional organisations established in 1971 to support a system of agricultural research around the world. DFID is now supporting fifteen of the international agricultural research centres in the CGIAR system, most of them located in developing countries. Their research includes improving plant varieties and methods of production, farming, systems, plant protection, postharvest systems and various aspects of food policy. One of their particular strengths is their collections of genetic resources. Since 1975, institutions sponsored by the CGIAR have built up the world's largest collection of PGR, some 532,500 individual accessions accounting, for over 35% of global unduplicated holdings. The CGIAR's policy supports the unrestricted interchange of germplasm throughout the world. In 2008, DFID’s support for core funding for CGIAR institutions concerned with plant sciences research and genetic conservation amounted to over £17.5M.

In the financial year 2009/10 DFID contributed £1,000,750 towards Bioversity International (formerly the International Plant Genetic Resources Institute IPGRI) core funding.

DFID has contributed £10m to the endowment fund of the Global Crop Diversity Trust. The Trust is a unique public-private partnership raising funds from individual, corporate and government donors to establish an endowment fund that will provide complete and continuous funding for key crop collections, in perpetuity.

6.3 Regional Intergovernmental Initiatives

The UK is participating in Phase VIII of Bioversity's European Programme for Genetic Resources (ECPGR). Defra is providing an annual contribution of 42,500 Euros for five years. The UK is represented, and leads on some of the ECPGR's Working Groups and also contributes in kind to ECPGR, as several of the UK collections have database responsibilities.

6.4 Bilateral Intergovernmental Initiatives

UK bilateral aid is organised mainly on a country programme basis. Activities include technical co-operation for conservation and utilisation of PGR where this fits in with country programme objectives agreed between the UK and overseas governments.

As well as bilateral assistance, and as part of its commitment to the Biodiversity Convention, the UK Government announced the Darwin Initiative in 1992 (see 6.1 above). This is a UK grant scheme that funds conservation projects in developing countries to strengthen scientific, educational and commercial aspects of biodiversity. There have been numerous Darwin Initiatives throughout the developing world which support the International Treaty on Plant and Genetic Resources for Food and Agriculture.

UK institutions actively collaborate with institutes from other countries. For example, Warwick HRI's GRU is actively involved internationally through crop networks, support to overseas development projects and training. Warwick Horticulture Research International Genetic Resources Unit (WHRIGRU) is a member of a GENRES Leafy Vegetables project and the University of Birmingham is a member of the GENRES *in situ* PGR Conservation project funded by the European Union. Warwick HRI has a BBSRC/DFID project on disease resistance in East Africa based on Warwick HRIGRU material.

The John Innes Centre (JIC) has a bilateral agreement with the Nordic Gene Bank on work relating to the Pisum genetic stocks. The JIC is involved in biodiversity studies using DNA markers to identify differences between varieties and to establish the population structure of the John Innes Pisum Collection. This study was extended to other European collections in collaboration with members of the ECPGR Grain Legume Working Group. There is also work with scientists in Kenya and South Africa focused on identifying novel sources of disease resistance in wheat and its transfer into locally adapted germplasm and breeding programmes.

The Millennium Seed Bank partnership led by RBG Kew (Wakehurst Place) is the only international network for the seed conservation of wild species. As above, it comprises 123 institutes in 54 countries. Most of these institutes are linked to the

Project through bilateral agreements with RBG Kew. Conservation efforts have focused on endangered, endemic and locally economic species particularly within dryland vegetation. Within Europe, RBG Kew co-ordinates the EU-funded European Native Seed Conservation Network (ENSCONET), comprising 31 institutes in 17 countries.

The University of Birmingham is leading an IUCN funded project concerned with IUCN Red Listing of European Crop Wild Relative Diversity. This project involves the selection, species prioritisation, collation of ecogeographic data sets and IUCN Red Listing of approx. 1,000 crop wild relatives that are native to Europe, as an aid to the formulation of a systematic global conservation strategy. The University is also coordinating two international agrobiodiversity conservation and use projects: CWR China, which is funded by Defra UK-China Sustainable Agricultural Innovation Network and is focussed on the conservation for enhanced utilisation of crop wild relative diversity for sustainable development and climate change mitigation in China: and PGR Secure, which is funded by EC FP7 and aims to research novel characterisation techniques and conservation strategies for European crop wild relative and landrace diversity, as well as enhancing crop improvement by breeders, as a means of underpinning European food security in the face of climate change.

