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SCHOOL OF BIOSCIENCES

UK National Inventory of Plant Genetic Resources for Food and Agriculture

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ABBREVIATIONS AND ACRONYMS

BAP	Biodiversity Action Plan
BDAA	Biodynamic Agricultural Association
BSBI	Botanical Society of the British Isles
BSPB	British Society of Plant Breeders
CAP	Common Agricultural Policy
CBD	Convention on Biological Diversity
CSS	Countryside Stewardship Scheme
CWR	Crop Wild Relative
DANI	Department of Agriculture for Northern Ireland
DARD	Department of Agriculture and Rural Development (Northern Ireland)
DEFRA	Department for Environment, Food and Rural Affairs
DUS	Distinctness, Uniformity and Stability
ECO-PB	European Consortium for Organic Plant Breeding
ECP/GR	European Cooperative Programme for Crop Genetic Resources Networks
ESA	Environmentally Sensitive Area
FAO	Food and Agriculture Organisation (UN)
FOSSE	Forum on Seeds for a Sustainable Environment
HDRA	Henry Doubleday Research Association
HRI	Horticultural Research International Wellesbourne
IGER	Institute for Grassland and Environmental Research
IHAR	Plant Breeding and Acclimatization Institute
IPK	Institut f ü r Pflanzengenetik und Kulturpflanzenforschung
ISSA	Irish Seed Savers Association
IUCN	International Union for Conservation of Nature and Natural Resources
JIC	John Innes Centre
JNCC	Joint Nature Conservation Committee
KWWC	Kent Wild White Clover
NBN	National Biodiversity Network
NFU	National Farmers Union
NIAB	National Institute of Agricultural Botany
RSPB	Royal Society for the Protection of Birds
SAC	Special Area of Conservation
SAC	Scottish Agricultural College
SAP	Species Action Plan
SASA	Scottish Agricultural Science Agency
SCF	Scottish Crofting Foundation
SCRI	Scottish Crop Research Institute
SEFRAD	Scottish Executive for Rural Affairs Department
SEERAD	Scottish Executive Environment and Rural Affairs
SFU	Scottish Farmers Union
SGA	Seed Growers Association
SOGG	Shetland Organic Growers Group
SPBS	Scottish Plant Breeding Station
SSSI	Site of Special Scientific Interest

TDWG	International Working Group on Taxonomic Databases for Plant Sciences
UHI	University of the Highlands and Islands
UKASTA	United Kingdom Agricultural Supply Trade Association
UKBAP	UK Biodiversity Action Plan
UKPGRG	United Kingdom Plant Genetic Resources Group
VCU	Value for Cultivation and Use
WCA	Wildlife and Countryside Act 1981
WCMC	World Conservation Monitoring Centre
WPBS	Welsh Plant Breeding Station

1 EXECUTIVE SUMMARY

1.1 Crop Wild Relative Assessment

There are at least two categories of useful plants occur in the wild that may be regarded as wild PGRFA:

a. Wild useful plants (WUP) - wild plants that are of direct use and are harvested from the wild.

b. Crop wild relative (CWR) - wild plants of indirect use whose use is derived from their relative closeness to agriculture and food crops, these are referred to as crop wild relatives[1].

While a CWR can be more precisely defined as (Maxted *et al.*, in prep.):

> *A wild taxon either in the same genepool (GP1 or GP2) or the same taxonomic genus, subgenus, section or species (TG1 – TG4) as a taxon of direct socio-economic importance.*

The difference between WUP and CWR however is not always clear-cut, many intermediate categories exist. In fact it may be more appropriate to think of a continuum between WUP occurring in natural habitats on the one extreme and CWR that only occur in agricultural habitats. However, Sanderson and Prendergast (2002) have recently produced an inventory of commercial uses of and potential threats to approximately one hundred wild harvested and traditionally managed useful plants in England and Scotland. Therefore, this inventory will focus on CWR.

The first step in the collation and assessment of wild plant genetic resources was to create a list of UK crop wild relatives, which could subsequently be supplemented by existing distribution and conservation data. A preliminary list of UK PGR was abstracted from a list of European crop wild relatives (Kell, 2003). This list was harmonised and cross checked with the standard UK flora (Stace, 1997). The taxonomy of the original European list and the UK taxonomy were both retained in the database in order to maintain cross-referencing and future integration with the European database.

R1 *The database of wild crop relative genetic resources created in this assessment should be viewed as a starting point for the establishment of a UK CWR database that will require extension to include population level data and regular updating, a* modus operandi *should be established to ensure the necessary database management.*[2]

Currently there are seventy two families in which crop wild relatives or wild plant species of useful taxa in the UK are represented. The five most CWR species-rich families in order of richness are: grasses (Gramineae), rose family (Rosaceae) with many fruit relatives, legumes (Leguminosae), Brassicas (Cruciferae), and composites (Compositae). The list of crop wild relatives contains:

- 778 species with 130 subspecific taxa.
- 20 species are unique to the UK (endemics)
- 20% of the UK Flora can be considered crop wild relatives.

For each CWR species in addition to nomenclatural data, the English common names, usage, and distribution and conservation data were also recorded. Of the UK languages, only English common names were included in the database, the data source being the *New Flora of the British Isles*, but non-English names could be obtained from the Flora Celtica for example (Milliken and Bridgewater, 2001). Also highly localised 'ethnic' uses were only incorporated if they were mentioned

[1] The term crop wild relative often includes those wild species closely related to ornamentals, medicinal plants, poisons or forestry taxa but these fall outside of the remit of this exercise.

[2] Recommendations are highlighted green in the text.

in Mabey (2001) or Sanderson and Prendergast (2002). Data sources for uses were the general economic botany reference of Mansfeld's Encyclopaedia of Agricultural and Horticultural Crops (Hanelt and IPK, 2001), Wiersema and Léon (1999) and supplemented by some specific European references such as Schlosser (1991).

R2 The UK CWR database should be further linked or integrated with regional databases for common names and local usages.

The data provided by Preston *et al.* (2002) formed the basis of the distribution data and trends analysis. This atlas is based on recent floristic surveys, the most recent being in 1999 and used a 10 by 10 km grid square system. Long term trends were based on the change index given for many taxa in the Preston *et al.* (2002). This index should be interpreted as reflecting a relative change. Although the resolution of these data is arguably low and the data suffer a certain degree of recorder bias, no alternative was available. However, data from the follow-up on the BSBI Monitoring Scheme may be available after summer 2004

R3 As national floristic surveys are undertaken the distribution data on which the current UK CWR assessment is based will require updating and extension. The inclusion of introduced taxa (archeophytes, neophytes and casuals) in these surveys is advocated because they constitute an important plant genetic resource for the UK.

Preliminary data analysis of the distribution data showed that:

- Almost half of the crop wild relative taxa are scarce, that is, occur in less than 200 10 by 10 km grid squares.
- 15% of these are rare, they occur in less than 16 10 by 10 km grid squares
- Only 19% of the taxa are very common, that is, they occurs in more than 50% of the grid squares
- Among the less common taxa, archaeophytes (species introduced to the UK before 1500) more frequently showed a long term decline than native taxa (17% compared to 12% of taxa).

PGRFA species were categorised using three criteria: legal protection, threat assessment and actual conservation plans. In the database these criteria were recorded whether they were included in Schedule 8 of the Wildlife and Countryside Act; the IUCN assessment status category, ranging from NE (not evaluated) to EX (extinct) and whether a Biodiversity Action Plans existed which inturn reflected actual active conservation of the species. Fifteen species are listed under the Wildlife and Countryside Act Schedules 8 for plants and twelve of these are also rated with some level of threat using the IUCN criteria, but the vast majority of species has not been evaluated (note: IUCN does not assess below the species level). Overall ten species have been rated as critically endangered, 9 as endangered and 38 as vulnerable. An additional 21 are near threatened. Several UK PGRFA taxa were threat assessed as part of the current project using BSBI data (and descriptions) as presented in Preston *et al.* (2002) and the remaining taxa will be assessed in the near future (Mitchell, in prep.). However only one UK PGRFA taxa, *Asparagus officinalis* subsp. *prostrates*, has so far had a Biodiversity Action Plan.

R4 All UK PGRFA taxa should be assessed using IUCN Red List Threat criteria and currently available BSBI data (Preston et al., 2002), and priority should be given to constructing Biodiversity Action Plans for threatened taxa, those with negative change indices or those most with restricted distributions.

It was not possible to obtain data on the occurrence of PGRFA species within conservation areas. For the more than 4,000 English SSSIs for example, no systematic and only fragmented surveys of the areas were available. Representatives of conservation organisations confirmed that these data were extremely sketchy and therefore it would not be possible to assess *in situ* conservation of PGRFA species at this stage. As a consequence it is not possible to make detailed recommendations on the location and future establishment of genetic reserve for crop wild relatives.

R5 There is an urgent need to gather appropriate population distributional data for all UK PGRFA taxa to identify where genetic reserves should be established to conserve in situ *UK crop wild relatives.*

Historically little has been done to document UK socio-economic use of wild harvested species, but recently Sanderson and Prendergast (2002) produced an inventory and database of such species, listing their commercial uses and the potential threats they face. The database includes approximately one hundred wild harvested and traditionally managed useful plants in England and Scotland. This database of Commercial use of wild and traditionally managed plants in the UK (www.kew.org/scihort/ukplants.htm) hosted by the Royal Botanic Gardens, Kew is an allied database to the inventory presented here.

R6 The UK CWR database should be linking to the existing wild harvested and traditionally managed useful UK plants database either by mutual web site links or provision of a single platform.

There is little evidence that the mainstream UK conservation agencies have considered crop wild relatives or wild harvested species in formulating their conservation priorities. It seems likely that there is widespread ignorance of the real socio-economic value of these species and the need to conserve and have continued access for utilisation to these species. Estimates of the value of these plant genetic resources for the UK are unavailable but worldwide the global sales for products derived from plant genetic resources is US $ 366-519 billion and for natural origin products it is US $ 81 billion (ten Kate and Laird, 1999), so the UK resources have a significant value and it is imperative that they are conserved for future generations.

R7 Improve professional and public awareness of the notion and value of crop wild relatives as a means of promoting their conservation and extending their utilisation.

1.2 Landrace Assessment

Landraces may be defined as having certain characteristics (Camacho Villa, 2003): historic origin, heterogeneity and / or generally, but not necessarily genetically diverse, distinct identity, local adaptation, lack of formal improvement and seed saving on-farm. Although perhaps not all these criteria are met by every entity recognised as a landrace some are commonly associated with landraces.

To assess extant landraces, the project time frame as well as actual timing of the assessment itself, presented some constraints for primary data collection. The limited time available necessitated focusing the assessments on a priority crop group rather than providing multi-crop breadth; cereals were selected primarily because of their economic importance as arable crops in the UK and forages because they provided a contrasting pattern of cultivation. As a consequence, the crops with possibly the highest numbers of landraces, namely fruits and vegetables, fell out of the scope of the current assessment. Their omission does not imply that they are currently adequately assessed, that their diversity is currently adequately conserved or that there is not a need to prioritise them in the future. Although for fruits, apples and gooseberries have been recently assessed for extant landraces (UK Malus Network Newsletter, 1999), along with hops (Darby, pers. comm.). For vegetables the situation is slightly more comprehensive; there has been a recent survey of heirlooms and heritage vegetables

grown by amateurs (Stickland, 2001). However, exotic heirlooms associated with recent and longer established immigrants have not been surveyed. For potatoes, it is believed that many landraces still exist and further work is required to quantify this statement.

R8 Comprehensive inventories of all extant UK landraces, particularly for fruits and vegetables which will likely yield the highest number of extant landraces, are urgently required as a prerequisite to their efficient conservation.

A previous pilot survey of UK landraces (Camacho Villa, 2003) showed that a significantly high number of landraces are still commercially / legally available. Their continued existence is linked to implementation of National Listing and the European Common Catalogue for agricultural and vegetable varieties. The effect of these on continued UK landrace cultivation is exemplified by the example of local forage varieties currently present on the UK National List. Seven extant forage landraces were identified and three of these are still maintained by the original seed growers. These seed growers are the last in a widespread tradition of UK local forage seed production. Notwithstanding their continued presence on the Recommended Lists, most of these varieties suffer from either severe competition from foreign varieties or local production problems, which have led three out of the five current seed growers to consider withdrawing of their unique variety from the National List in the near future.

Evidence from landrace cultivation in other regions of the world (Jarvis *et al.*, 1999) suggests sustainability can only be ensured if there is a 'real' requirement for the locally adapted material; that is farmers even in a niche market situation can make a comparable profit growing landraces compared to modern cultivars. Associated with the efficient conservation of UK landraces there is a need to research their continued and future exploitation.

R9 Agricultural and socio-economic studies should explore the legislative and policy environment within which UK landraces are grown searching for so-called 'perverse incentives' that mitigate against continued cultivation, as well as investigating alternative uses and novel marketing opportunities. One suggestion for the maintaining of forage landraces would be to include landraces in conservation mixtures recognised within Countryside Stewardship Schemes.

It would be naïve to expect a small group of enthusiastic growers to continue bearing the burdon of maintaining localised landraces as a common good for all of society. Of the two extant sainfoin landraces identified neither is currently included in the National List due to the costs of seed certification compared to the small scale of production. Even were the certification fees to be waived by the national statutory testing centres for localised landraces, the *in situ* maintenance of the landraces would not be guranteed as the enthusiasm for cultivating the landrace may wane with the change of grower generations, therefore alternative substainable means of landrace maintenance are required.

R10 Gene banks or other public institutions should be encouraged to take the role of nominated landrace maintainer to ensure sustainable landraces diversity on the UK National List.

One of the two extant sainfoin landraces is safely conserved in the *ex situ* reference collection held at DARDNI. However, if the current grower was to cease cultivation and their landrace was lost the legal status of the 'statutory' reference collections would mean that the duplicate would remain unavailable to potential users.

R11 The legal status and public accessibility of ex situ *collections used for reference or genetic resources purposes by the national statutory testing centres associated with seed certification*

(NIAB, SASA and DARDNI) should be clarified and made compatible with conservation and use priorities.

Vegetable landraces on the National list are largely represented by Open Pollinated local varieties, which represent a long standing local UK breeding tradition often of a Victorian or older origin. Compared to modern F1 hybrids, they can be considered primitive forms. At a national and European level, Open Pollinated varieties are in continuous decline. A comparatively high number of vegetable landraces are found on the National List, the majority of which are found on the so-called 'B-list'. At the time of the introduction of the National List, exemptions were allowed from listing as well as exemptions from the DUS standards in order to facilitate continuation of older pre-1972 vegetable varieties on the list. This mechanism for retention was the so-called B-list, which comprised varieties marketed as 'standard seed' in contrast to A-list or certified and / or standard seed. These pre-1972 varieties were added on the Common Catalogue without initially having to undergo the DUS testing. After a transitional period, the B-list continued to exist. The B-list at present shows its initial function to keep many pre-1972 varieties on the Common Catalogue as is evident from the many landraces and Open Pollinated varieties present on the UK National List in 2003. The requirement for B-listed varieties to have a maintainer was dropped in a revision of the Directive in 2001, as it "should help to retain more of them on the National List" (PVS Gazette November, 2001). Again this points to the UK's 'unofficial' interpretation of the B-list as a means of conserving traditional material. This would help retain amateur varieties and permit the re-introducing of landraces for broader usage.

R12 The possibility of transforming the UK National B-list, which already functions as a register for pre-1972 vegetable varieties and landraces, into a Heritage Seed List should be investigated. Existing DUS protocols need to be adapted to allow further landraces to be added to the National List.

New plant breeding practices and objectives are emerging to meet the requirements of the organic sector, which deviate from the pure-line / maximum yield objectives of most commercial breeders. For landraces the objectives are more generally associated with yield stability, ability to form part of a mixture of varieties and adaptation to lower-input conditions.

R13 Current governmental support for breeding activities should be reviewed to take into account changes in breeding objective associated with non-industrial production, such as the organic, low input and alternative product sectors. In this context, adaptation of current VCU criteria for agricultural landrace varieties may be recommended.

Seed saving of obsolete varieties is important as a common good in terms of providing diversity for future breeding programmes but also has ancillary benefits in terms of providing multiple uses. The survey of cereal landraces indicated numerous minor uses for cereals that would not have been immediately apparent at the start of the inventory, such as thatch, furniture, basketry, handy crafts and church rituals. For instance, a significant amount of long-straw wheat is grown for thatching, mainly in the South-East and South of England and a small number of old to very old English wheat varieties of which 'Squarehead's Master' is the most important are retained independent of the National List. Although a range of functions of these obsolete varieties was seen, the actual number of farmers cultivating these 'specialised landraces' was small. However, during the course of the survey several inquiries were made to the survey team by farmers concerning the availability and suitability of these 'traditional' local varieties. The move toward locally sourced food and heritage varieties is likely to increase the demand for traditional and specialised local varieties.

R14 There is a need to review the traditional uses made of crops that are often associated with 'specialised niche' landraces, these landraces should be credited with Heritage Variety status and seed exchange for these landraces legalised.

The genetic background of landraces may have two broad origins; what might be referred to as '*secondary landraces*' are derived from now obsolete bred varieties that have been seed saved for a significant period of time and '*original landraces*' which are thought to have a much more ancient non-bred origin and these are the historical landraces found on the Northern and Western Islands in Scotland and on one location in Wales. Examples of the latter are Bere barley found on Orkney, Shetland and the Outer Hebrides (used for human or animal consumption) and Small oat (*Avena strigosa*) in Wales, Shetland and the Outer Hebrides (used as fodder and on the Hebrides usually grown in a mixture with an unknown rye landrace). No evidence was found of any Bere or Small oat landrace cultivation on mainland Scotland. The scale of cultivation on the Northern Islands is rather restricted and both crops went through a severe bottleneck some years ago. However, awareness of this agricultural heritage in combination with an awareness of the value of arable crop production as such has led to a renewed interest and on Shetland in a 'living heritage' project.

On the Outer Hebrides, Bere barley cultivation was restricted to few crofters. However, small oat and rye were grown on the Machair soils on an island-wide scale. These machair soils are very light, manganese deficient and the areas are also prone to high winds. The small oat is the only suitable oat for these soils that can be grown without additional treatment. Extrapolated from SEERAD statistics, ESA schemes and crofters interviews, small oat cultivation may involve hundreds of crofters and hundreds of hectares. This scale is larger than any known current area in Europe, based on a preliminary estimation and consultation with some European experts. The scale of *Avena strigosa* cultivated makes the Outer Hebrides likely to be the single largest area of cultivation of this crop, which is on the verge of extinction, within Europe, thus the production has both national and European significance. Possibly as a consequence of the previous lack of documentation about UK cereal landraces, no systematic *ex situ* collecting has been undertaken on any of the three landraces. The morphological and genetic diversity of these landraces is unknown.

R15 Diversity knowledge should be reviewed particularly for the most economically important UK landraces (i.e. notably cereals) and representative ex situ *conservation of landraces diversity should reflect their pattern of diversity.*

The survey to obtain the data for the inventory focused primarily on cereals and the main threat facing cereal landrace cultivation as perceived by crofters were over-population of geese in the Hebrides. These increasing numbers of geese are associated with the two RSPB reserves on the islands. The tension apparent on the Hebrides between birdlife conservation and landrace cultivation may require further investigation with stakeholders. However, in the long-term, the future of crofting in general was seen as the most serious threat to landrace cultivation. The degree of further depopulation of the islands, increased loss of local off-croft employment, lack of rejuvenation of the crofting population and the lack of interest in cattle husbandry were factors specifically mentioned.

The potential of a niche market for these landraces was illustrated during the survey by several enquiries into use of traditional barley landraces in the production of traditional local whiskies. The cultivation of these cereal landraces takes place in a traditional manner with few external inputs, seaweed being the preferred fertiliser. Notwithstanding this, accreditation of use of these cereal and other landraces is absent from agro-environmental schemes which tend to credit farmers and crofters for traditional or low-input management of the land and for the farming of traditional animal breeds but ignore landrace cultivation. The crediting of UK landraces in agro-environmental schemes may also have spin-offs in promoting local seed production (for example of forage landraces). The integration of

landraces into these schemes may also create resource efficient mechanisms to monitor landraces *in situ* conservation. This assessment has shown that the UK retains significant and unique cereal landrace cultivation on a relatively large-scale in Europe. The UK therefore is in a unique position to take a leading role in the development of a conservation policy for landraces in Europe.