Annex 1

List of PGR Collections in the UK

Collection and Curator	Number of Accessions	Contact Address
Forage grasses, forage legumes and cereals Contact: B G Waters and L Childs	1900	Agri-Food and Biosciences Institute, (AFBI), Crossnacreevy Belfast, Northern Ireland BT6 9SH
Apples, Pears and Quinces Contact: Contact: F. Fernández	~ 600	East Malling Research, East Malling, Kent ME19 6BJ
Cherry, plum and related species (Prunus sp.) Contact: F. Fernández	~ 250	as above
Raspberries, blackberries and related species Contact: F. Fernández	~ 125	as above
Strawberries (*Fragaria* sp.) Contact: Dr D W Simpson	257	as above
The Vegetable Gene Bank (includes; *Allium* sp., *Brassica* sp., *Raphanus* sp., *Daucus* sp. and *Lactuca* sp.) Contact: Dr D Astley	13,411	Warwick HRI Wellesbourne Warwick. CV35 9EF
Near Isogenic Lines of Tomato Contact: Dr F.A. Langton	~ 900*	as above
Oat Collection (Avena sp.) Contact: I D Thomas	~ 4,360	Institute of Biological, Environmental and Rural Sciences, Aberystwyth University, Plas Gogerddan, Aberystwyth, Ceredigion, Wales, SY23 3EB
Rhizobium Collection Contact: D Allen	536	as above

Collection and Curator	Number of Accessions	Contact Address
Grass and Legumes Contact: I D Thomas	23,677	as above
BBSRC Small Grain Cereals Collection (wheat, barley, oats) Modern Cultivars, Landraces and Traditional Varieties	36,736	John Innes Centre Norwich Research Park, Colney Lane, Norwich, Norfolk NR4 7UJ
John Innes *Pisum* Collection Contact: M J Ambrose	3,553	as above
Wheat Precise Genetic Stocks Contact: S Reader	6,099	as above
Rye, Wheat and related spp. Contact: S Reader	2,574	as above
National Fruit Collection (includes top fruit, bush fruit and ornamentals) Contact: M Ordidge, University of Reading	3,942	National Fruit Collection Brogdale Farm, Brogdale Road, Faversham, Kent ME13 8XZ
Fibre Flax and Linseed, Forage and Amenity Grasses Contact: D T Johnston	~ 400	AFBI, Loughgall, Co Armagh BT61 8JB
Wild and semi-cultivated species of Potato; *Solanum sp.* Contact: P Watts	~ 40	as above
Armagh Orchard Trust collection of Irish apple varieties Contact: S MacAntSaoir	~ 100	as above
Barley Collection (*Hordeum* sp.) Contact: Dr W Spoor	1,000*	Scottish Agricultural College, West Mains Road, Edinburgh EH9 3JG
Fibre Flax and Oil-bearing Linseed Contact: Dr G Marshall	350*	Scottish Agricultural College, Auchincruive, Ayr KA6 5HW

Collection and Curator	Number of Accessions	Contact Address
Cereal Crops Seed Collection Contact: Miss C Struthers	3,0*	as above
Raspberries, blackberries and related species (*Rubus* sp.) (mainly virus indexed) Contact: R M Brennan	507*	Scottish Crop Research Institute, Invergowrie Dundee DD2 5DA [NB: From April 2011 SCRI will be known as The James Hutton Institute]
Blackcurrants and related species (Ribes sp.) Contact: R M Brennan	860*	as above
Commonwealth Potato Collection (*Solanum* sp) Contact: Dr Gavin Ramsay	1,499	as above
Faba bean and related species (*Vicia* sp) Contact: Dr G Ramsay	754*	as above
UK reference collections for tests for National List and Plant Breeders' Rights - modern and traditional cultivars Genetic resource collections - wild species, landraces, traditional cultivars and genetic stocks	16,229	Science and Advice for Scottish Agriculture Roddinglaw Road, Edinburgh, EH12 9FJ genetic.resources@sasa.gsi.gov.uk
Potato Contact: Heather Campbell	comprising 943	as above The European Cultivated Potato Database www.europotato.org
Potato Pathogen-tested Nuclear Stocks (microplant) Contact: Sandra Goodfellow	728	as above The British Potato Variety Database http://varieties.potato.org.uk