R16 To ensure continued cultivation of ancient cereal landraces, measures should be adopted to support crofting in general and cereal production by crofters more specifically. This should be linked to an exploration of widening marketing opportunities and/or the creation of local employment directly or indirectly linked to cereal production. One option would be to incorporate the cultivation of landraces into agro-environmental schemes as a means of safeguarding our living agricultural heritage.

An obvious factor noted while undertaking the landrace survey in preparation for the inventory was the fact that each landrace interest group worked in complete isolation of the other landrace interest groups. Even within a crop or speciality group individual groups did not communicate with each other even though they are addressing similar issues. For example farmers growing long-straw wheat in Southern England have no knowledge or contact with crofters growing Bere barley or even farmers in Wiltshire growing forage sainfoin. Each commented on the relative isolation of their task and their feeling that no one else cared.

R17 To support current farmers and growers of landraces and to encourage wider utilisation of landraces, the creation of a newsletter or nation-wide network of landrace growers is recommended to facilitate information exchange concerning landraces agronomy, current and alternative usage, seed supply and conservation.

2 GENERAL INTRODUCTION

2.1 Assessment Context

The inventory and assessment of the UK's Genetic Resources for Food and Agriculture (GRFA), funded by the Department of the Environment, Food and Rural Affairs (DEFRA), was undertaken as partial fulfilment of the UK's commitment to international biodiversity and genetic resources conservation agreements, including the Convention on Biological Diversity (CBD), the Global Strategy for Plant Conservation (GSPC) and the International Treaty on Plant Genetic Resources for Food and Agriculture (IT). Formally a strategic approach to the conservation and sustainable use of the UK's animal, plant and microbial genetic resources for agriculture and food was being hampered by a lack of baseline information on this important UK resource. Therefore, the general objective of the UK National Inventory of Genetic Resources for Food and Agriculture was to:

> Produce a common inventory for the UK's animal, plant and microbial genetic resources for agriculture and food, in consultation with various stakeholders and which meets the needs of GR stakeholders and the broader user communities. Further, it will provide a GR review of what data are currently available electronically and permit preliminary gap-analysis and assessment of taxonomic and genetic diversity.

This report encompasses the plant genetic resources element of the UK GRFA inventory and assessment, the inventory and assessment of UK animal and microbial genetic resources will be reported on in complementary reports by Woolliams (2004) and Smith (2004).

Within the plant domain four specific objectives were identified:

- to collate data and assess on the UK *in situ* distribution of *crop wild relative species* and identify priority locations for the establishment of CWR genetic reserves within existing UK protected areas;
- to collate data and assess on UK *utilised wild species*, by forming a link with the existing 'Wild Harvest' database hosted by the Economic Botany Section at the Royal Botanic Gardens, Kew;
- to collate data and assess on UK *obsolete cultivars and breeding stocks* in *ex situ* collections, either by links to *ex situ* collection web sites or through the UK EPGRIS national focal point at the Institute of Grassland and Environmental Research, Aberystwyth;
- to collate data and assess on currently extant UK *land races and primitive forms.*

It is noted that while assessing the four categories of UK PGR a degree of overlap occurred in data collation and assessment. Thus crop wild relatives and utilised wild species effectively form one group of wild genetic resources; hence a comprehensive approach was taken to their data collation and assessment. Similarly, some overlap was found between obsolete cultivars and landraces data collation and assessment, and their relationship to the collections at the national testing centres (NIAB, SASA and DARNI).

2.2 Concepts and Definitions

As this is the first UK national inventory of plant genetic resources, it was necessary to clarify certain concepts, this was particularly necessary for landraces which are generally ill defined. The concept of what constituted a landrace was sought using historical monographs, earlier surveys of landraces and the general PGR literature. In general landraces or 'farmers' varieties' are taken to be:

> Plant varieties that have been grown and seed saved by farmers or growers over a significant time period.

This broad definition was used for the inventory to maintain the breadth of assessment. For practical reasons attempting to verify or at least document the historical origin of extant landraces would have gone beyond the scope of this assessment. Both classical and the more recent scientific literature distinguishes between original and derived or secondary landraces and this distinction was applied during the inventory. Original landraces are defined as farmer's varieties that have long historical use and which have not resulted from formal breeding programmes. Derived landraces on the other hand, are historic products of formal breeding programmes that have subsequently been maintained by farmers for an extended period.

There is also a need to clarify what is understood by wild plant genetic resources. Wild utilised species and crop wild relatives in practice form a continuum there being no clear distinction as many crop wild relatives are utilised in their own right. Therefore an inclusive approach was adopted to provide breadth of scope for these wild plant genetic resources. Therefore, species in the original list of European crop wild relatives (Kell, 2003), for which in the UK no cultivation could be found but which are harvested from the wild were also included in the inventory.

Alien genetic resources of non-native origin, either in terms of species or diversity found within the UK, form an important component of the UK national genetic resources. It may be argued that the UK national inventory of plant genetic resources should exclude alien diversity but in practice it is often difficult to distinguish truly native from alien diversity without the expenditure of extensive time and resources. For example, to limit the inventory to strictly native genetic resources would exclude all wild plums diversity. Therefore, a pragmatic approach was adopted and a comprehensive assessment was made. It will be possible when assigning conservation priorities to use relative 'nativeness' as a means of prioritisation along with socio-economic factors.

3 CROP WILD RELATIVE ASSESSMENT

3.1 Objectives

1. To collate data on and assess the crop wild relative species of the UK.
    a. List crop wild relatives native to the UK
    b. Collect information on their *in situ* distribution and conservation
    c. Suggest locations for the establishment of genetic reserves within existing conservation areas
2. To collate data on and assess utilised wild species in the UK.

3.2 Background

Historically much surveying of plant genetic resources has focused on major (field) crops in their centres of diversity, which has meant that the plant genetic resources of European countries have often been neglected. Although if total number of plant species is taken as an indicator of diversity Europe possess about a tenth of the species diversity in the Americas and Asia, Europe does contain Vavilov centre of crop origin and has significant diversity in forage and vegetable species, various oil-producing plants and spices, along with olive, beets, cabbages, onion, asparagus, lettuce and parsnip.

Zeven and Zhukovsky (1975) provide one of the first attempts to list the plant genetic resources for Europe. They distinguished 2 European centres of diversity for plant genetic resource species: the Mediterranean centre with approximately 212 species and the European-Siberian centre with 218 species. They excluded ornamentals and forestry resources from their list and conclude that grass and forage diversity were the more important species forming this European-Siberian centre. Subsequently a group of Biodiversity and Bio-subsistence specialists was established by the Council of Europe to review the present diversity of cultivated plants native to Europe, to identify research priorities and to develop procedures for basic and efficient research for conservation. One of the products of this group was a catalogue of wild relatives of crops native to Europe (Heywood and Zohary 1995) that included 206 species and subspecies. Presence in the primary gene pool of major European crops was used as the criterion for inclusion in the list. Davis *et al.* (1994) in 'Centres of Plant Diversity' had previously observed that Europe had a surprisingly high number of wild genetic resources, endemics examples included *Brassica oleraceae* and *Asparagus officinalis* subsp. *prostratus.*

In recent years national inventories of wild plant genetic resources have been undertaken by several European countries. In the early eighties, for example, the former German Democratic Republic produced an inventory of wild genetic resources which included all species of potential, actual or past valuable that were native or naturalised. This was largely a literature study undertaken by experts from IPK. The list included 642 wild species, covering 10 use-categories and prioritised in three categories of importance (Schlosser *et al*., 1991). This list was later expanded to include Central Europe and 980 species were listed, 28% ornamental and turf, 23% medicinal plants, 19% wood, 8% fruit, and 7% fodder plants (Schlosser *et al.*, 1991). Within France the approach was to prepare a list of target species for *in situ* conservation (Mitteau and Soupizet, 2000); 23 genera and 44 species were listed using the following selection criteria:

a. Species with suitable resource person able to provide advice on conservation.
b. Species for which sufficient knowledge exists.
c. Species not currently protected.
d. Species whose genetic diversity is either threatened or for where there is insufficient knowledge of threats they face.

While for Italy a first inventory, including 163 species, was derived from the Italian distribution list abstracted from the Heywood and Zohary (1995) catalogue and as a result proposals were made for *in situ* conservation of 16 most rare or endemic taxa not covered by conservation existing areas (Mazzola *et al.*, 1997). However, in the UK no such national list of plant genetic resource species existed until the present study.

The 4th International Technical Conference of the FAO (Leipzig 1996) defined 'national' or indigenous genetic resources as:

a. Cultivated plants.

b. Old varieties and landraces of crops grown currently or in the past.

c. Related wild plants and forms of cultivated plants as well as wild plants with potential uses, including neophytes (plants introduced in the last 500 years).

Under category c. for example approximately 900 wild plants with actual or potential value available for food, agriculture and forestry have been listed as national plant genetic resources for Germany, with an additional list of native plants of ornamental value (BELF 1996). In a more recent governmental brochure on genetic resources the number of 'national' genetic resources is given as 1000, with reference to the paper from 1996 (BMVEL 2002).

This 'comprehensive' definition of genetic resources is compatible with that proposed by CBD (Convention on Biological Diversity, 1992) and IT (International Treaty on Plant Genetic Resources for Agriculture and Food; FAO, 2001) as a plant with actual or potential value. However, a 'spectrum' of plant genetic resources is favoured by the FAO, representing an evolutionary continuum linking ancient wild forms with modern cultivated varieties and also an ecological continuum, linking wild with domesticated crops (Hoyt 1992):

a. Wild relatives

b. Landraces and primitive cultivars

c. Obsolete cultivars

d. Advanced breeding lines, mutation and other products of plant breeding programmes

e. Modern cultivars

The CBD and International Treaty on Plant Genetic Resources for Agriculture and Food have refocused the agenda for genetic resources on national and regional level activity and have widened the scope of plant genetic resource conservation to include wild genetic resources. At the same time the IT drew attention to the imperative of conserving national landraces, which had been ignored in most European countries.

3.3 Composition of UK Wild PGRFA

There are at least two categories of useful plants occur in the wild that may be regarded as PGRFA:

c. Wild useful plants (WUP) - wild plants that are of direct use and are harvested from the wild.

d. Crop wild relative (CWR) - wild plants of indirect use whose use is derived from their relative closeness to agriculture and food crops, these are referred to as crop wild relatives[3].

[3] The term crop wild relative often includes those wild species closely related to ornamentals, medicinal plants, poisons or forestry taxa but these fall outside of the remit of this exercise.

While a CWR can be more precisely defined as (Maxted *et al.*, in prep.):

> *A wild taxon either in the same genepool (GP1 or GP2) or the same taxonomic genus, subgenus, section or species (TG1 – TG4) as a taxon of direct socio-economic importance.*

The difference between WUP and CWR however is not always clear-cut, many intermediate categories exist. In fact it may be more appropriate to think of a continuum between WUP occurring in natural habitats on the one extreme and CWR that only occur in agricultural habitats.

Table 1. The Range of Wild Utilised Plants and Crop Wild Relatives

Plant Type	Habitat	Example
Wild species used in the past or present	Natural to semi-natural	*Carex* ssp., *Phragmites australis, Persicaria bistorta,* (see Sanderson and Prendergast 2004)
Native wild species, relatives of present or past crops, ancestors of cultivated species	Natural	*Brassica, Raphanus, Allium, Trifolium, Lolium, Festuca, Apium* ssp., *Pyrus cordata,*
Wild relatives of formerly cultivated plants or trees	Natural	*Trifolium incarnatum* subsp. *molinerii, Camelina microcarpa,*
Naturalized relatives of cultivated species, integrated in the natural vegetation	Natural to semi-natural to man-made	*Prunus avium, Prunus domestica, Ribes* ssp.
Neglected crops, naturalised or integrated in (semi-)natural areas	Natural to semi-natural	*Mespilus germanicus, Sorbus domestica, Rubia tinctorum,*
Wild species used as food or industrial plants, and cultivated/domesticated in the past	Natural to semi-natural	*Portulaca oleracea, Cichorium intybus, Chenopodium bonus-henricus*
Wild or naturalised plants used as rootstocks for productive crops	Man-made	*Crataegus monogyna*
Remnants of old plantations or naturalised populations of tree crops	Semi-natural	*Prunus avium, Pyrus, Malus domestica*
Wild relatives 'weeds' of herbaceous crops,	Agricultural	*Avena fatua, Rapistrum rugosum, Beta maritima, B. patellaris, Atriplex patula, Malva* sp. pl., *Apium nodiflorum, Daucus* sp. pl., *Pimpinella major*
Remnants of former cultivation	Agricultural	*Avena strigosa, Trifolium incarnatum* subsp. *incarnatum, Carum carvi, Camelina sativa*

3.4 Indigenous and Introduced PGRFA

Within the UK context CWR may be further demarkated as those taxa as indigenous or native to the UK. As could be seen in the previous section, crop wild relatives cover a range from natural habitats to strictly man-made environments. They can also range from native species to recently introduced ones. From a perspective of plant genetic resources, the status of a taxon (whether it is native or introduced) is secondary to its actual, potential or past use and benefit for the UK economy. Therefore, within the survey both indigenous and introduced PGRFA were included.

Historical ecology also gives an additional reason for this inclusive approach to wild plant genetic resources. From a historic-ecological perspective, the nineteenth century was the apex of UK plant biodiversity, due to the wide spread introduction of new agricultural species yet before the intensification of land use and the loss of native biodiversity. Among the many neophytes that arrived between the 16th and 19th century were crimson clover, some vetches and vetchlings, Lucerne, white melilot and lupines. Many of the 60% of introduced taxa listed in Stace (1997) result from humans having visited an area in which the species was native and returning with samples either intentional or unintentional. Methodologically there are flaws in the determination of the status of a taxon in the field surveys. As recorders for the 1999 survey were asked to identify for every species status alien / native, two types of records can be found for a species: 'native' and 'alien' records (Preston *et al.*, 2002). One can expect a degree of subjectiveness in this determination according to the collector. Therefore for the inventory the assessment provided by Stace (1997) and Preston *et al.* (2002) was followed.

Plant introductions may either be archeophytes (plant that became naturalised before AD 1500) or neophytes (palnts introduced after AD 1500) or casuals (plants only present due to repeated re-introduction). Examples of archeophytres are plants introduced by the Romans and naturalised since such as: *Mentha pulechrium* and *Carum carvi*. Casuals are present only as populations which fail to persist in the wild for periods of more than approximately five years. They are dependent on constant re-introduction. They can be considered relics or escapes from cultivation as for example, *Lactuca sativa* and *Raphanus sativus*. However, for other taxa, their status is unclear or ambiguous, for example, the origin of Horseradish, *Armoracia rusticana*, is disputed but may possibly be European Russia (Schulze-Motel 1986).

An additional reason to include all status categories is heuristic. From the literature it is clear that status should not be seen as a fixed characteristic. *Camelina sativa* has been considered an archeophyte for Britain (Preston *et al*. 2002) but archaeological evidence suggests a central-European origin of domestication (Zohary and Hopf 1994), which may suggest a more recent introduction to the UK. Its current status, however, is as a casual as it only occurs as a bird feed spill. Technically the taxon could be considered extinct in the wild as its former source of naturalisation, a common contaminated of flax seed, has been lost due to more thorough seed cleaning and a decline in flax cultivation. This is one of many examples of archeophytes that have been regraded as casual because of changing agricultural practices. Another similar example is the decline of minor clovers such as crimson clover due to improved seed cleaning[4]. As such, the description 'formerly widely naturalised' in Stace (1997) is indicative of a decline of the species. The status 'casual' may reflect this regression of formerly widely naturalised crop wild relatives; it may even reflect a factual 'extinct in the wild'. This inclusive policy is in line with BSBI attitudes as recently archeophytes have been considered for IUCN assessment (BSBI newsletter, 2004).

3.5 Production of UK Crop Wild Relative List

The creation of a list of UK crop wild relatives is one of the deliverables from the National Inventory of PGR for food and agriculture. The procedure was to abstract a preliminary list for UK taxa from the European crop wild relative list produced by PGR Forum (www.pgrforum.org). The latter was in turn generated from two existing European databases: Euro+Med PlantBase (www.euromed.org.uk) for wild plants and Mansfeld's Database of Agricultural and Horticultural Crops (Hanelt and IPK 2001: www.Mansfeld.ipk-gatersleben.de/Mansfeld/) for cultivated plants. To produce the PGR Forum list a list of genera containing plant of socio-economic use for food and agriculture species was constructed from the Mansfeld's Database, then matched to the Euro+Med PlantBase database to produce a list of genera with all subordinate taxa. This then constituted the list of European crop wild relatives, the first

[4] With kind thanks to Dr. Tim Rich for discussing data interpretation of long term trends

version of this list was produced in 2003 and contained 813 genera. Within this list, taxa with an ISO country code GBR were selected leaving 401 genera present in Great Britain[5] which constitutes the UK crop wild relative list.

The taxonomy of the European list was harmonised with the taxonomy used in the national flora of the UK: New Flora of the British Isles, second edition (Stace 1997). The taxa on this preliminary list for the UK were further checked:

1. For potential missing Northern Irish taxa (Preston *et al.*, 2002).
2. For missing UK taxa important for agriculture and food (Mabey 2002, Phillips 1983).
3. On uses in order to exclude ornamentals, forestry and medicinal taxa which were excluded from this PGRFA based list.

As the objectives of the National Inventory of Plant Genetic resources includes both utilised wild plants and crop wild relatives, no differentiation was made in the list produced by PGR Forum between wild-harvested plants with importance for food and agriculture and crop wild relatives in the strict sense.

3.6 Crop Wild Relative Inventory Database Structure

Data for the two main components of the National Inventory were collated in two separate Microsoft Access 2000 databases: one for crop wild relatives and one for landraces. Database structure and format rules were as far as possible consistent with the UK National Inventory for EURISCO. As general format rule, multiple values in a field are separated by spaces. Only one entry for common names was allowed. The database does not have common name synonyms. Where no values were available the field was left blank. The reasons for the lack of availability are explained per field in the following tables. This database is a collation of four types of crop wild relative information:

1. taxonomic
2. usage related
3. occurrence
4. conservation related

The database structure also reflects the origin of the nomenclatural data held in the database from Euro+Med and to allow synonymy and comparison of the two databases, the taxonomy of the original database was retained alongside that for the UK flora taken from Stace (1997). The two taxonomies are incorporated in the database with three different fields for their respective scientific names. The scientific names of the original database are preceded by the extension EUR (EURGENUS, EURSPECIES, EURSUBTAXA) while UK scientific names from Stace (1997) are simply named GENUS, SPECIES and SUBTAXA.

Native status as a category refers to the putative indigenousness of plants and two sources were used to collate data on status: Stace (1997) and Preston *et al.* (2002). Stace (1997) uses two categories: native or probably native and introduced or alien, while Preston *et al.* (2002) uses: native, archeophyte, neophyte and casual. Native species can also be categorised as endemics. Inconsistencies between the two systems were solved by allowing more than one value in a field, for example, NA / AL meaning that the taxon is native, but has a distribution wider than its native range. This was also necessary to allow for the double recording system used by Preston *et al.* (2002), which allows more than one status ranking to be recorded for each taxon. For taxa where both native and introduced is recorded, the distribution data collated in the database are for native records only.

Data for taxon usage were collated from several sources; general use from Wiersema and Leon (1999); European and specific UK uses from Hanelt and IPK (2001), Schlosser (1991) and Mabey

[5] With kind thanks to Ms. Shelagh Kell of PGR Forum

(1996, 2003). Multiple uses were allowed and summarised using the TDWG coding standard. In three other fields data related specifically to conservation status were collated: legal status, threat assessment and actual conservation plans respectively. The compatibility with external database is shown in Table 2 and the field description, field types, blank descriptions and field filling percentages for the CWR database are provide in Table 3.

For citation or author index, four author names were not given in Stace (1997). Four being hybrids, the fifth blank was an extra record to designate an aggregate field of Taraxacum agg., for which convention does not require a citation. Eighty six status fields are missing, these apply to subspecies level taxa and here the status is given at the higher species level. Common names were often not available at subtaxa level: for either subspecies or hybrids, 169 common names were missing.

Table 2. Overview of potential relations of UK PGRFA database with other databases.

Database name	Database maintainer	Field in common	Geographic focus	Plant Category
EURISCO	ECP/GR National Focal point at IGER	GENUS, SPECIES, SUBTAXA ACCENAME	European	Crop cultivars and landraces
PGR Forum	PGR Forum	EURtaxonomic fields (EURgenus, EURspecies, EURsubtaxa)	European	Crop wild relatives
Wild utilised plant project database	RBG Kew Economic Botany	GENUS, SPECIES Product description (use) Vernacular name	England and Scotland	Utilised wild species
Flora celtica	RBG Edinburgh	GENUS SPECIES USE	Scotland	Crop wild relatives

3.7 Analysis of UK Crop Wild Relatives List

After excluding ornamentals, medicinal and forestry plants, there are 972 UK crop wild relatives or wild-harvested taxa with importance for food and agriculture, see Table 4. For comparison: there is a total of 4111 taxa present in the British Isles of which 60% are introduced (Stace, 1997). Therefore we conclude that: *20% of taxa on the British Isles can be considered crop wild relatives for agriculture and food*. This is comparable with the estimated 15% for Central Europe (Schlosser, 1991). The 972 taxa are divided over 72 families, 233 genera, 837 species or hybrids and 129 subspecific taxa. Dandelion (*Taraxacum officinalis*) is the only species to include a complex of micro-species, all other species with sub-ordinate taxa are represented by subspecies or variety rank. The 59 hybrids are spread over 21 genera, with the majority being present in willow (*Salix*), rose (*Rosa*), poplar (*Populus*) and mint (*Minta*). An overview of the ten species richest families is given in Table 5.

Table 3. Description database structure crop wild relatives

Field Name	Data type	Field description	Empty field description	Number of records	% fills	EURISCO field
EURGENUS	Text	Generic name as in PGR Forum European CWR database.	Absent in mother file	914	94%	No
EURSPECIES	Text	Specific epithet as in PGR Forum European CWR database.	Absent in mother file	913	94%	No
EURSUBTAXA	Text	Subspecific epithet as in PGR Forum European CWR database.	Absent in mother file	113	12%	No
FAMILY	Text	Family name from Stace (1997).	No blanks permitted	973	100%	No
GENUS	Text	Genus name from Stace (1997).	Not listed in reference	973	100%	Yes
SPECIES	Text	Specific epithet from Stace (1997).	Not listed in reference	972	100%	Yes
SUBTAXA	Text	Subspecific epithet from Stace (1997). The following subtaxa categories are used: 'subsp.' for subspecies; 'var.' for variety, 'f' for form.	No subtaxon listed in reference	134	14%	Yes
SPAUTHOR	Text	Author citation.	No citation given in reference	968	99%	Yes
DISLEVEL	Text	Taxon level at which distribution data are given in Preston *et al.* (2002).	Distribution level at taxon level identical with taxonomic fields	7	1%	No
STATUS	Text	Status categories NA = Native; ARCHEO = Archeophyte; NEO = Neophyte, CASUAL = Casual; ENDEMIC = Endemic; AL = Alien, taken from Preston *et al.* (2002) and Stace (1997). Double entries allowed.	Status not given in either Stace (1997) or Preston *et al.* (2002)	887	91%	No
USECODE	Text	Numerical codes follow Cook (1995) Economic Botany	Taxon not listed in	718	74%	No

		Data Collection Standards.	references			
OCCUR	Number	Number of 10 by 10 km grid squares present from Preston *et al.* (2002). Only one value entered.	No distribution data available in reference	858	88%	No
TREND	Decimal	Decimal number or change index reflecting relative distributional change comparing first BSBI national survey (Perring and Walters, 1962) with the latest national survey (Preston *et al.* (2002). Only decimals greater or smaller than +/- 1.50 are considered significant increases, respectively decreases.	No change index given in reference	569	58%	No
COMMONNAME	Text	Common English vernacular name from Stace (1997).	No common name listed for this taxonomic level in reference	804	83%	No
IUCNSTAT	Text	IUCN threat assessment and BSBI scarcity assessment taken from Wiggington (1999) and Cheffing (2004).	Not listed in either references	190	20%	No
LEGAL	Text	Protected by Wildlife and Countryside Act Schedule 8 (WCA-8).	Not listed in WCA-8	20	2%	No
CONSER	Text	Biodiversity Action Plan (BAP) in place (http://www.ukbap.org.uk/).	No BAP	16	2%	No

The UK CWR families represented are related to important native UK crops, such as grasses, rosaceous fruits, legumes, cabbages, salad vegetables, root vegetables, umbellifers and the mint family, the majority of which are native crops. Within the rose family, the highest number of endemic taxa are found in the genus *Sorbus* (e.g. rowan, whitebeam). However, some families show significant numbers of introduced taxa, which reflects their history of cultivation in the UK. Many legumes were introduced to Great Britain in the late seventeenth century as new crops, which is reflected in the high number of neophytes within the legume family. Legumes are also the group with the highest number of taxa with both native and introduced status. Many introduced legume species have native or naturalised relatives, e.g. subterranean clover, crimson clover, sainfoin, broad bean. While the family with only wild-harvested taxa, Cyperaceae, has low numbers of introduced taxa compared to families with relatively high numbers of crop wild relatives. The relative native / introduced status is summarised in Table 6.

Table 4. UK CWR Species Rich Families.

Family	Crop Exemplars	Species
Poaceae	Fescues, ryegrass, timothy, cocksfoot, bent grass	117
Rosaceae	Apple, pear, plum, cherry, service tree	99
Fabaceae	Clovers, lucerne, vetch, sainfoin, trefoil,	84
Brassicaceae	Cabbage, radish, watercress	53
Asteraceae	Lettuce, salsify, chicory	41
Chenopodiaceae	Beet, Good King Henry	36
Apiaceae	Carrot, chervil, parsnip, celery	32
Lamiaceae	Mint, thyme, wild marjoram	19
Liliaceae	Asparagus, onion	14

Table 5. Total Number of UK CWR Taxa.

Taxonomical Level	Number Of Taxa Following Uk Flora (Stace 1997)
Family	72
Genus	233
Species	778
Hybrid	59
Aggregate.	1
Section	1
Subtaxa (Hybrids Excluded)	130

Table 6. Status Categories Per Taxon Within The 10 Species Richest Families.

Family	Native	Endemic	Archeophyte	Neophyte
Poaceae	103	2	8	19
Cyperaceae	91	0	0	1
Rosaceae	70	14	9	12
Fabaceae	69	0	2	24
Asteraceae	31	0	6	6
Brassicaceae	25	2	14	13
Chenopodiaceae	24	0	8	5
Apiaceae	21	0	6	6
Lamiaceae	13	0	2	3
Liliaceae	12	0	2	5

3.8 Occurrence Data and Change Index

Preston *et al.* (2002) records are mapped in 10 by 10 km squares of the Ordnance Survey National Grid. The total number of grid squares for Great Britain is 2852. Recent records have been assigned priority over older records and native records over alien, i.e. if the most recent record for a species is for the alien, and older records are for native, the alien records will have precedence over the native status. As a consequence, older native records can be obscured. In the London area the replacement of native species by introductions is probably most frequently (Preston *et al.*, 2002). Confounding factors in recording: taxonomical inconsistencies, identification problems, under-recording can also play a role and lead to recorder bias (Preston *et al.*, 2002).

To analyse changes in time Preston *et al.* (2002) use a change index based on regression analysis (Telfer, 2002) used in the Scarce Plant Project, BSBI monitoring scheme and Carabid beetle project (Tefler, 2002). The index is created by plotting range sizes for all species for two periods against one another; calculating a regression function that is used as standard to develop the indices for individual species (Tefler, 2002). The drawback of this method is that is does not reflect absolute changes but indicates direction of change and significance of changes. For the trends in time analysis, two of the possible three available sets of record (pre-1970, 1970-1986, 1987-1999) were used, the first and the last because these were the only UK-wide assessment. An alternative change indication would be the approach followed by Rich and Woodruff (adjusted) comparisons, to compensate for under-recording and different recorder efforts in the 1962 Atlas compared with the BSBI Monitoring Scheme (Rich and Woodruff, 1996). However, here the change index as proposed by Tefler (2002) was used.

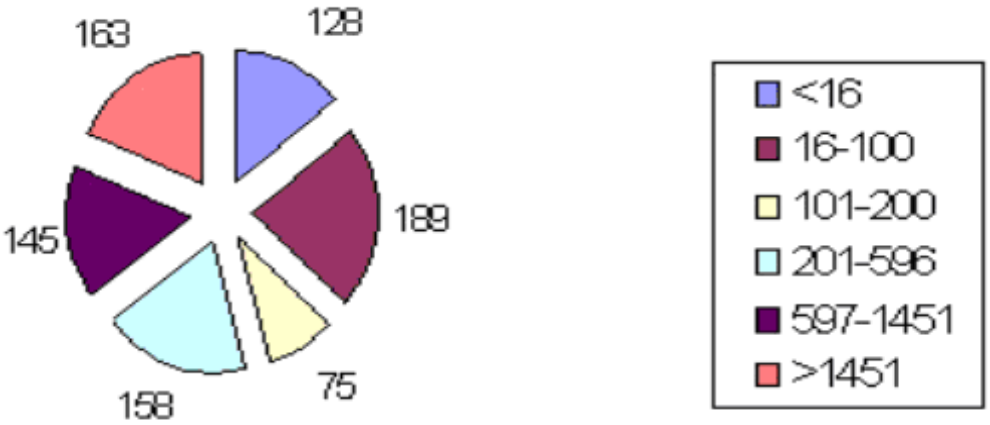
Occurrence data categories were used to assess Red Data List categories (Wiggington, 1999):

1. rare = < 16 10 by 10 km squares or 0.56% of 2852
2. scarce = between 16 - 100 squares or 0.56% - 3.50%
3. near-scarce = 101 - 200 squares
4. between 201 – 596 grids

5. 597 – 1451 grids
6. more than 50% or more than 1451 grids

The number of taxa falling into the 6 frequency categories is shown in Figure 1. For 115 taxa no distribution data were presented in Preston *et al.* (2002). As can be derived from Figure 1 only 19% of crop wild relative taxa are very common and 36% common to very common. An equal proportion can be considered scarce to rare. The near-scarce category covers 9% of taxa. Almost half of the taxa, (46%), for which distribution data are available, occur in less than 200 10 by 10 km squares.

Figure 1. Occurrence frequency categories (number of taxa within a given range of 10 x 10 km grid squares.



In general the change indices were negative indicating decline for 308 out of 569 taxa, but of these only 21 can be considered significant using the Preston *et al.* (2002) criterion of significance with a change in excess of -1.50%. However, as can be seen from Table 7 many endemic species are not only scarce they are also threatened.

Table 7. UK endemic crop wild relative taxa.

Family	Genus	Species	Subspecific Taxa	Gird Sq. Distribution	Trend	IUCN Status	Legal Protection
Brassicaceae	*Cochlearia*	*micacea*		18		NS	No
Brassicaceae	*Cochlearia*	*officinalis*	*scotica*	50			No
Linaceae	*Linum*	*perenne*	*anglicum*	22	0.43	LC	No
Poaceae	*Calamagrostis*	*scotica*		1		VU	No
Poaceae	*Spartina*	*anglica*		212	0.11		No
Polygonaceae	*Rumex*	*acetosa*	*hibernicus*	1		NR	No
Rosaceae	*Sorbus*	*anglica*		13		VU	No
Rosaceae	*Sorbus*	*arranensis*		1		VU	No
Rosaceae	*Sorbus*	*bristoliensis*		1		EN	No
Rosaceae	*Sorbus*	*devoniensis*		27		NS	No
Rosaceae	*Sorbus*	*eminens*		8		VU	No
Rosaceae	*Sorbus*	*hibernica*					No

Rosaceae	*Sorbus*	*lancastriensis*	8	NT	No
Rosaceae	*Sorbus*	*leptophylla*	3	CR	No
Rosaceae	*Sorbus*	*minima*	1	VU	No
Rosaceae	*Sorbus*	*porrigentiformis*	26	NS	No
Rosaceae	*Sorbus*	*pseudofennica*	1	VU	No
Rosaceae	*Sorbus*	*subcuneata*	4	VU	No
Rosaceae	*Sorbus*	*vexans*	3	VU	No
Rosaceae	*Sorbus*	*wilmottiana*	1	CR	No

An overview of taxa with a significant negative change index is given in Table 8. Significantly, the majority of these taxa in severe decline are introduced species: 7 neophytes, 9 archeophytes and 1 casual. Four of these taxa are common to not-scarce; all other taxa occur in less than 200 10 x 10 km squares. However, 35 taxa showed a significant positive trend, among these 6 native taxa and 6 archeophytes, the vast majority being neophytes.

Table 8. Number of Scarce Taxa in Decline.

Status Category	Number of Taxa With Occurrence <200 10 x 10 Squares And A Negative Change Index	Percentage Of Total Taxa
Native	83	(12%) of 623
Archeophytes	14	(17%) of 81
Neophytes	16	(10%) of 169
Total	113	(12%) of 972

It should be noted that for many rare species, change indices were not available. Notwithstanding this limitation, the proportion of scarce taxa in decline can be assessed by filtering the data on an occurrence lower than 200 grids and a negative change index. The results are that 12% of all taxa show these two criteria. Remarkably, among archeophytes this long term decline seems to occur more often than on average. In comparison, only 62 scarce taxa had a positive change index, 35 of which are significantly.

For very few species more detailed data are available and only one is a UK BAP species *Asparagus officinalis* subsp. *prostrates*, the description of the data available is given below:

> IUCN status: vulnerable. BAP species
>
> Preston *et al.* (2002) data shows the taxon has been lost from 7 10 x 10 km squares since 1970, out of a present distribution of seventeen grid squares, a loss of more than 40%. However, Rich *et al.* (2002) investigated the species on site and found of the past recorded thirty four sites, twenty eight remined extant in 1999-2001, implying a more accurate loss of 18%.

As this species occurs on difficult to access and dangerous locations (sea cliffs), it is possible that this species has been under-surveyed and new sites may be found in the future. The twenty eight sites (Rich *et al.*, 2002) had approximately 1200 plants in total, ranging from 1 to 398 plants per site. Trends for populations were difficult to assess because of lack of comparability in recording methods. Five sites had fewer than 10 plants, four only had a single plant and of these nine sites, three were thought to be

seriously at risk of extinction and at only three sites were the populations considered secure with more than 100 plants.

3.9 Legal Protection, Threat and Conservation

Legal protection

The legal protection of plant in the UK has an international and a national dimension, for an overview of the different legislation, see Wiggington (1999), which is summarised in Table 9. The main national legal instrument for the protection of wild plants is the Wildlife and Countryside Act (1975), which makes it an offence to uproot any wild plant. Listed under Schedule 8 of this law are species that need special protection and there are 20 crop wild relative taxa listed, see Table 10.

Table 9. Overview of International Obligations for the Protection of UK Plant Species (After Wiggington, 1999).

Species	EC Habitat & Species Directive Annex	Bern Convention	Cites	WCA 8
Apium repens	IIb, IVb	I	II	YES
Rumex rupestris	IIb, IVb			YES
Ruscus aculatus	Vb			NO

Table 10. CWR Taxa Listed Under WCA Schedule 8.

CWR Taxa	
Allium sphaerocephalon	*Lathyrus tuberosus*
Apium repens	*Mentha pulegium*
Artemisia campestris	*Potentilla rupestris*
Atriplex pedunculata	*Pulicaria vulgaris*
Carex depauperata	*Pyrus cordata*
Chenopodium vulvaria	*Rumex rupestris*
Cyperus fuscus	*Ruscus aculeatus*
Equisetum ramosissimum	*Schoenoplectus triqueter*
Eryngium campestre	*Scorzonera humilis*
Lactuca saligna	*Thlaspi perfoliatum*

Threat Assessment

The maintenance and updating of the Red Data List and the Species of Conservation Concern in Great Britain is the responsibility of JNCC. The list of threatened, rare and scarce plants has been recently updated for the species listed by Preston *et al.* (2002) and this list was published in January 2004 in the BSBI Newsletter (Cheffings, 2004). The threat status of species is assessed using the IUCN criteria as published in the Red Data List (IUCN, 2001). Five factors are taken into consideration in order to assign threat criteria:

a. Declining population (past, present and/or projected)

b. Geographic range size, and fragmentation, decline or fluctuations

c. Small population size and fragmentation, decline, or fluctuations

d. Very small population or very restricted distribution

e. Quantitative analysis of extinction risk (e.g., Population Viability Analysis)

The threat categories used are:

Extinct (EX)

Extinct in the Wild (EW)

Critically endangered (CR)

Endangered (EN)

Vulnerable (VU)

Data deficient (DD)

Only taxa in the categories CR, EN and VU are considered to be threatened. The criteria are applied only to species that are 'native' or 'archeophytes', therefore Cheffings (2004) excludes neophytes. A further review of the UK Red Data List is currently being undertaken by the Vascular Plant Working Group although the final report is not expected until 2005; they will be paying particular attention to the 'near-threatened' category. As well as the Red Data List Categories (IUCN, 2001), Preston *et al.* (2002) add two addition criteria:

- Nationally Rare (NR) - Occurring in fewer than 16 hectads in Great Britain and the Isle of Man
- Nationally Scarce (NS) - Occurring in between 16 – 100 hectads in Great Britain and the Isle of Man

It should be noted that these two categories assess occurrence rather than threat in the strict sense of the word. For the IUCN assessment the taxa were screened on scarcity and short-term decline which was sometimes but not necessarily reflected in a negative change index. An overview of IUCN assessments for CWR taxa is given in Table 11. The table is based on two sources of information: the current British Red Data List (Wiggington, 1999) and personal assessment following a practical IUCN Red List training course given at IUCN in Cambridge by Craig Hilton-Taylor. In the latter regional criteria were applied (IUCN, 2003).

Table 11. IUCN Threat and Occurrence Assessment Categories for UK CWR.

IUCN threat category	No. of Native taxa	Total no. of taxa
CR	9	10
EN	8	9
VU	35	38
NT (Near Threatened)	18	21
LC (Least Concern)	13	14

DD (Data Deficient)	3	3
NS (Nationally Scarce)	84	92
NE (Not Evaluated)	451	783

***In situ* conservation data**

In order to fulfil objectives 2 and 3 of this assessment, to collect information on their *in situ* distribution and conservation and to suggest locations for the establishment of genetic reserves within existing conservation areas, data were sought on the occurrence of the crop wild relatives within existing conservation areas. Methods to achieve this objective were discussed with contact persons at Joint Nature Council and English Nature.

One option considered was to use (high resolution) distribution data and overlay these with conservation area boundary maps. The optimum resolution for the analysis of occurrence of a species is considered to be data at tetrad level (that is 2 by 2 km grid). The vascular plant database at the Biological Recording Centre, Monkswood is the dataset from which the New Atlas (Preston *et al.*, 2002) was generated. However, the data included in the vascular plant database are extremely variable and patchy depending on taxa and locality; very little species distribution data are at a precise six digit level and most data are at the hectad level. The resolution of these data was therefore too meagre to permit an overlay with GIS conservation area boundaries. An alternative approach would have been to contact BSBI vice county recorders; however, it was not possible to send a general request for information to the BSBI in the time available for the CWR national inventory as any request would need to be accomplished via the BSBI Records Committee. Therefore, as neither high resolution data nor overlays of conservation areas were available, this option was not feasible. A third option would have been to screen species lists collected within conservation areas. However, again at the time of the CWR national inventory the National Biodiversity Network (NBN) was not publicly available. This was unfortunate as the NBN gateway will have a search facility available to identify species records from SSSIs and SACs. However, as with the vascular plant database, the information per SSSI is very variable and depends on the rationale for creating the area and CWR have not been a rationale for establishing SSSIs. Also species lists for SSSIs and SACs have yet to be centralised or accessible via a unified web portal. This detailed plant distribution information that is available is likely to be biased towards rare and threatened species, which has been the focus of SSSI and SAC designation.