Cereals Contact: Susan Harper	4,514	as above The Agricultural Crop Variety Database *www.agricrops.org*
Collection and Curator	**Number of Accessions**	**Contact Address**
Vegetables (except Pea) Pea Oil and Fodder Contact: George Campbell	7,017 2,722 305	as above
Living Plant Collections (not stored as seeds) Contact: J Main	39,055*	Royal Botanic Gardens, Edinburgh, 20a Iverleith Row, Edinburgh EH3 5LR
Living Plant Collections (not stored as seeds) Contact: LCD Curator	83,000* (34,000 spp)	Royal Botanic Gardens, Kew, Richmond, Surrey TW9 3AB *http://data.kew.org/seedlist/itpgrfalist.html*
The Millennium Seed Bank (seeds of wild species from 131 countries) Contact: P Smith	50369 (27,651 species)	Royal Botanic Gardens, Kew, Wakehurst Place, Ardingly, West Sussex RH17 6TN
Nottingham *Arabidopsis* Stock Centre Contact: Dr B Mulligane	~7,000*	School of Biological Sciences, University of Nottingham, University Park, Nottingham NG7 2RD
Cocoa Collection Contact: AJ Daymond	400	Centre for Horticulture and Landscape School of Biological Sciences, Harborne Building, University of Reading, Whiteknights, PO Box 221, Reading RG6 2AS
Collection and Curator	**Number of Accessions**	**Contact Address**
Seeds of major components of ecological groupings in Britain Contact: Dr G Hendry	3,000*	Department of Animal Plant Sciences, PO Box 601, University of Sheffield, Sheffield, S10 2UG

* Figures from the 1996 report

Abbreviations

AFBI Agri-Food and Biosciences Institute, Northern Ireland

ASSI Area of Special Scientific Interest

BBSRC Biotechnology and Biological Sciences Research Council

BGCI Botanical Gardens Conservation International

CAP Common Agricultural Policy

CGIAR Consultative Group on International Agricultural Research

CGN Centre for Genetic Resources, the Netherlands.

CWR Crop Wild Relative

Defra Department for the Environment, Food and Rural Affairs

DUS Distinctness, Uniformity and Stability

ECPGR European Co-operative Programme for Plant Genetic Resources

ESA Environmentally Sensitive Area

EU European Union, formerly known as the European Community (EC)

FERA Defra's Food and Environment Research Agency

GATT General Agreement on Tariffs and Trade

GPA Global Plan of Action for the Conservation and Sustainable Utilisation of Plant Genetic Resources for Food and Agriculture

GRA Genetic Resources in Agriculture.

GOR Garden Organic Ryton (formally Henry Doubleday Research Association HDRA).

HSL Garden Organic's Heritage Seed Library

JIC John Innes Centre

JNCC Joint Nature Conservation Committee

ICRISAT International Crop Research Institute for the Semi Arid Tropics (India)

ICRAF International Council for Research in Agro-Forestry

IBERS Institute of Biological, Environmental and Rural Sciences, Aberystwyth University

UPOV International Union for the Protection of New Varieties of Plants

IPGRI International Plant Genetic Resources Institute

IPR Intellectual Property Rights

IRRI International Rice Research Institute

IT International Treaty on Plant Genetic Resources for Food and Agriculture

IUCN World Conservation Union

LNR Local Nature Reserve

NGO Non-Governmental Organisation

NASC Nottingham Arabidopsis Stock Centre

NL National List

NCCPG National Council for the Conservation of Plants and Gardens

NIAB National Institute of Agricultural Botany

OECD Organisation for Economic Cooperation and Development
PHSI Plant Health and Seeds Inspectorate
PBR Plant Breeders' Rights
RBG Royal Botanic Gardens
RHS Royal Horticultural Society
RNR Renewable Natural Resources.
SACs Special Areas of Conservation
SASA Science and Advice for Scottish Agriculture
SCRI Scottish Crop Research Institute
SG Scottish Government
SSSI Site of Special Scientific Interest
UK United Kingdom of Great Britain and Northern Ireland.
UKPGRG United Kingdom Plant Genetic Resources Group
VCU Value for Cultivation and Use
WHRI Warwick Horticulture Research International.
WHRIGRU Warwick Horticulture Research International Genetic Resources Unit.