Thus unfortunately given the lack of distribution data for CWR taxa and their occurrence within conservation areas it was not possible to assess the *in situ* conservation of UKCWR taxa. For individual species and individual counties data may have been present, for example through Wildlife Trusts, local records centres and the BSBI threatened plant database, but within the time scale of the UK CWR national inventory this approach was not possible.

3.10 Useful Wild Plants Inventory

In the UK until the present study there was no such national list of plant genetic resource species, however, Sanderson and Prendergast (2002) recently produced an inventory of commercial uses of and potential threats to approximately one hundred wild harvested and traditionally managed useful plants in England and Scotland. These taxa are partially duplicated in the current database as many of these species are also crop wild relatives as well as being taxa that are harvested in from the wild in their own

right. This database of Commercial use of wild and traditionally managed plants in the UK (www.kew.org/scihort/ukplants.htm) hosted by the Royal Botanic Gardens, Kew. There is a need to ensure the UK CWR database is compatible with and is linked with the wild harvested and traditionally managed useful UK plants database managed by the Royal Botanic Gardens, Kew.

3.11 Crop Wild Relatives Inventory Recommendations

R1 The database of wild crop relative genetic resources created in this assessment should be viewed as a starting point for the establishment of a UK CWR database that will require extension to include population level data and regular updating, a modus operandi should be established to ensure the necessary database management.

R2 The UK CWR database should be further linked or integrated with regional databases for common names and local usages.

R3 As national floristic surveys are undertaken the distribution data on which the current UK CWR assessment is based will require updating and extension. The inclusion of introduced taxa (archeophytes, neophytes and casuals) in these surveys is advocated because they constitute an important plant genetic resource for the UK.

R4 All UK PGRFA taxa should be assessed using IUCN Red List Threat criteria and currently available BSBI data (Preston et al., 2002), and priority should be given to constructing Biodiversity Action Plans for threatened taxa, those with negative change indices or those most with restricted distributions.

R5 There is an urgent need to gather appropriate population distributional data for all UK PGRFA taxa to identify where genetic reserves should be established to conserve in situ UK crop wild relatives.

R6 The UK CWR database should be linking to the existing wild harvested and traditionally managed useful UK plants database either by mutual web site links or provision of a single platform.

R7 Improve professional and public awareness of the notion and value of crop wild relatives as a means of promoting their conservation and extending their utilisation.

4 LANDRACE ASSESSMENT

4.1 Objectives

As outlined in above the broad objectives of the on-farm land race element of the inventory was:

- To collate data and assess on currently extant UK crop land races and primitive forms.

These general objectives were elaborated into more specific goals:

- To establish a general overview of crop types of which currently land races and primitive forms occur in the UK:
- To assess the general (national) context of land races and to evaluate the National Listing system from a land races perspective; this was done by the examples of forages and vegetables;
- To study more in depth current extant cereal land races at farmer level: to collate primary data on varieties grown, areas (number of hectares) grown, geographical locations and current uses;
- To build a database containing the data collated for cereals;
- To assess research needs and implications for conservation and to formulate recommendations for the conservation and on farm maintenance of UK land races.

4.2 Background

In order for the UK to fulfil CBD obligations and inventory national genetic resources it is necessary to answer the question: what type of traditional landraces and primitive crop varieties remain extant in the UK highly rationalized and industrialized agriculture? A pilot study was recently undertaken at the University of Birmingham (Camacho Villa, 2003). She reported the continued cultivation of landraces for all crop types, justifying a wider assessment of the scope of these landraces. Prior to this however, some discussion and delineation of what constitutes a landraces is required. Frankel remarked in his introduction to the First FAO survey of plant genetic resources (Frankel, 1973) that one of the difficulties encountered in the survey was the problem of distinguishing wild from primitive material, and landraces derived from advanced cultivars; and thus which material to include or exclude in any survey.

Zeven (1998) reviews historical definitions of the term; the first references to landraces appear around 1890 in German–speaking countries and these early German (and Dutch) articles focus on the agronomical side of cereal landraces. For example Schindler's book on cereal growing (Schindler, 1908) in which the term landrace (*Landrasse, Landform*) is used for primitive cultivated forms grown since 'memorial times', often bearing the name of the region where they were grown and often associated with extensive farming practices. In his description of landraces, the focus is the agronomical and morphological description of varieties. As there are transition forms between the primitive varieties to the more advanced cultivated types, Schindler explicitly states there can be no clear-cut division between the two. In the early literature, the regional character of landraces is often emphasised, to the extent that landraces are classified into primary or secondary types, depending on their origin (Zeven, 1998).

The first review of the concept into English was by Harry Harlan (Harlan, 1936) and was extended by his son, Jack Harlan in a Science article that became a classical reference for landraces (Harlan, 1975). Landraces are described as populations having evolved in subsistence agricultural

societies as a result of 'millennia long' selection pressures. Selection was 'artificial' being mediated through human migration, seed exchange and natural selection. Harlan (1975) believed that landraces have three basic characteristics:

- Variability of genotypes
- Integrity
- Adaptation.

Hawkes (1983) extended the term in his application to garden diversity and coined the term 'garden-race'.

> "Old land races obtained from remote areas or small garden plots where the new, highly bred cultivars have not been introduced. These are races or populations that have not been bred as varieties but that, under natural and artificial selection (probably largely of an unconscious nature) have become adapted to the conditions under which they are cultivated"

Landraces were thought to disappear in the process of modernization of agriculture and *ex situ* conservation of this threatened heritage their only secure way of retaining diversity (Hawkes 1983, Zeven, 1996).

As is evident from Zeven's account, landraces were discussed in the context of conservation from the very start and Zeven gives examples of plans for their *in situ* conservation dating from 1921 (Zeven, 1996; 1998). The early field surveys undertaken by the FAO (FAO, 1972) focused on collecting landraces for *ex situ* conservation. Genetic resources of major arable crops were collected in their centres of diversity, and in the European context this meant mainly the Mediterranean region. The definition of landrace used to delineate material for collection in these surveys was as follows:

> "Primitive or traditional cultivar, populations evolved during an extended period under local conditions of cultivation, without interference from deliberate, and especially from scientific selection" (Frankel, 1973)

As can be seen from this quotation, the definition of a landrace became more general and the reference to a specific identity or region of origin was lost.

Contrary to general expectation, landraces have survived in the face of modern agriculture, be it in scattered, marginally communities (Brush 1990). Brush provides three examples of landraces and shows the conditions under which they have survived. Seed management is seen as a crucial aspect of landraces retention (Louette, 1994; Brush, 1995). Brush's studies focused on developing countries or countries in transition and take primarily an agro-anthropological perspective to elucidate farmer's roles and strategies in landrace retention. Over time the use of the term landraces has lessened in favour of 'farmer's varieties' which emphasises the role of the farmers in the retention process. Zeven (1998) has also remarked that the differences between cultivation and conservation disappear in Brush's (1990) *cum suis* analysis as continued cultivation (without interference) is seen as a form of dynamic *in situ* conservation.

A second new element of landraces in these studies is the finding that cultivars can gradually turn into landraces (*creolisation)* or form a permanent minor component of them (Louette, 1994; Zeven, 2000). Although the acceptance of derived landraces may seem to be a watering down of the original

landraces definition, the notion of mixtures of genotypes is retained. The degree of genetic diversity of these derived landraces and their contribution to conservation *per se* does require researching as the diversity contained is unlikely to be so 'unique' as landraces *sensu stricto*. The recognition of 'creolised' or secondary derived landraces re-poses the question of what to conserve: alleles within or the on-going evolutionary process that generates landraces (Louette, 1994)?

The recognition of two forms of UK landraces and the distinction between historical or original landraces and derived or secondary landraces is an important consideration for their inventory and conservation.

4.2.1 Working definition

During the pilot study undertaken by the University of Birmingham, the following criteria to distinguish UK landraces were proposed (Camacho Villa, 2003):

- Historic origin
- Heterogeneity and / or generally, but not necessarily genetically diverse
- Distinct identity
- Local adaptation
- Lack of formal improvement
- Seed saving on-farm

Seed saving by farmers was used as a defining criterion for cereals within the current inventory, but not for fruits, nuts and vegetables with the exception of the heirloom varieties. However, where this criterion was applied no specific number of years of seed saving was specified. Seed saving as such cannot be used as the sole criterion because between 30 - 50% of British farmer's seed save for a limited time period in recent years, depending on the crops (Turner 2003, pers. comm.). For organic farmers the statistics are comparable and there is no indication that they are growing more heritage varieties (Taylor *et al.*, 2001). The majority of seed saving in all crop categories is undertaken by industrial farmers and relates to recent cultivars for which BPBS collects royalties and the length of seed saving is relatively short, probably not more than a couple of years. Turnover rates for modern cultivars have been estimated to be 5 –10 years (Brennan and Byerlee, 1991).

Conventionally in order to maintain crop heterogeneity in landraces, mixing of genotypes has to occur. This may happen either through seed exchange or seed replacement among farmers. How many farmers are needed to maintain this diversity, hence maintain the landrace is hard to define[6]. As a consequence, an essential characteristic of landraces is this community-level interaction. Local adaptation of landraces is as pointed out by Wood and Lenné (1997) is logical but is an assumption in want of scientific evidence. The aspect of traditional management is also often considered a component criterion for a landrace. Within the contemporary UK context this can be interpreted as a form of low-input or small scale agriculture, e.g. thatching straw is necessary grown under low-input conditions to prevent lodging, however, fungicides and pesticides are usually applied.

[6] Dr. ir. Anton Zeven introduced this point during a meeting in Wageningen, September 2003, for which Carolina Tania and Maria Scholten would like to express their gratitude.

Notwithstanding the discussion of the defining criteria, it seemed appropriate for a first assessment of landraces in the UK to apply the term 'landrace' in a very broad sense in order to have a scope as comprehensive as possible. Therefore, farmer's or grower's varieties must have been home seed saved over an extended period. They must constitute 'historical' plant material, although the estimated ages of which may vary widely. Harlan (1975) mentioned 'millennia' for the landraces of the Middle East but more recently and in a European context Italian landraces have been circumscribed as being of at least 'one generation of home seed saving' (Negri, 2003). Therefore, a time framework was thought necessary in order to gauge the historicity of current extant landraces. A short and by no means exhaustive literature review on the historical origin of landraces will be given below.

4.2.2 Crop prioritisation

Resources were not available in this short term project for undertaking an inventory of all UK landraces; therefore there was a need to prioritise which crops should be the focus of this initial inventory. Traditionally, the collecting of plant genetic resources has been undertaken primarily in the 'centres of diversity' of the major crops, e.g. in the Middle East grains and legumes still occur commonly as landraces growing alongside their wild relatives (FAO, 1972). Landraces from these areas are considered diverse because besides farmer's practices there is the opportunity of natural hybridisation of crops with wild relatives. Following this approach, landraces native to the UK should be given priority in research; within the UK this would include primarily the native grasses, some forage legumes and Brassicaceae. Along with this important group priority was also ascribed on the basis of economic importance of the crop in the UK. Thus cereals which are the major economic agricultural crop of the UK were included. The last review and collection of cereal landraces was undertaken Perceval in the 1920's (Perceval 1934). Forages were also assessed for more biological reasons; they are native to UK and are also of agricultural importance in grasslands throughout the UK. The importance of the UK for the plant genetic resources of forages is reflected in many collecting missions completed by IGER in the recent years (Humphrey, 2003). Although local varieties have been the subject of several agronomic trials in the past, no systematic collecting of these landraces has been undertaken.

However, prioritisation of crops does mean that some groups with a high potential number of extant landraces were not included in the current assessment, notably fruits, potatoes and vegetable were excluded. This was partially due to the time limits of this assessment and the large-scale labour-intensive surveys required for these crop groups, and partially because some work on these groups had been done recently (Mason and Brown, 2004). Fruits are likely to be the group with highest number of extant landraces or historical varieties. For example, apple, there are many local varieties that are conserved *ex situ,* however, 269 apple varieties were evaluated as being 'at risk' by the UK Malus Network (UK Malus Network Newsletter Issue 2, October 1999). Therefore, 1 in 10 of the *ex situ* conserved 2310 apple accessions of the UK National Fruit Collection are assessed as being 'at risk', This situation is aggravated by the continuous losses of orchards and the new Single Farm Payment as of 1 January 2005 (Farmer's Weekly, 29 March 2004). Neither pear, plum or cherry and none of the ancient fruits (figs, mispel, mulberry) or soft fruits (blackberry and other berries, or vines) have been systematically surveyed to date.

For vegetables, a heirloom seed search was organized by Henry Doubleday Research Association between 1996 –2000. This yielded a return of 200 accessions of which 80 were new heirloom varieties (Stickland, 2000). In other words, a recent survey of amateur garden landraces

showed a return of 40% previously unknown accessions. Although this survey was set up for Great Britain, most coverage was in the South. Larger urban areas with specific immigrant 'heirlooms' were not included. For comparison a recent German study had a return of more than one hundred landrace species from immigrant urban gardens (Gladis, 2001). For the UK, collecting of these immigrant landraces has started on a very local scale (Michaud, pers. comm.)

Arable root crops, such as potatoes, were not included in this inventory. However, MacDonald (1991) and Wilson (1993) provide recent overviews of UK landrace potatoes. Anecdotal evidence indicates that many potato landraces are extant: as is testified by the HDRA potato day or Seedy Saturday. An assessment of field *Brassicas*, Swedes and turnips, was undertaken in parallel to the cereals survey, however not a single landrace was found.

Industrial crops as hops and flax also fell outside the scope of the inventory. However, a survey of hops landraces was undertaken in the 1980's and resulted in the current field gene bank at HRI – East Malling (Darby, pers. comm.). Culinary herbs are another crop group that are considered likely to have a high number of landraces that falls out of the scope of this assessment, for example there is a local variety of rosemary called 'Severn Sea'.

4.2.3 Research questions

Neither time length nor the time of year when the assessment was undertaken allowed fieldwork, therefore there was no collection of landraces or confirmation of the existence of landraces. The goal of the current assessment is to assess the scale of cereal landrace cultivation and the range of their current uses. Cultivation in the context of the inventory is understood as cultivation by farmers or commercial growers, therefore museums were not systematically approached. The value of the assessment lays in the establishment of the breadth and scale of landraces cultivation in 2003/2004 and would enable such questions as these to be addressed:

a. How many farmers and growers are regularly growing cereal landraces?
b. What is the scale of cultivation, in terms of area (number of hectares and geographical location)?
c. What is the context of current landraces and primitive forms in terms of their economic relevance in general and their specific usage?
d. What is the context of current landraces and primitive forms in terms of specific present threats, availability and future usage?

Geographically, the focus was on Great Britain. Consultation was sought with the Irish Seed Savers who have been very active in recent years surveying landraces in Ireland, cereals, fruits and vegetables (www.issa.ir). Although there is anecdotal evidence of small oat cultivation in Northern Ireland, time constraints prevented building up a network of informants in this part of the country. Agronomical data were not collected and will not be referred to in this report. Values and qualities associated with the landraces have been attached to them by the respondents, not the researcher.

No primary data collection was undertaken for crops other than cereals and forages. However, it is noted that an heirloom survey has been undertaken (HDRA, 1995). Systematic collecting of UK *Brassica* landraces and local strains was undertaken in the early 1970's by HRI (Johnson, unpublished data provided by B. Smith pers. comm.) and in the early 1980's (Van der Meer *et al.* 1984).

To complete the UK Inventory there is also a need to establish the legislative context within which UK landraces are grown. UK crops must fulfil the standard DUS criteria of Distinctness, Uniformity and Stability in order to be marketed legally, however, these criteria seem incompatible with landraces which by there nature are variable and mixed. Nevertheless, one of the remarkable findings of the pilot study (Camacho Villa, 2003) was that many local forage varieties and open pollinated vegetable landraces are commercially available and remain on the National List. As such the functioning of the National List and the European Common Catalogue will be reviewed in the context of landraces. This will be undertaken in two sections: one on forages and one on vegetables. Issues that were explored in this part of the assessment are:

- The number and type of landraces on the National List
- The position of landraces compared to modern cultivars on the National List
- Problems and opportunities for landraces related to National Listing

4.3 Methods and data sources

Many believed that landraces would largely disappear with the industrialisation of agriculture. Possibly as a corollary of this, very few surveys have been undertaken in Western Europe and no methodology for surveying landraces has been described or formalized. However, one approach would be the 'checklist method' developed at IPK since the 1980's. These are organized on a country-basis. In Europe they have been extensively used in Italy (Hammer, *et al.* 1997 and 1999) and also in Albania. The approach is focused on obsolete or rare varieties, on a country-wide and comprehensive scale and for all crop types (Hammer, 1990).

Most searches for North and West European landraces have had their origin in collecting missions from gene banks, be it public or NGO based, and the results of which have not been publicised. Hammer (1977) used advertisements in amateur gardening newsletters to collect selected garden landraces in the former GDR, which resulted in hundreds of accessions. The HRI vegetable gene bank was initiated with a seed search among professional and amateur gardeners (Dave Astley, pers. comm). Zeven collected perennial kale accessions in the southern Netherlands in the 1980's using advertisements, a radio announcement and by private contacts (Zeven, pers. comm). While Stickland (2000) used advertisements in gardening magazines, local radio and to a lesser extent direct contact with allotment holders to search for heirloom seeds among non-HDRA members.

Perhaps the only West-European-wide, systematic survey and collection of landraces was undertaken in the early eighties for the cruciferous vegetables (van der Meer *et al.*, 1984). Two complementary methodologies were used. In the Netherlands and the UK primarily seed companies where approached to obtain existing and delisted varieties. The other method adopted in France, Italy, Germany and Belgium was to approach farmers directly, through agricultural extension departments or through personal contacts. Interestingly the latter method resulted in significantly higher numbers of landraces compared to the Netherlands and the UK.

As landraces have become rarer, their detection has often been a matter of chance or more rarely the result of dedicated conservation aware individuals. For example, a local fodder beet 'Vogelsberger', that had been seed saved on-farm since the Second World War, was detected in a remote area in Germany in 2001 (Efken and Frese, 2003). In this case, a dedicated teacher at an agricultural vocational school did his best to make conservation of the threatened beet a public issue thus ensuring its maintenance.

A recent pilot study for the survey of landraces in the UK used consultation and interviews with crop experts, gene bank curators, farmers and growers, as well as internet and literature searches to access data. It was found that landraces exist for all important crop groups, but that they were most numerous for fruits and vegetables, with substantial numbers remaining in cereals, forages, potatoes and hops (Camacho Villa, 2003). The cereal landraces fell into three groups: long-straw wheat varieties for thatching, corn-dollies etc, concentrated in the South of England; a group of mainly organic or biodynamic farmer's seed-saving older varieties on-farm for a variety of reasons, most of these in England; and a few growers on the Northern Islands. Most cereals found by Camacho Villa had been seed saved on-farm for many years, hence these old varieties were managed as landraces.

For the current assessment, the pilot survey was expanded, informants and sources of information included:

- breeders and a botanist
- individual researchers
- Agricultural Advisors and Scottish Agricultural Colleges SAC
- organisations: National Farmers Union, Soil Association, British Society of Plant Breeders, UKASTA, the National Society of Master Thatchers, the East Anglia Master Thatchers Association, the Rutland and Leicestershire Master Thatcher Association, Thatching Information Services, English Nature, the Countryside Agency, National Trust, Royal Society for the Protection of Birds, Crofters Commission, Scottish Crofters Foundation, Elms Farm, Demeter Certification, Biodynamical Association, The National Whisky Maltsters Association, local wildlife trusts, colleges, local organic gardeners groups,
- gene banks (JIC, IGER, HDRA) and the 3 national statutory seed testing institutions (NIAB, SASA and DARD)
- statisticians at DEFRA, SEERAD
- scientific literature, articles, journalistic investigations, gene bank archival documentation, seed catalogues and EU Common Catalogues
- seed companies and their archives
- individual farms, mills, corn dollies producers, breweries, whisky distilleries
- and mouth to mouth

Information was also sought through:

- articles (Scottish Farmer and local newspapers)
- advertisement: Farmers Weekly
- internet searches
- email survey using for example the Organic Directory 2002-2003

During the survey a short field trip was made to the Outer Hebrides at the beginning of March in order to explore further the local situation *in situ*. In contrast to the Northern Isles, it had been hard to assess the scale of cereal cultivation on the Western Isles by phone. Two Scottish Crofters Foundation

Annual General Meetings were visited and a short presentation of the project given[7]. Crofters whom I had contacted before and also whom I became contacted to during my stay were interviewed in depth. The local SEERAD and SAC officials were contacted as well. Thus the report will have more material from the Western Isles compared to the rest of the UK.

Each survey informant was informed about the purpose of the survey and permission was asked to make the information given public whereby contact details were to remain confidential. Previous to the assessment, survey clearance was given by the Survey Clearance Group at DEFRA. Responses to the articles and advertisement were few. The number of requests for information about traditional cereal varieties was almost as high as reactions to articles. The majority of interviews were by phone. Of those interviewed, one person showed no interest in the project and one other refused to give some specific details of his varieties but agreed to participate. Of the questionnaires posted to what were believed to be key informants, 50% were returned. It should be noted that the non-responses were from areas were no landraces were thought to occur. Email questionnaires were also used but only a small fraction of these were returned.

4.4 Landrace Inventory Database Structure

The database on extant landraces is one of the key deliverables of this project. The design and structure of the plant National Inventory database was discussed with the EPGRIS national focal person, Ian Thomas at IGER, in order to ensure future linking of the current UK National Inventory with the EPGRIS database. Field names were where possible identical to those used in the EPGRIS project. The database was created as a flat Access 2000 database, covering the following fields:

- Scientific name of the crop
- Name of landrace
- Number of hectares under cultivation
- Geographic location (county)
- Number of farmers involved
- Usage

Full details of the landrace database structure are provided in Table 12.

All findings were included in this database, except those for the Outer Hebrides, as the scale of this element of the survey was larger than other regions. As actual fieldwork fell out of the scope of this assessment, estimations of cultivated acreages were largely based on existing statistics. However, these estimations showed a considerable range and divergence from the data supplied by farmers, so further clarification will be necessary in order to assess more accurately.

[7] With kind thanks to David Muir and Ena MacNeill of SCF for their invitation

Table 12. Landraces Database Structure.

Field Name	Data type	Field description	Empty field description	Number of records	% data fill	EURISCO corresponding field
CROPNAME	text	Name of the crop in colloquial English	Not applicable	67	100%	Yes
GENUS	text	Generic name as in Stace 1997	Not permitted	67	100%	Yes
SPECIES	text	Specific epithet as in Stace 1997	Not permitted	67	100%	Yes
SUBSPECIES	text	Subspecific epithet as in Stace 1997	No subspecific level present	3	4%	Yes
SPAUTHOR	text	Citation of author as in Stace 1997	No author's name given	67	100%	Yes
ACCENAME	text	Either a registered or a informal name given to landrace by respondents	not applicable	67	100%	Yes
UK_USE	text	Current UK use as listed by respondents	not applicable	67	100%	No
LOCATION	text	Geographical location of landrace as listed by respondents	not applicable	67	100%	No
NO_FARMERS	text	Number of farmers cultivating landrace	not applicable	67	100%	No
EST_AREA	text	Estimated average area of cultivation in hectares; area based on respondents estimations; not entered for landraces cultivated for research or demonstration purposes	unknown or not-applicable	66	99%	No

4.5 Landraces Inventory (1): Forage Landraces

4.5.1 Background

Wild white and red clover, perennial ryegrass and timothy are native to the UK and almost ubiquitous. From this genetic source, several landraces have been developed by local seed growers, especially in South-East England which proved to be very suitable for clover seed production (Haggar and Holmes, 1963). North-Western Europe is considered a centre of diversity for grasses (Zhukovsky and Zeven, 1975). Grasses are one of the few landraces that can hybridise with native wild relatives in the UK, this is especially important as temperate forage grasses are outbreeders. Cultivated forms will actively introgress with wild forms leading to a gradual transition from the wild relatives of grasses through natural and semi-natural grasslands to sown grassland (Tyler, 1978). For this reason, no clear-cut division between ecotypes and landraces is possible.

Domestication of forages in Europe has an extensive history: (Dutch) white clover seed was traded from the end of the 16th century (Zeven, 1991) and was introduced into the UK at the end of the 17th century. Considerable quantities of clover seed were grown by local farmers in Southern England. Many local varieties were produced by natural selection as a result of continuous growing on the same farm year after year. These became stabilised into valuable commercially, distinctive forms (Sneddon, 1980). However, before the 1900s little grass seed was grown in England, at that time Cambridgeshire was the most important county for the production of ryegrass (Sneddon, 1980).

The early 20th century saw a wide diversity of local commercial forage landraces, as documented by local seed catalogues. For example, Townsend's seed catalogue from 1936 lists the following local varieties: two red clovers, two cowgrasses, three wild white clovers, one sainfoin and one English trefoil, while Williams (1945) lists six clover landraces commercially available. In 1961 eight British sainfoin varieties were on trial at the Welsh Plant Breeding Station, these included five of the common type: Vale of Glamorgan, Cotswold, Hampshire, English and Eastern Counties, and three of the Giant type: English I, English II and Woodford (Evans, 1961).

Forage landraces were closely connected with local seed growers, for example in 1943 there was a Cornish Marl Clover Growers Association; Devon Seed Growers Association; South Western Seed Growers Association; Montgomeryshire Late Flowering Red Clover Association; Vale of Clwyd Seed Growers Association; South Western, Cambridgeshire and Cotswold Seed Growers Association and the Essex, South Western, Cambridgeshire, East Suffolk and Cotswold Seed Growers Association (Sneddon, 1980). Therefore there was a close link between seed supply specifically for the local market. In 1955 there were 830 herbage seed growers with a total of 26,000 acres under cultivation. This was the first year of the National Certifying Authority and 90% of eligible crops were entered in the certifying scheme.

Seed certification in its early days facilitated the retention of local seed origin and thus maintenance of the character of these landraces. The principle adopted at this time was that morphological criteria alone were not the only base for certification (Sneddon, 1980), historical evidence and details relating to origin were also relevant "because they depended on adaptation to a particular environment, seed production should be confined entirely to a defined area and be subject to traditional management to ensure maintenance of the type" (Sneddon, 1980).

The inclusion of ecotypes and local varieties or landraces is visible in the earliest formal breeding programs. Formal breeding of forage grasses in the United Kingdom started in the 1920's with selections based on indigenous pastures (Tyler, 1978). An example of an early WPBS cultivar is S.23, a cultivar consisting of several indigenous perennial ryegrasses populations, which so variable that the variety proved to be highly unstable (Humphrey, pers. comm).

In the 1960's exotic material was introduced into the breeding programs at Aberystwyth. Targeted collection missions commenced in 1963 with the establishment of the Plant Introduction Unit. In these missions both foreign primitive cultivars and wild relatives were collected in order to capture a wider range of climatic ecotypes for the breeding program (Tyler, 1978). An overview of the IGER collection missions is given by Humphreys (2003). In the 1970, highly bred synthetic clover cultivars started to replace local varieties or ecotypes (Woodfield and Caradus, 1994). This trend is reflected in forage seed imports compared to home grown seeds shown in Table 13; the vast majority of varieties are now imported cultivars, with the exception of perennial ryegrass.

Table 13. UK grown versus foreign forage seed sown in 2002 (Data source: DEFRA, 2003).

Species	UK grown seed (tonnes)	Imported seed (tonnes)
Timothy	30	467
Perennial ryegrass	5077	8433
Red clover	15	126
White clover	9	338

Associated with this movement away from UK forage seed production and replacement of native with exotic varieties is the genetic erosion in grasslands in the UK in the form of the continuing loss of traditional permanent grassland or landraces (Sackville Hamilton, 1999). Management practices have changed to high input-high output agricultural systems with new cultivars, new machinery and practices as constant ploughing and reseeding for improving production (Chorlton pers. comm. quoted in Camacho Villa, 2003).

The five forage landraces found in this assessment are each at least 80 years old and have been developed by local seed growers without intervention of formal breeding programmes. These forages have a distinct local area of origin although current actual seed production may be wider. Their survival on the UK National List is remarkable in comparison with for example The Netherlands where Fries-Groninger clover, the last Dutch landrace, was removed from the Dutch National List in 1979 (Zeven, 1991).

4.5.2 Results

Kent Wild White Clover: is probably the widest known English landrace. It was first certified in 1930 (Caradus, 1986). Kent Indigenous, a perennial rye grass was developed in the same area. Kent White Wild Clover is one of the oldest UK indigenous forages on the National List. In 1940 the Kent Wild White Clover Perennial Grass Committee was formed. It was a model for herbage seed certification (the so called Kent Scheme), and has been used as control variety for VCU herbage trials and as control in scientific trials (Hamilton Sackville, 1978). Between 1943 and 1960 between 1000 and 3000 acres of

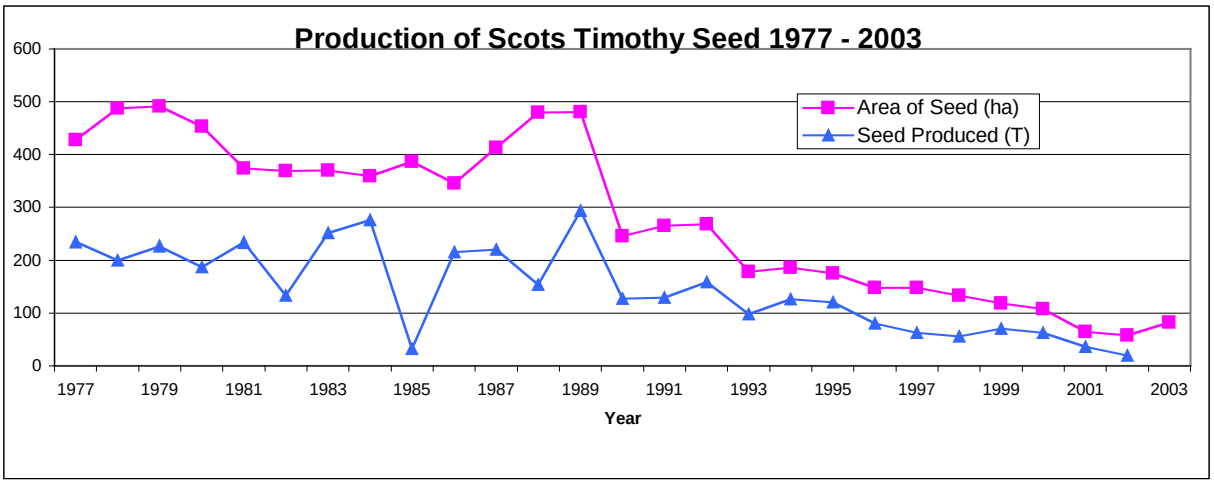
Kent Wild White Clover were seed harvested with an estimated total yield ranging from 14 to 105 tonnes per year (Haggar and Holmes, 1963). Currently seed production is restricted to four or five growers on Romney Marsh and seed production in 2003 was 0.5 tonnes (Holiwell, pers. comm.). Kent Wild White was on the DARD Recommended List for 2002-2003.

Kersey white clover: was resurrected from 17 kilos of seed that remained after a period of no production (T. Church, pers. comm.). It is currently maintained by the seed company Church of Bures. It was first developed in 1924 from a single plant in a Lucerne field near Bury St. Edmunds by Mr. E. Partridge (Hawkins, 1967). In 1946 Mr. Partridge's son gave it to the West Suffolk Seed Growers Association. In 1951 NIAB approved of filed inspection of Kersey and in 1956 Kersey White Clover was admitted as eligible for the production of British Certified Seed. In 1963 the Eastern Region Clover committee was formed which recognized that seed for Kersey can be multiplied anywhere east of a line along the Thames, the Great North Road and the river Ouse from St. Neots (Hawkins, 1967). At the time Hawkins was writing, about 1000 acres of it were grown annually. Seed production of Kersey was 0.9 tonnes in 2003.

Essex Broad Leaved Clover is another old local variety maintained by Church in Bures and traded over more than 70 years (Church, pers. comm.). It is the only surviving type of the English Broad Leaved clovers. There was no seed production in 2003.

Scots Timothy was in danger of being lost after the Second World War due to the widespread introduction of exotic stocks. At that time, public breeding efforts were geared towards upgrading Scotland's marginal arable and rough grazing land. The Scottish Plant Breeding Station grass' program was "predominantly directed towards selection of land races that were judged to be most suitable for growing in Scotland' (Gregor 1971). A certification schedule was set up in co-operation with the West of Scotland Agricultural College and James Gray & Coy Ltd. and a regional race of timothy was marketed as 'Scots' timothy (Gregor, 1971). Scots is currently produced by a small grower's co-operative, the Scots Timothy Seed Growers Association (STSGA). In 2003 it was still on the National List and on the SAC Recommended List for Scotland. Almost 20 tonnes of seed were produced in 2003 but production has been in steady decline since the early 1990s as can be seen from Figure 2.

Figure 2. Production of Scots Timothy Seed 1977 – 2003 (Sots Timothy Growers Association, 2003).



Kent Indigenous perennial ryegrass: is still a higher seed production ley grass which might reflect the stronger position of home grown perennial ryegrass compared to clovers (as can be seen from Table 13).

Sainfoin landraces

Sainfoin has been cultivated in the UK since the 18th century and was used as a source of high quality hay (Koivisto and Lane, 2001). There have been several historical landraces of sainfoin in two basic forms: 'common' types such as Cotswold Common, Hampshire Common, Essex Common, Cambridge Common, and Vale of Clamorgan Common, and the taller 'giant' type, such as Hampshire Giant and English Giant (Koivisto and Lane 2001). In the current assessment, Cotswold Common and Hampshire Common were found in cultivation. The Cambridge Common landrace has been observed for many years in weedy form in Cambridge (Edmunds, pers. comm.). There is also anecdotal evidence that one of the Giant landraces may still be grown. Neither the Hampshire nor Cotswold Common are currently certified but both have been in the past. Both were tested for agronomic performance in Aberystwyth in 1961 (Evans, 1961).

Hampshire Common is currently grown on the Cholderton Estate in Hampshire (www.cholderton-sustainable.com), where it has been cultivated and seed saved since 1720. Currently on the estate 440 hectares are cultivated in a legume/ grass ley – cereals rotation. Four to five tonnes of seed are produced on average per year, the seed being harvested with combine and cleaned off-farm then planted in the following year. The delisting of Hampshire Common in the 1980's illustrates the difficulties of local landraces in the National List system. In the early eighties only one maintainer and one grower for Hampshire common was left and he contacted NIAB concerning the certification fees:

> *I have come up with a considerable problem because the costs of certification are so enormous that it makes it quite uneconomic for me to certify a field each year. I believe that it is in the National Interest that Hampshire Common Sainfoin is kept on the lists. Do you think the N.I.A.B. could assist me in some way? It seems grossly unfair to me that I, as a dedicated grower, should be expected to pay the same charges as a commercial seedsman. (15th March 1978).*

NIAB was unable to offer assistance and in 1984 Hampshire Common was delisted and so made unavailable to other potential maintainers / users.

Cotswold Common is currently used in Conservation Mixtures and seed is produced on 8 hectares with a seed production of 250 kg per year and marketed as part of a conservation mixture (www.cotswoldseeds.com). Without probably realising it, some 140 UK farmers are growing landraces as part of their Countryside Stewardship Scheme (Hill, pers. comm.). As with Hampshire Common, the survival of Cotswold Common is entirely ascribed to a single grower's enthusiasm for the landrace.

Research into sainfoin cultivars is currently undertaken by Forages Legume group of the British Grassland Society in a variety trial (Koivisto and Lane, 2001). Only one UK sainfoin landrace has been conserved *ex situ*, the EURISCO database shows two accessions of Cotswold Common are conserved *ex situ* but neither of these is in the UK. Both landraces are, however, conserved in the statutory reference collection of DARD at Crossnacreevy. These statutory collections are not accessible as the legal position of their collections is unclear. However, seed from the Cholderton Estate was sent to the Millennium Seed Bank for conservation in 2000.

4.5.3 Market position and future prospects

Since the start of clover breeding in the 1930's, more than 250 synthetic cultivars and 'ecotypes' of white clover alone have been released, with a sharp increase since 1970 (Woodfield and Caradus, 1994). During this time the older selections and ecotypes have been superseded by cultivars (Woodfield and Caradus, 1994). The long-term future of the five currently commercially available landraces is uncertain to doubtful, see Table 14. For Kent White Wild Clover, Kent Indigenous and Scots Timothy hard decisions are currently being taken about their maintenance on the National List (Holliwell pers. comm; Muirhead, pers. comm).

Table 14. Overview of forage landraces seed production(DEFRA, 2003).

Landrace Name	Tonnes/Year 2003	Number Of Growers	Trend
Kent wild white clover	0.5	4-5	Decline
Kersey clover	0.9		Unknown
Essex broad Leaved Clover	2049 (2002)		Variable
Kent Indigenous perennial ryegrass	10-15	7-8	Decline
Scots Timothy	19.8 (2002)	9	Decline
Hampshire Common	4 - 5	1	Not marketed
Cotswold Common	0.25	1 – 2	Increasing

For the former two, a complex of factors was mentioned to describe their decline[8]. The clover needs heavy grazing by sheep, hence its survival is dependent on sheep and declining sheep production is one factor. Along with changing agricultural practices; contemporary farmers are less willing to undertake herbage seed production in general, so that when it comes to generation change on a farm, the younger generation stops the seed production. Seed of Kent White Wild Clover is relatively expensive to produce and has to compete with cheaper seed from abroad. The unpredictability of English production was also cited as a reason for decline, lack of pollination is thought to be a limiting factor. The latter two factors are also believed to impact on Scots Timothy: competition with cheaper foreign seed and the unpredictability of British weather making yields haphazard. Two problems, mentioned by more than one forage seed producer was scale of production and the UK weather, both do not favour UK forage seed growers as foreign seeds are grown on larger scale and under more reliable weather conditions. Another factor influencing future seed production of all of these landraces is the current CAP reform. The replacement of the Seed Production Aid subsidies (see Table 15) by the Single Payment planned for 2005 may be considered by many farmers to present another disincentive for seed production. However, inclusion of landraces in Countryside Stewardship Scheme has been suggested as a new marketing opportunity.

[8] Kindly listed by Mr. Allan Holliwell, The Holliwell Seed and Grain Co Ltd.

Table 15. Overview of current aid rate £ (pounds) per tonne (DEFRA, 2003).

Crop	£ aid per tonne
Sainfoin	139.52
Red clover	372.40
White clover	522.92
Perennial ryegrass	215.75
Timothy	581.74

4.6 Landraces Inventory (2): Cereals

4.6.1 Background

Historically, only one reference has been found to 'landraces' in UK cereals. Hunter (1952) describes in 'The Barley Crop' two form of indigenous varieties or 'barleys from the country'[9], these were Old Irish and Scotch Common. The latter is described as a very mixed population including two well defined types. Perceval (1934), Beaven (1947) and Findlay (1956) do not refer to 'landraces', however, all three authors describe cereal varieties with characteristics which can be recognised as defining landraces and all three report on landraces survival into the 20th century.

Cultivation of cereals in the UK dates back to the Neolithic Age. From the Iron Age, English archaeological findings included Emmer (*T. dicoccum*), Spelt (*T. spelta*), a barley 'chiefly of the kind known as Bere' (*H. vulgare*) and oats (*A. strigosa* and *A. brevis*) were known (Perceval, 1948). Two types of barley (*H. hexastichum and H. distichum*) and Emmer are known from Stone and Iron Age sites on the Shetlands (Fenton, 1999). Both bere barley and small oat are part of a very old Celtic agricultural heritage (Ernle, 1961; Seebohm, 1927). Neolithic and Iron Age remains of six-rowed barleys were recently found on Orkney (Jarman, 1996).

Formal breeding of wheat, barley and oat commenced in the late eighteenth – early nineteenth century with the selection of single ears (or off-types) Early breeding was the domain of farmers, clergymen, merchants and farm labourers alike and as the century progressed increasingly by professional breeders. For wheat, barley and oat this seems to have been a general, parallel trend. A milestone was achieved in the mid 19th century with the first controlled crosses and in 1851 hybrid wheat was exhibited in London (Paterson, 1925), although attempts at hybridization were undertaken by Knight as early as the 1790's (Lupton, 1987).

All widely grown English wheats of the 19th century were selections from individual ears: Chidham, Fenton, Hunter's White, Browick, Squarehead's Master[10] were descended from 'rogue' plants (Perceval, 1934). Perceval recognized only two types of wheat being cultivated in twentieth century Great Britain: Rivet or Cone (*T. turgidum*) and Bread (*T. vulgare*) (Perceval, 1948). We can therefore assume that none of these earlier wheats as spelt or emmer survived as farmer's material into the 20th century in the UK. Perceval does provide examples of medieval landraces, commenting that by the end of the 18th century almost every market town had its own favourite species and that in the mid-19th

[9] With an explicit reference to the German 'Landgersten' in Atterberg

[10] The position of Squarehead is ambiguous. Perceval states that its origins are obscure. Zeven lists it as a cultivar in his analysis of British wheats, but treats it as a landrace in his catalogue of Dutch landraces and old cultivars (Zeven 1990).

century almost a hundred names for wheat varieties were in use. Zeven (1990) believes that based on the information provided by Perceval (1934) we would recognise 25 landraces. Although Perceval did not himself use the term landrace, Schindler's book on landraces appears among his references and he must have been familiar with the concept, he may just have preferred to use the term *Old Form*. Some of these Old Forms are described as mixtures with local adaptation. 'Old Welsh Wheat' is for example described as a mixture of many varieties and being adapted to the damp climate of Wales (Perceval, 1948).

The extent of survival of wheat landraces and their selections into the 20th century is discussed in Perceval (1934): of the 51 contemporary popular varieties listed for Wheat in Great Britain, 25 can be regarded as landraces, 26 as cultivars (Zeven, 1990). The relative popularity of some historical wheat landraces (i.e. Rivet) had dropped to less than 3% in the 1920's (Wellington and Silvey, 1997). The rivet landraces were still cultivated early 20th century but gradually replaced (Letts, 2000). Long-straw wheat was gradually replaced by high yielding dwarf varieties, less prone to lodging. Nevertheless, Squarehead's Master survived more than 30 years after 1923, Rivet 17 years (Srinivasan, 2003). Squarehead's Master or Red Standard or Standard Red were still the most widely grown wheats as Perceval was writing 'Wheat in Great Britain' (first edition 1934, second 1948):

> *"Most farmers and seedsmen assume that these are all alike and do not hesitate to sell the same wheat under either name."*

However, "a comprehensive study of crops from a great many parts of the country has revealed certain differences in the wheats" and although the constancy of these traits was not clear, Perceval grouped Squarehead's Master in two groups. The Squarehead's Masters 13/4 is described separately, as a single ear selection from a collection of commercial stocks at the Plant Breeding Institute.

From Beaven's monograph on British barley, two varieties stand out as landraces in his listing of barley varieties before 1914: Scotch Common and Archer. Both are described as composed of a large number of mixed races, the former being common in Scotland, the latter 'probably the old English common narrow-eared barley of the country, and as generally met with is composed of a large number of slightly differing races and is therefore not uniform in quality' (Beaven, 1947, p. 91). Besides these, Plumage is listed as an old land variety (Lupton, 1987).

Bere barley is in the older literature often classified as four-rowed barley. McConnell (1908) describes four types of these: common bere, Black 4-row, Victoria and Winter White Bere. Apparently only the common bere survives today. Neither Beaven nor Hunter mention bere as a distinct variety or old form, the reason being that they both use 'bere' as a general term for a six-rowed barley (*H. vulgare*), classified under *Hordeum polystichum*. All other barleys, the two landraces Old Irish and Scotch Common included, listed by Hunter are of the *H. distichum* type: two-rowed barleys.

> *In Scotland, where both winter and spring sorts are cultivated, barleys of the vulgare type are known as 'Bere' or 'Big', words most probably derived from 'byg', the Scandinavian word for barley. It is also cultivated as a spring crop in upland soils in Wales where it is known as Haidd Garw, literally 'coarse barley'.*
>
> *At times, forms of vulgare produce malting barley of fair quality, but they are most commonly grown and the grain utilised for stock-feeding.*
>
> (Hunter 1952: page 52)

Peachy (1951) describes bere (commercial 6 row) as 'an old commercial six-row barley which has been reselected by many people, including W. Findlay Esq. of the North of Scotland Agricultural College. It is a very old Scottish variety, grown more in the North of Scotland then elsewhere. Here, the name appears as a variety name. Summarising, bere has been referred to as a generic term, as a type and as a commercial variety. Jarman (1996) points out that Perceval used 'bere' in the first, generic way: he labelled a six-row barley ear as 'Winter bere' and another with black pigmented lemmas and paleas as 'Black bere'.

Bere barley seems never to have been part of breeding programs. Hence Jarman's conclusion that bere barley described by Fitzherbert is probably the same today and that its origin may be in the Scandinavian invaders of the 8th century (Jarman, 1996). However, although bere may not have undergone formal breeding, Peachy (1951) refers to many selections having taken place. The degree of relationship of today's bere and medieval or pre-historic bere still has to be established.

While for oat, Findlay (1956) states that before 1800 probably all stocks were mixtures of several varieties and few had specific names. Earliest classifications of oats before 1800 have only three types of oat for Scotland: White, Black and Grey, covering the hexaploid *Avena sativa* and the diploid *Avena strigosa* (Gaelic: *Corc baeg*). *Avena strigosa* Schreb. is an annual diploid oat including both wild and cultivated forms. It is thought to be native to the North Atlantic area (Baum, 1977). Cultivated forms include *A. brevis* Roth, *A. nuda* L. and A. *hispanica* Ard. (Ladizinsky, 1989; Leggett, 1992). These forms are inter-fertile, but crosses with the hexaploid *A. sativa* are difficult. Marquand (1922) describes three subspecies within *A. strigosa*: subspecies *pilosa* is the variety cultivated in Wales under the name Ceirch Llwyd, the subspecies *glabrescens* of which the var. *cambrica* is 'the predominant variety of the mixed aggregate cultivated in Wales' and thirdly the subspecies *orcadensis*, cultivated in some parts of Scotland, particularly Orkney and Shetlands, 'sometimes known as the 'small oat'' with three varieties dependent on the colour of the grain.

Most of the oats grown in Great Britain and Ireland until the 17th century was small oat (Findlay, 1956) but at the end of the 18th century the Small or Grey oat cultivation was almost entirely restricted to some of the poor soils on the higher grounds in central Scotland, to Orkney and Shetlands and the islands of the west coast (Findlay, 1956). The seed production of this diploid oat was very poor, sometimes not even two to three times the amount of seed (Findlay 1956). *Avena strigosa* was used for human food, horse and cattle feed, the straw for furniture, thatch and basketry. Hexaploid oat landraces called Black, White and Grey Winter and Black Tartar survived into the first half of the 20th century as testified by NIAB statistics (Wellington and Silvey, 1997).

Barley oats, Black Tartarian[11], Murkle, Potato oat and Sandy were important pre-1900 varieties that were still grown until the 20th century. Black Tartarian is taxonomically *A. orientalis* and represents a 17th century introduction from Eastern Europe. Potato oat was discovered in 1788 and was probably a natural line from Essex. It was the most widely grown oat for a century in Scotland, started as a pure line but degenerated. Many pre-1900 farmers' oat varieties however were short-lived (Findlay, 1956). Eighty to ninety percent of 19th century barley grown was Chevalier, a single ear selection. However, there were several types of Chevalier as it was not genetically uniform (Ridout, 2001). Other widely grown varieties were Goldthorpe, a single ear selection from Chevalier and Spratt-Archer, a cross from Irish Archer with Spratt, and Plumage Archer, a cross between Plumage and Archer. Unlike the other

[11] There was evidence in this assessment that Black Tartarian survived into the second half of the 20th century, at least on Islay

major cereals, formal breeding for *A. strigosa* did not start until the early 20th century. Selections were developed in the 1920's and grown in Wales: Ceirch Llwyd and S. 171 or Ceirch Llwyd cwta, a cross between *A. brevis* and *A. strigosa*. The latter cultivar was trialed on some of the Western Isles (Findlay, 1956). Findlay also mentions the Scottish Plant Breeding Station attempts to produce higher yielding varieties for the Western Isles. The most recent oat breeding trials for the western Isles were probably carried out in 1974 –1975 but were not followed up (Cameron and Phillips, 1974; 1975) due to mildew problems (R. Ellis pers. comm.).

Among the surviving oat landraces is *A. strigosa*. Findlay, earlier describing its performance as very poor, describes – with some surprise - its survival into the twentieth century:

> *"Even now (*emphasis authors*) there is as much as 500 to 600 acres grown on these Western Isles and fully that amount in some of the Orkney Islands (Sanday etc) but there is a reason for this. The flat low-lying fields of light soils (called machair lands) are very alkaline, and this is possibly intensified by the large amounts of seaweed which have been applied almost every year for a long time.*
>
> *So far, under these conditions, no varieties have been found that will produce a crop of any kind except this oat. Another feature of this oat is that it stands up to high winds so common in the Western Isles and it is not easily shaken" (page 18)*

Findlay lists in this quotation as many as three reasons for the survival of *Avena strigosa* in the Western Isles, all relating to its adaptation to a range of local growing conditions unfavourable to common oat. A botanical survey on *A. strigosa* in Cardiganshire was undertaken in the early 1990's by Chater (1993). He found it twice in the southwest of the county, in both cases as a crop contaminant (Chater, 1993). He also found the hexaploid cultivars S.220 and S.221 or Maldwyn, first released in the 1940's and both long withdrawn. One farmer still had seed although she had stopped farming in 1980 (Chater, 1993). One farmer grew Supreme until 1985. The naked oats only occurred as casuals.

For rye there is no account of the origin of older varieties before the early 20th century literature. Paterson (1925) lists the chief British varieties in 1925 as a Winter or common rye, Giant rye, Mammoth White rye and the St. John's Day of Midsummer rye, the latter being the only summer rye. He does not give descriptions of their pedigree. Perceval states that 'no well-marked races of rye are met with and the number of constant varieties is small' (Perceval, 1946) and he lists only the St. John's day or Midsummer Rye and Winter Ryes.

Modern UK spring barley varieties have been shown to be largely a subset of 19 landraces and key progenitors (Russell, 2000). The historical importance of some of these landraces and their selections is reflected in the Rothamsted long term trials: one, Chevalier was tested for 28 years from the very start of the Rothamsted experiments, while Archer crosses comprised 70 years of experimental field trials and institutional research interest in Squarehead's Master also spans a remarkable 90 years of field experimentation on Broadbalk. It was grown (selections from it included) and tested in 36 growing seasons[12]. Squarehead's Master survived commercially for 35 - 40 years, measured in terms of acreage shares (Srinivasan *et al.*, 2003). Both their extended cultivation and their contribution to the oldest agricultural field trials make these cultivars of global as well as UK agricultural heritage significance.

[12] Rothamsted data, kindly made available by Dr. Paul Poulton, Rothamsted

Letts (2000) gives an overview of cereal types historically used for thatching: the rivet wheats landraces, with solid piths and the improved Rampton Rivet, along with the bread wheat landraces Squarehead's Master, Chidham, Lammas, cultivars Yeoman, Little Joss, N59, Elite Lepeuple, Chalk, Squarehead's Master have been widely used, along with rye and both cultivated and wild oat types. Regional differences in the composition of smoked black thatch suggest different agricultural practices in medieval times: bread wheats were present in all samples from Devon, while Rivet wheat was present in non-Devon samples, however, rye was very common for thatching throughout (Letts, 2000). Maris Widgeon and Maris Huntsman are the most popular among thatchers today, but Letts found older varieties such as Squarehead's Master, Little Joss, N59, Elite Lepeuple and Chalk are still grown on a small scale (Letts, 2000).

Field trials on Chevalier barley have been conducted in order to test its malting quality (Ridout and Thomas 2001). Diversity in bere barley has been studied morphologically and through electrophoresis by Jarman (1996) and an MSc project of the University of Birmingham (Standen, 1994). Jarman investigated ten bere accessions, three from Orkney and Shetland, and the other seven with unknown UK origin, ranging in age from 1932 to 1995. The 1932 accessions originated from the Perceval collection, as part of the NIAB historical reference collection, however, the seeds were no longer viable so could not be multiplied. Jarman compared the bere barley accessions with modern six-rowed varieties and discovered that two accessions on the basis of visual inspection and electrophoresis were not bere barley. He also found a high correspondence between the 1932 and 1995 (Orkney) accessions. Jarman concluded that 'true' bere is a mixture of two morphotypes, identified by the presence or absence of spicules, and that Bere is probably unique among European six-rowed barleys in not having hairs in the ventral furrow of the grain (Jarman, 1996). Standen (1994) studied sixteen bere accessions from the John Innes Centre collection. One was a Tiree-six row, three from Orkney, two from Shetland and the remaining ten did not have geographic passport data but listed the institution of origin (i.e. NIAB, East Craigs, etc). The Tiree accessions were morphological distinct from all the other accessions. Five of the sixteen accessions clustered closely and this group included two of the three Orkney accessions. The Shetland accessions were distinct suggesting regional differentiation between the islands (Standen, 1994). Interestingly neither the Jarman nor Standen studies included bere germplasm from the Outer Hebrides. Bere barley is currently part of a trial on Orkney set up by the University of the Highlands and Islands. Its primary aim is to multiply seed and test beer's potential for human consumption, particularly in traditional whisky production (www.uhi.ac.uk/).

While *Avena strigosa* remains important for its earliness and stress resistance. The relevance of diploid oats for resource-poor environments was demonstrated by Stevens *et al.* (2000). In glasshouse experiments it produced a much larger root mass than traditional (hexaploid) oats, and as such it may have a role in soil erosion control (Stevens, 2000). Current research on its potential for sustainable agriculture is carried out by the University of Warmia and Mazury in Olsztyn in Poland (Zielinski, pers. comm.). The morphological and isozyme diversity of European and South American *A. strigosa* cultivars has been studied by Podyma (1994) using herbarium and gene bank material. From the UK he included the old WPBS cultivars S.75 and S.171 but no UK landraces were included in his comparative analysis (Podyma, 1994).

UK wheat landraces were collected by Perceval in the 1930s. However, not all the landraces collected by Perceval are currently conserved in the national cereal germplasm collection (Ambrose, pers. comm.). The Watkins wheat collection at the John Innes Centre does not have any of the UK landraces listed by Perceval in 1934 (Miller, pers. comm.), the UK national collecting priority for wheat

germplasm was primarily oriented towards collection in the centre of diversity for wheat, for a summary of current UK landrace holdings see Table 16.

Table 16. British land varieties in the BBSRC cereal germplasm collection (Ambrose pers. comm.).

Cereal	UK Provenance			Total landraces
	England	Wales	Scotland	
Wheat	4	1	0	1047
Barley	20	16	8	166
Oat	6	3	14	80

The relative under-representation of UK wheat landraces in *ex situ* conservation is likely to act as a bottleneck for their potential re-introduction. However, examples of reintroduction of landraces are known from the thatching straw industry (Camacho Villa, 2003). Bere barley and Murkle oat have recently been sourced from the BBSRC cereal germplasm collection for re-introduction (Martin, pers. comm.)

Oat and barley are relatively better represented by UK landraces in the BBSRC cereal germplasm collection. Of the listed Scottish oat landraces, eight are Murkle oat; three are Scottish Berlie and two Scottish Chief and one *A. strigosa*. Some accessions are landraces known from the literature, such as Grey Winter, but not listed as such. From pedigree information for cultivars, it can be seen that there are many more selections from landraces than 'pure' landraces; there are 4 Scotch Berlie selections, 9 Potato selections, 6 Sandy accessions, etc. Of the twelve accessions with *A. strigosa* in their pedigree, 6 are derived from the Welsh cultivars Ceirch Llwyd Bach and Ceirch Llwyd Cwta (the hybrid between *A. strigosa* and *A. brevis*), two are Piley Corn. Besides these there are 23 *A. strigosa* accessions with no recording pedigree data. Further collecting of bere was undertaken for the Scottish Heritage Collection at SASA in the mid 1990's and is currently being undertaken for small oat and bere (Hall, pers. comm.).

In conclusion for historic landraces it can be concluded that:

- Most 19th century cereal varieties were selections from landraces.
- Few historical landraces survived into the 20th century.
- Few cereal landraces were collected for *ex situ* conservation, particularly wheat is under-represented.
- Passport documentation could be improved on the basis of literature.
- Surviving (selections from) landraces declined dramatically in late 20th century.
- Re-introduction of landraces will be limited by the germplasm collecting earlier in the 20th century.

4.6.2 Cereal landraces in mainland Great Britain

As barleys become outclassed, they are replaced by varieties that can more closely match the market. The removal of such a variety from the list does not mean they are no longer suitable for malting; some may very well serve a valuable niche market, like the variety

Maris Otter. Farmers, who have grown such varieties well for many years, may prefer to continue to supply customers who request them.

(Website of the Maltsters Association Great Britain (MAGB) 2004)

Many old varieties are still grown by individuals, right or wrong they are under the impression that the wrath of the Lord will descend on them if they admit to the use of self grown seed for straw!

(Email from thatcher, current assessment)[13]

Long-straw wheat

Of the primitive wheat species, currently emmer was only found grown in museums or for research purposes. Spelt is a nationally listed species and the varieties commercially available are all cultivars. The latter is grown organically on about 100 hectares by an unknown number of farmers, most of whom obtain seed by personal contract (Younie, 2002). Neither of these 'primitive' wheats can be considered to have extant landraces.

In the past many materials have been used for thatch, ranging from heather to oat, but nowadays only two types of material are used: reed and wheat straw. Water reed or Norfolk reed (*Phragmites australis*) is used by the majority of the approximately 900 thatchers (Sanderson and Prendergast, 2002), thus the approximately 30 000 thatched buildings in England are thatched with water reed. Of the long-straw thatchers, half use Triticale (a wheat / rye cross) and the majority of the other half use 'Maris Widgeon' (Letts, pers. comm.). Sanderson and Prendergast estimated that there are about sixteen growers of long-straw wheat for thatch (Sanderson and Prendergast, 2002). Long-straw wheat and wheat reed refer to different techniques in thatching: combed wheat reed is a winter grown cereal straw; it may be wheat, rye or a hybrid. Long straw is on the other hand not combed and has passed through the drum of the threshing machine (English Heritage, 2000). Maris Widgeon and Maris Huntsman are two medium-length wheat cultivars used by thatchers; the latter was recently withdrawn from the National List. Annually 80–90 tonnes of Maris Widgeon seed is bought by approximately 80 –110 farmers per year (Prickhard, pers. comm.) and it is the main wheat variety used for long-straw thatching. It is, however, also used for (organic) milling. The fact that Maris Huntsman was recently de-listed means that the number of commercially available long-straw wheat varieties for thatching has been reduced to one. In order to assess the scale of thatching wheat growers, thatching organizations were approached for numbers, however, they hold no central data on numbers. Individual thatchers and farmers were contacting through gene bank contacts, thatching organisations members' lists and personal contacts and they were approached by phone or email. As the traditional area for combed wheat reed thatch was Devon, data collation was focused in this area and some of the major growers in this area were approached. A network of five to six small scale long-straw wheat growing farmers is also to be found in Suffolk and Norfolk, traditionally associated with long straw thatching.

Seven farmers had 'Squarehead's Master', the most prevalent variety, Other varieties mentioned were 'April Bearded' (2), 'Rampton Rivet' (3), 'Blue cone'(1), 'Little Joss'(1), 'Rivet'(1) and N59 (2). Some varieties were family inheritances, some seed was bought when it was still commercially available, and some originated from the John Innes Centre. The areas grown varied between 0.3 and 300 acres, the majority however around 5 acres and only a couple of growers cultivated more than 20

[13] with kind permission of the sender to quote

acres. Many informants emphasized the risky character of growing thatching wheat, especially Squarehead's Master, as a crop. Agricultural soils nowadays were said to be 'too rich' for cereals from a low-fertility era which often resulted in lodging problems. Another often mentioned drawback of the older varieties is their lower yield compared with modern types such as Maris Widgeon. A relatively large number of the thatchers and farmers contacted had given up growing Squarehead's Master because of these reasons and because it was too labour-intensive. Those thatchers actually still growing Squarehead's Master, were, on the other hand, inclined to emphasise its superior straw 'with a different feel to it', compared with Triticale and the more recent Maris wheat types. All wheat grown for thatching is cultivated under a low nitrogen regime to prevent lodging. Some of the farmers use herbicide but many are organic.

There is concern among thatchers about seed availability. De-listing of existing varieties was seen as a problem for the future. For farmers with small acreages bulking-up of seed on their small plots was mentioned as a problem. Some expressed concern about the small number of varieties available and mentioned that thatchers either did not have the time or the acreage to bulk up more varieties from gene banks. One thatcher, instead of seed saving on-farm, bought Maris Widgeon seed every year, partly because of the quality, partly because of political considerations, i.e. to support the seed producing company in order to safeguard the future availability of long-straw wheat.

A new use for the older long-straw wheats is for their flour: Holnicote Estate (National Trust) is currently testing bread made from traditional thatching wheat varieties grown on the Estate as a means of product diversification (BBC4 Inside Out 12/1/2004). Besides thatching and milling, one long straw wheat variety was used for church ceremonies. Acreage required is very small: the wheat variety in question was grown on only 1/3 of an acre. Long-straw wheat is also used in ornamental flower arrangements and for corn-dollies, although also modern cultivars are used. One farmer mentioned the use of long-straw wheat as suitable for the conservation of old, steam-driven tractors. The cultivation of older cereal varieties for the purpose of the conservation of older agricultural equipment was not further investigated but might have revealed more farmers cultivating older cereal varieties.

Barley

Many names of beers once bear reference to barley landraces and past cultivars (Archer Stout, Plumage Archer, Plumage Archer Special, Spratt's Special Bitter)[14] but I found only one barley variety seed saved on-farm 'Plumage-Archer' for brewing of beer. According to the Scottish Whisky Association the vast majority of barley for whisky is 'Optic' and no traditional barleys were currently used for whisky. Interest in traditional barley for whisky became evident in two emails sent in with a request for information on traditional barley varieties suitable for whisky distilling:

> *"… as a private distiller, we are using organic barley and others from the Inverness region with spectacular results. I would like to get hold of some of the older, original varieties, ideally persuade some one on Islay to grow them so that we can distil it …If you are able to direct me to any supplier / grower of these old varieties, I would be delighted. I have one farmer who would be prepared to grow some for me on Islay …"*
>
> (Email, distiller, current assessment)[15]

[14] www.beermad.org.uk

[15] with kind permission to quote the email

4.6.3 On-farm uses of obsolete cereal cultivars

There is a diverse range of uses of home seed saved cereals including as a green manure, as feed, as bedding straw and composting material. A succinct example of these multiple functions of older cereal cultivars was given in an email[16] in response to our article in the Scottish Farmer:

> *"…I am writing principally because we maintain a variety of oat which went off the recommended seeds list in the late 1970's or early eighties. The variety is called 'Forward' and was last sold by Sinclair McGill, a seeds company, in the mid-eighties. We have managed to maintain this variety to this day and I intend to sow it again this spring (possibly 10-12 acres, sorry … about 4.5-5.0 hectares!)*
>
> *This oat has so far suited us admirably and I see little reason to change the variety. Allow me to give you a brief description of the variety and why we grow it.*
>
> *The oat is a very tall variety, with good straw, an open panicle and, in our experience, a very fast growing spring oat (although I have heard it said that it would also do well as an autumn sown oat). In 2001 random samples taken for establishing growth rates were 1770 mm from two random quadrants on an area in the field displaying dense and vigorous growth. This was at 100 days from sowing, therefore an average growth rate of 0.74 mm / hour, if my arithmetic is correct. Yield was not as good as the following year, 2002 when we reached almost 2 tonnes per acre. This does not sound a great yield by present day standards! However, perhaps I should explain that we run an organic farm (Demeter certified, i.e. bio-dynamic, Organic Certification UK 6) on very hungry, sandy soil next to the River Dee, in Aberdeenshire. We used virtually no inputs, certainly no weed killers, no straw stiffeners, etc as these are not permitted, and anyway we would not use them on principle!*
>
> *Because of its immense height it is prone to lodging. However, with early sowing, with no FYM if sown after grass, lodging can be reduced. Because of its immense height it also yields a great deal of straw!!!! In a mixed farming system such as ours, with a small herd of suckler cows with progeny finished on the premises, we inevitably need lots of straw. Our aim is to reduce external inputs. We therefore produce all our feed for the livestock on the farm. The one external input we have to purchase is: straw!*
>
> *Because of its exceptional growth rate it also manages to suppress many weeds, an important factor for organic systems.*
>
> *We use the oat some years to include it in the arable silage mixture where it forms 30% (by weight) of the seeds mixture.*
>
> *We have grain cleaning equipment on the farm and after harvest we always clean and grade the oats, "seconds" are fed to the sheep or sold for feed.*
>
> *Thereafter I send a sample to SASA (Scottish Agricultural Science Agency, the official seed testing station for Scotland). I aim for a high germination % and a high 1,000 grain weight. Germination is usually about 95-96% although I have had a surprising 98%, with a 1,000 grain weight up to 52.6g.*

[16] with friendly thanks to the farmer for his permission to publish his full-length email

I usually use two year old seed, figuring that if it remains viable for this length of time then it can only improve by sowing this vigorous seed.

The variety seems to be suitable for this particular locality as bio-dynamic farming acquaintances who have sown this variety in other areas of the UK (Dumfries, Northern Ireland, North Yorkshire) appear to have had less success. I also seem to recall that in my student days (long ago! I am over 55, but not yet 60...) the Scottish colleges recommended this variety for Deeside in particular (…) Should you hear of an oat variety called: Onward then I would be most interested to know!

Generally, there was no evidence that organic farmers are using more home seed saved traditional cultivars than non-organic farmers. This is in agreement with the results from a survey of organic cereal growers, carried out by SAC in 2000. Less than a quarter of the surveyed crops were sown with home-saved seed and the cereal varieties were mostly those found on current or recent SAC, NIAB or DARD recommended lists (Taylor *et al.*, 2001). However, among biodynamic[17] farmers, seed saving of traditional crops was more pronounced as the farmer quoted before with the Forwards oat. Of an in total 27 Demeter registered[18] biodynamic cereal growing farms, 10 were seed saving cereals on-farm, most of these obsolete or 'no name' cultivars: a Hungarian rye, a Polish rye, 'Schmidt' rye, a French wheat mixture of six varieties, 'Holdfast wheat', 'Maris Widgeon', two instances of 'Black oat', 'Dandy oat', 'Silver' oat and two spelt varieties. One farmer has started experimenting with some obsolete wheat varieties as a result of this assessment. A range of on-farm uses was mentioned: long straw for bedding and composting, oats and rye as green manure, feed, and milling. The origin of the biodynamic movement is central-European and this origin is reflected in the number of continental cereal varieties seed saved on-farm by UK biodynamic farmers. Seed saving on-farm in order to create crops with local adaptation has been a component of the biodynamic movement from the very start in the 1920's. A Seed Development Project supports this in the UK. One farmer was growing 'White Belgium' fodder carrots from HDRA. According to the certification agency, on 12 of 74 with Demeter registered livestock farms, rare or minority breeds were kept (Brink, pers. comm.) In my assessment, most farms where seed was home saved, also had some traditional animal breeds.

4.6.4 Farmer's commitment to cereal landraces conservation

Within and outside the thatch growers, the cultivation of traditional cereals was often accompanied by in an interest in traditional crops and their conservation in general, and in one case an interest in traditional harvest equipment as steam powered tractors. According to the farmer, this was good for spectacular harvests with visitors coming in to see both machinery and the long-straw wheat. Two farmers had an outspoken interest in experimenting with older material. For example: one farmer had five different wheat varieties, two oat varieties, and two bean varieties all of which were obsolete. Among these the Squarehead's Master and the beans were a family tradition. The Black potato oat had been sourced from the John Innes Centre. Another small scale farmer had a keen interest in animal breeding as well as experimenting with crop mixtures of (obsolete and foreign) varieties. Other farmers expressed an interest in and dedication to the heritage that these crops represent and the importance of continuity. The awareness of the importance of 'keeping it going' was strongest expressed on Orkney and the Shetlands Isles (see more below) where bere barley had clearly gone

[17] Biodynamic farming considers the farm "a self contained evolving organism which relies on home produced compost, manures and animal feeds and in which external inputs are kept to a minimum (www.bdaa.uk)

[18] With kind thanks to Peter Brinch BDAA and Timothy Brink, Demeter Office, Edinburgh

through a conservation bottleneck. Both types of farmers, the 'experimenters' and the 'heritage' farmers, were also the persons who had re-introduced material from gene banks and seemed to be a source of information for other farmers. Interest in traditional cereal varieties came from both organic and non-organic communities, although the former seemed to prevail. The following email highlights potential new markets for traditional cereal landraces:

> *"…We have not grown any of these old varieties but are very interested in doing so (having found seed hard to come by) also because we would be interested in these varieties for the reasons you mention - furniture, thatching etc. (we have studio / workshops on the farm, currently mainly focused on the supply of locally sourced timber and timber components and ecological building materials). So, keep us posted!"*

4.6.5 Extant cereal landraces on the Inner Hebrides

> *Bear (barley) and small oats are the common produce of Skie; but the island is too wet to ripen them to perfection; and the produce of the crops is very rarely in any degree proportioned to the wants of the inhabitants: the years of famine are as ten to one.*
>
> (Thomas Pennant visiting Skye in 1772, quoted in Steven 2003*)*

Of the two cereals associated with the Scottish Highlands and Islands, bere precedes oats in length of cultivation (Fenton, 1999). Bere barley was the main crop of the Highlands and Islands until the 18th century, while oat only came into fashion from the 18th century onwards. Bere, used for both bread and ale, was cultivated on raised peat beds, so-called 'lazy beds' and has been increasingly replaced by potatoes since the 18th century (Fenton, 1999). There is historical evidence of bere grown on Oronsay, Colonsay and Islay in the late 18th century (Clarke, 1991), with small oat cultivated on the latter during the same time period. Islay and Jura were reported to be self-supportive for oat and barley at the end of the 18th century (Walker quoted in Clarke, 1991). So much of the Bere on Colonsay was used for distilling that the islanders had to import meal for food. The area of cultivation of cereals changed historically, especially after the Sheep Clearances in the 19th century when large resettlements took place on small patches near the coast (Fenton, 1999). After the introduction of tractors, the cultivation of cereals on the so-called in-bye lands was ceased and only the machair was ploughed (crofters, pers. comm.).

The 'mosaic' pastoral mixed farming based on traditional methods has a important role in conserving wildlife on the islands (Bignal, 1988). Crofting agriculture typically involves small scale production of lambs and cattle with cereals (barley and oats) and hay (Bignal, 1996). The combination of 'in-bye' land where crops of hay, silage, cereals and roots are grown and extensive grazing by cattle and sheep throughout the year is of great ecological importance as has been shown for the islands of Mull and Islay which are European strongholds for the marsh fritillary (Bignal,1999). The wildlife habitats associated with traditional crofting "have not been created by nature but are largely the result of generations working the land in the traditional crofting manner" (David Muir in The Crofter, January 2003). This traditional system however has now changed: the majority of croft fields has been turned into pasture or completely abandoned, e.g. for Shetland between 1972 and 1991 there was a 52% decrease in crops and fallow and for Orkney 31% decrease of 31% (Bignal, 1996). For the islands of Islay, Jura, Colonsay and Gigha long-term statistics are available for cereal (and root) cultivation from 1866 to 1989 based on agricultural return records for six parishes on the four islands (Clarke, 1991). Since 1866 85% of cornfields, 90% of root fields and 13% of grasslands were lost, and the rate of loss has increased dramatically since the 1950's. In 1870 27% of farmland was arable crops and 73% grass

while in 1989 this was 5 and 95% respectively. This decline is paralleled by a decline of agricultural holdings on these islands (Figure 3) and a total decline of cultivated land by 33% (Figure 4).

Figure 3. Number of agricultural holdings on Islay, Jura, Colonsay and Gigha 1866 – 1989 (Clark, 1991).

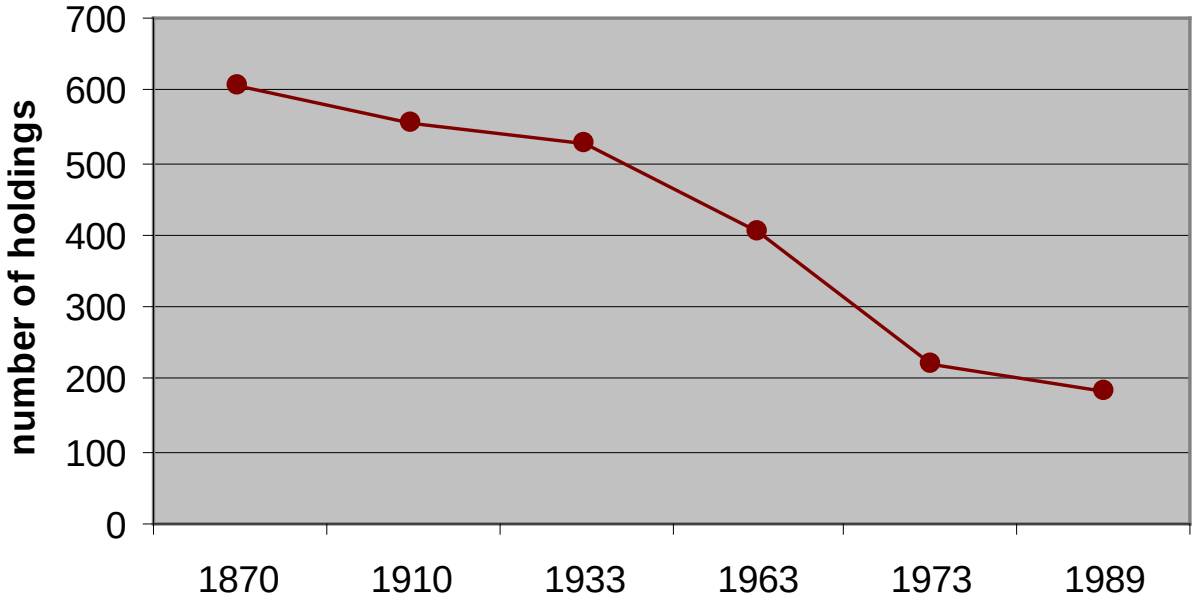
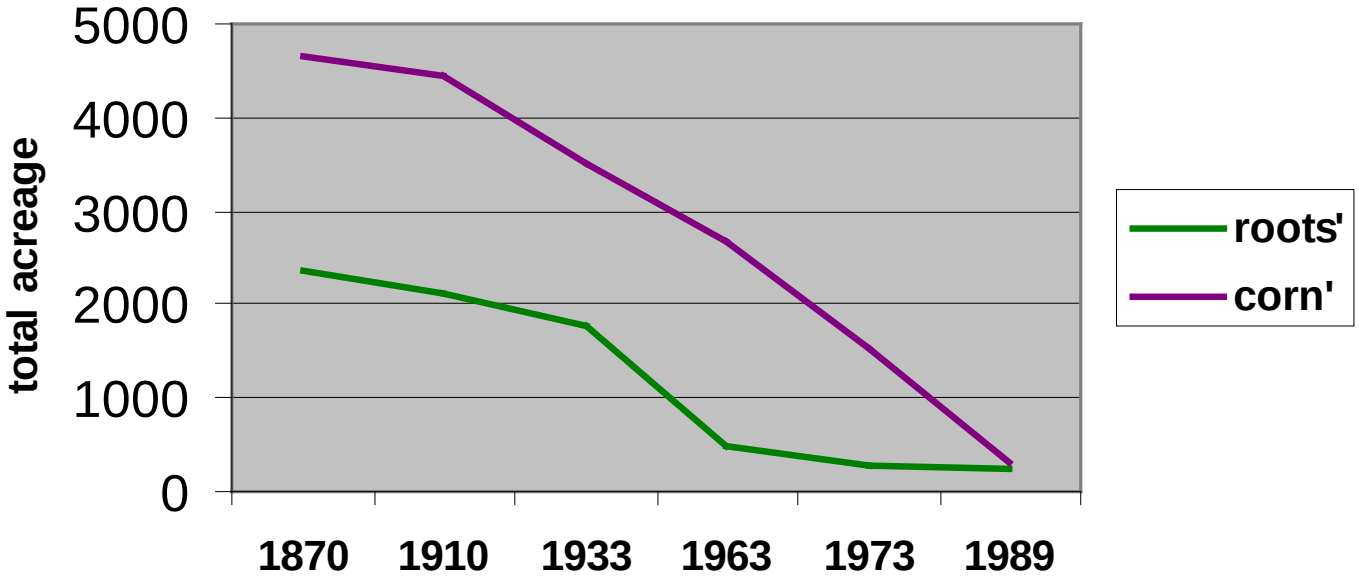


Figure 4. Cereals and root crops cultivation on Islay, Jura, Colonsay and Gigha 1866 – 1989 (Clark, 1991).

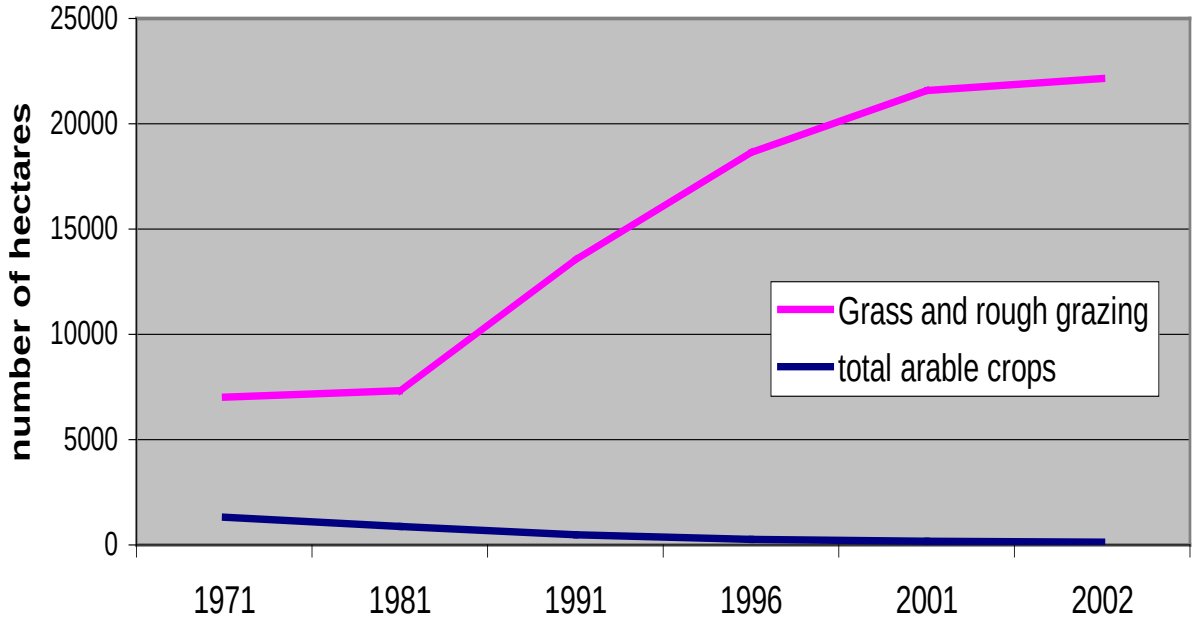


Associated with this change in agricultural practice is an associated decline of native birds, such as the corncrake, corn bunting and chough (RSPB Scotland, 2003). For the corn bunting the main threats are agricultural intensification, especially the loss of grain sources and early harvesting of crops. RSPB survey showed that the Uist population has more than halved since 1995. The corncrake is now

dependent upon agro-environmental funding for maintenance of suitable habitat management. This trend in the relative areas under grass to arable crops is also reflected on Shetland (Figure 5).

> "*Overstocking with sheep and the decline of cattle numbers and cropping are the main concerns. Current funding schemes (esp. the Sheep Annual Premium) animal welfare regulations, a break-down of co-operative practices and an ageing cohort of crofters all operate to favour sheep ranching systems.*" (Custodians of Change, 2002)

Figure 5. Relative areas under grass to arable crops is reflected on Shetland 1971 – 2002 (Shetland Council, 2003).



These factors have not been in favour of the cultivation of the traditional, labour-intensive landraces. Several interviewees gave this as the reason why cultivation ceased years ago in their particular area. On three of the Western Islands indications were present of incidental very small-scale cereal growing. These could however, not be verified within the timeframe of the assessment. On Tiree there might be perhaps 9 crofters with 10 –15 hectares under small oat, on Oronsay few, in co-operation with the RSPB and on Islay one. On the larger islands Skye and Colonsay, and on Argyll and Caithness, small oats cultivation had been given up, sometimes more than 50 years ago, according to my informants.

Isolated or incidental cultivation of traditional cereals creates a problem not only of harvesting logistics but also of identification and knowledge of the crops as witnessed by one farmer who stated that he had seen small or little or grey oat "Corky peg" grown on Islay last year. He had been asked to give advice on the grey oat and to identify a contaminant in the crop. Apparently he was the only farmer around with knowledge of these traditional crops. He recognised the contaminant as (small quantities of) bere barley. This farmer had started farming in the 1949 and had grown oat and barley, but no small oat. With regards to the future of bere barley and small oat, he said that the Inverness, East-Rosshire or Black Isle areas, which had a similar rainfall to Uist should be used to bulk up the seed, because 'if they have a couple of bad years, it will die'.

4.6.6 Extant cereal landraces on the Outer Hebrides

Cropping on the Outer Hebrides currently occurs entirely on the Machair, which falls entirely under Environmentally Sensitive Area schemes, for reasons given below:

> *"Machair is one of the rarest habitats in Europe. This distinctive coastal grassland is found only in north and west Scotland and western Ireland. The soil is mixed with wind-blown shell sand and is traditionally enriched with seaweed gathered from the beaches. The machair is often the main area of cultivation and may include grassland pasture, hay meadow, rotational arable and wetlands. The departure from traditional cropping, increased use of fertilisers and pesticides and more intensive stocking with sheep have led to a decline in the variety of plants and the characteristic animal species they support. The practice of leaving the area fallow for a couple of years while another area is cultivated allows annual and short-lived plants to germinate, flower and set seed. This helps to create the spectacular display of flowers for which the machair is well-known, and a very varied and rich habitat for other wildlife. Machair supports high numbers of breeding waders including: oystercatchers, lapwing, ringed plover, redshank, dunlin and snipe. It is also a critical habitat for corncrake. Earthworms, snails and flies, spiders, harvestmen and various bees are commonly found over the herb-rich machair."*
>
> (The Rural Stewardship Scheme, Scottish Executive, Edinburgh, 2003).

The machair soils are not only alkaline but also manganese-deficient and this is the very reason why small oat, rye and bere are grown as they can tolerate this condition. Both seaweed and compound fertilizer are used to fertilise the soils. Small oat and rye are grown as a mixed stand, the rye guaranteeing a crop in dry year, when the oat yields less. A 60 / 40 oat / rye ratio was mentioned but also 70 / 30 and for the darker soils a 50 / 50 half oat / rye and half barley mixture. Barley used to be grown as a single stand crop on the in-bye lands, but currently it is occasionally grown together with the other cereals as it was said to make good silage. One informant grew small oat as a single-stand because he found it easier to bale. On one larger croft Highland cattle were raised under certified organic management; more often crofters had faster maturing 'mainland' or continental breeds (Simmental, Charolais and Jersey). The small scale raising of Highland cattle was said to be the reserve of hobbyists because large scale production was necessary to make it economically feasible.

Scale of landraces cultivation

According to local crofters on North-Uist, Benbecula, South Uist and possibly Barra, the cultivation of small oat and to a much lesser extent, bere barley is, in contrast to the Northern Islands, still widespread and this proposition is supported by official statistics. Two sources of statistics were available to estimate the range of local cereal production, the Scottish Agricultural Census Summary Sheets by Geographic Area for June 2002 and ESA schedules contract data. These for 2002 estimate a total number of holdings growing cereals at 188 on 342 hectares. The SEERAD census 2002 figures were discussed while interviewing crofters, all agreed that the oat counted for in the statistics was small oat; and secondly that the area given by SEERAD was an underestimation of the small oat cultivation area. For South Uist only there were "more than a hundred" crofters growing small oat.

ESA statistics give for Uist in 2003 a total of 440 participants in ESA schemes; more than 400 of these are estimated to be crofts with cereals (Wilson, pers. comm.). The number of cropped hectares covered by these ESA schemes is more than 600 hectares. According to SEERAD the area under

cultivation has almost doubled since the introduction of ESA schemes and 90% or more of this would be due to oat / rye mixtures. On the basis of these data there are likely to be 200 – 400 crofters growing small oat / rye mixtures on 300 - 600 hectares. Since Findlay (1956) described the area of cultivation of small oat in the early 20th century as 500 – 600 acres on the Western Isles, the total area under cropping seems to have increased.

Comparable data for bere barley were not available, thus it was harder to assess the scope of its cultivation. SEERAD statistics for 2002 show 7 holdings with barley on 25 hectares. This would all be bere barley, but again based on interviews with crofters, the SEERAD statistics is likely to be an underestimation. Bere barley is grown on North-Uist, Benbecula, South-Uist and Barra. Estimations differed considerably among crofters, ranging from 'a handful' to 'perhaps 25'. Field inspection during the growing season is required to accurately assess the number of growers and hectares. Earlier estimations of the bere barley cultivation based on the Northern Isles of 5 - 15 hectares in total (Jarman, 1996; Wright, 2002) may be an underestimation.

Varieties, seed origin and seed production on the Outer Hebrides

All cereals were referred to by their crop names: oat or small oat, rye and barley. *A. sativa* oat types were referred to as 'mainland' or 'white oats', of which few varieties were grown. No informant mentioned more than one landrace type for the islands. The small oat of Uist however was said to differ from the more black Shetland oats. One crofter had tried the latter, and although it yielded better, it did not stand-up to the winds. One crofter had grown two hexaploid oat varieties in the 1960s, which, after initial treatment with manganese, had developed a tolerance for the machair-conditions as they started to yield without treatment. Because of off-croft activities he had not been able to keep these varieties and they are not commercially available anymore. All informants gave as their seed origin 'from the island'. One informant mentioned an Aberystwyth small oat variety but this 'gave up after 6 years' and the farmer returned to the local variety.

Seed exchange seemed to be rather common. Seed swapping as a practice to rejuvenate or invigorate the crop also occurred. A small patch of single-stand cereal is grown for seed production. These small patches were mentioned to be particularly vulnerable to geese eating the seed after the rest of the crop has been removed as silage. Also the traditional stacks seemed not safe for geese as these were said to be able to pull out the grain from the stacks. In 2003 'acute seed problems were noticed'[19] on Uist, with geese decimating the cereal production. None of the interviewed crofters mentioned a seed shortage at the moment. Only in very dry years a seed shortage could occur but at the moment there was 'plenty of seed'. In West-Benbecula hand-binder was still used by a small group of neighbouring (older) crofters and harvested grain 'stooked' and afterwards stacked. These traditional stooks can be seen on postcards for sale in Balivanich. The majority of cereals are harvested as silage.

Threats

One day it's going to be all geese and no crofters. (Ena MacNeill, quoted in Mitchell, 2001[20])

Geese were mentioned by all crofters as a problem for cereal production. Geese populations have increased on the island in the last twenty years, in the view of the crofters. They have started to over-winter on the islands and the migrating ones arrive earlier in fall. The two local RSPB nature

[19] Am Paipear, June 2003, Ena MacNeill

[20] with kind permission to quote by the author

reserves, the older of which was founded in the early 1950s, were mentioned more than once crofter as the source of the geese problem. In the 2004 RSPB bird count for North-Uist more than 1000 greylag geese were counted and more than 2000 barnacle geese. Cereal production concentrated on the west – and north shores, where about 100 active crofts are located. Hence the ratio crofter to geese is more than 30:1. For Uist the following specific problem was detailed: geese eat the seeds and the silage and subsequently dirtying the fields, so that the cattle refuse it. One of the reasons why silage is chosen instead of hand binding is that the threat of geese is less as the harvest is earlier (Mitchell, 2001). Geese Management Committees have been established on the islands, which during growing season send out live scarecrows for patrolling. Licenses to shoot greylag geese are given out but only for a limited number of geese. However, the number of guns on the islands was said to be very limited.

Disease problems in cereals exist but were considered by crofters far less urgent than the geese problem. Black or loose smut was often mentioned as a problem, mostly in oats, lowering the germination rate of the cereals.

Alternative cropping for the traditional local cereals were only mentioned by one (young) crofter: he was considering experimenting with lupines on the machair and if these would give better protein content, it would be rational to switch to this crop.

The future of Hebridean cereal landraces as perceived by crofters

Asked specifically what the major threat for the future of bere and small oat production was, there was general agreement that the decline in active crofting in combination with the decline of cattle production would be the end of traditional cereals on Uist. The current ongoing decline of crofting is a complex of factors including: a general population decline on Uist, difficulty of making the croft economically viable and loss of off-croft-employment (army, salmon fishery). To what extent cereal cultivation is ESA dependent remains to be clarified? The forthcoming replacement of ESA schemes by Rural Stewardship Schemes was seen by most interviewees as a likely loss of income due to the new tier system. None of the interviewed crofters mentioned the CAP-reform as an option that would favour traditional crops.

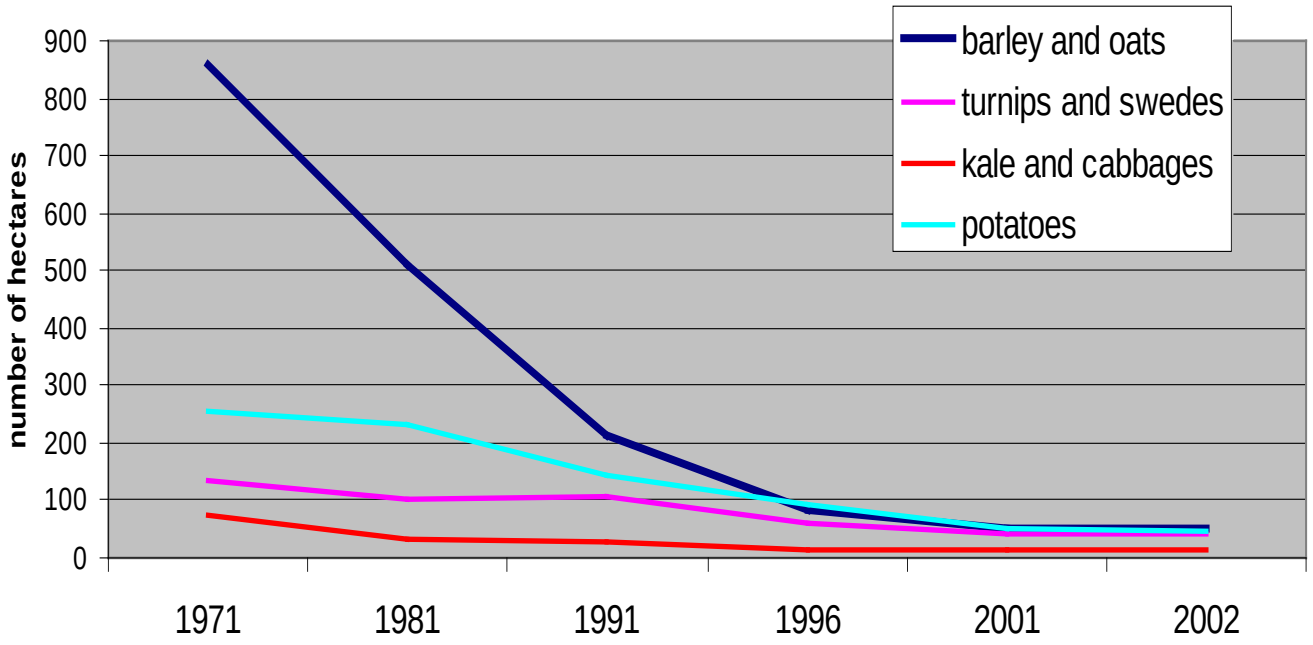
Other threats to the future of cereal cultivation were environmental issues as global warming and coastal erosion. Interviewed crofters (most in their 50-60's!) envisaged that small oats would still be grown in the next twenty years. One younger crofter envisaged the future as follows:

> *"cattle will stay, but there will be fewer crofters and the crofts will be bigger. Mainland cereals do not grow here unless they are treated and the treatment is tricky with wind blowing away the manganese."*

4.6.7 Extant cereal landraces on Orkney and the Shetland Islands

On Shetland, cereal production dropped from more than 800 hectares in 1971 to below 100 hectares in 2003. The decline of cropping is general, as can be seen in Figure 6 below. The cultivation of the traditional cereal landraces went through a bottleneck of two to three growers, both on Orkney and the Shetlands. The origin of the bere cultivated through this bottleneck period should be established as one informant suggesting that bere barley had been sent in from the Western Isles some ten years ago through the SAC after disease problems had wiped out a harvest. Some of the bere grown may have originated from the John Innes Centre collection. The oat on Shetland however seemed local in origin. Oat straw is still used for traditional crafting, basketry and thatching.

Figure 6. Area (hectares) under arable crops on Shetland 1971 – 2002 (Shetland Council, 2003).



Orkney is currently the only location where bere barley is still produced for human purposes, for the traditional bere-meal and bannocks (Mason and Brown, 2004). Four to five farmers grow bere on Orkney on a small scale for feed. One individual organic grower and one (non-organic) growers group were involved, producing meal for a local Orkney mill and for a mainland. Both growers considered the production of bere safeguarded for extinction for the time being. The organic grower however had severe leaf stripe problems on the bere some years ago for which he required derogation from the certification body for seed treatment.

On Shetland an initiative has been set up to rescue the traditional cereal landraces and to encourage cropping in general. This initiative was taken by the Shetland Organic Producers Group[21] but is not limited to organic growers. The project description is outlined as follows and quoted to some length in order to show the complexity of a contemporary 'on-farm' conservation project, involving agricultural, wildlife, educational, social, historical, architectural and art components and with an explicit objective of linking respective communities and organisations:

> *"Currently, Bere is only sown regularly by two growers, consequently there is not enough seed to disperse or to build up a seed bank as insurance against a bad harvest. Orkney and Shetland are the only places in the UK still cultivating Bere and it has died out completely in Ireland. An ancient 'land race' there is evidence that Bere has been in Shetland since at least 1500 BC. The growing of oats has also declined and is symptomatic of a reduction in crop production that is having negative impacts on the biodiversity of the islands.*

[21] www.organics.shetland.co.uk

This project will focus on safeguarding the future of these native species, as part of the living heritage of the islands. Planned over 5 years, it will begin with established growers consolidating their crop, minimising wastage, in order to maximise seed availability in 2004. New potential growers are being identified and, over autumn, winter the first of a series of 'skills transfer' sessions will take place. This training element of the project will help to ensure its sustainability.

With help of the local wildlife rangers and the Living Shetland bio-diversity project, links will be established with primary schools to explain the role of crops island culture and to show their environmental importance. A series of 'on-the-croft' sessions is planned and the SOPG will digitally record every stage of the project, to create a research and educational tool.

Aims:

To save the native Bere barley from extinction and encourage the growing of Shetland oats, as part of the living heritage of the islands

To encourage and promote interest in crop-growing in Shetland, particularly organic production

To ensure a GM free fodder crop is available for organic growers

Objectives

To purchase 1 custom made seed drier and trailer for collective use by the project

To transfer skills from established growers to new growers

To produce a 'checklist' of do's and don'ts for new growers

To produce a permanent records of the project, to be made available as a resource to schools, agencies and institutions

To establish links with local primary schools

…The project is generating interest and support from environmental and wildlife organisations, such as the RSPB, who will carry out bird monitoring on the crofts involved and craft/heritage groups. Letters of support have been received from Shetland Art trust, SCFWAG and the Living Shetland project. Both the Amenity Trust and the Arts trust are keen to see an increase in the availability of Shetland oats for heritage restorations and the craft sector and the Quendale Mill, a community owned, restored watermill would take Bere for milling, if it was available."

Jane Thomas (May 2003)

Shetland cabbage, Shetland potatoes

Besides cereals, members of the SOGG also maintain local vegetable landraces of Shetland cabbage and Shetland Black Potato. Shetland cabbage, a *capitata* type, in contrast to the Shetland kale, which is *acapitata*, has been on the islands since the fifteenth century. Shetland cabbage is the only landrace I encountered with an associated growing space: the 'plantie-crub', small circular dry-stone

enclosures for growing cabbage plants[22]. Shetland statistics for cabbage and kale are unavailable, however, Shetland cabbage is becoming increasingly rare according to the informants contacted during this survey. The valuable character of this cabbage was established by earlier research into its resistance to club root (*Plasmodiophora brassica*) (Anon. 1984). Twelve collections from disparate locations in Shetland were found to have considerable morphological variability but poor heading qualities and moderate levels of field resistance compared to control cabbages (Anon, 1984). HRI currently has 19 accessions of Shetland Cabbage and 2 of Shetland kale. The cultivation of Shetland Black Potato was considered to remain widespread.

4.6.8 *Avena strigosa*: a threatened species

A. strigosa is one of the few species in this assessment which occurs both as a weed and as a crop. As a weed it has been classified as a neophyte but also as a casual. As a weed, distribution data is available Preston *et al.* (2002), see Figure 7. The figures below from Preston *et al.* (2002) show on the left side the *Avena strigosa* distribution until 1970 and the right hand side the number of 10 by 10 km squares in which the species was found in the second botanical survey, from 1987-1999. The distribution data show a very steep decline over the last thirty years for Shetland, mainland Scotland and the Isle of Man, Northern Ireland, Cornwall, central England and East-Anglia.

Figure 7. *Avena strigosa* Distribution in 1970 and 1999 (Preston *et al.* (2002).

[22] from a Glossary to Shadowed Valley by J.J. Graham, Shetland Publishing Company, Lerwick, Shetland

A. strigosa does not form permanent soil seed banks. For this reason, its wild distribution data can be used to trace *A. strigosa* current and historic cultivation, one of the sources of the seeds of the wild plants. Singular, isolated records should be interpreted as spills from bird feed (Chater, pers. comm.). The high number of adjacent records on the Outer Hebrides however, especially South-Uist, and possibly the Northern Islands, suggest (retrospectively) more than chance-findings, they suggest continuous use of the *A. strigosa* as a crop. This was confirmed in this assessment. The presence of *A. strigosa* on St. Kilda may be related to the National Trust 'cultivating' an oat / rye mixture on the island since the early 1970's. It had not been recorded there before as the map shows. The oat in question was Sandy oat, mixed with *A. strigosa*, bulked up in East Craigs and originating from the Western Isles (Hall, pers. comm.).

A similar pattern of a series of adjacent records is visible for Guernsey. Closer inspection of the BSBI records for the Channel Islands show 12 records since 1970 in which the species was classified as a casual, and 7 in which it was classified as a neophyte (Stace, 2003). Although the difference may mirror different interpretations of recorders, it may also indicate different population sizes: 12 casuals or singular plants and most significantly 7 naturalised populations. This could be an indication of the cultivation of *A. strigosa* as a crop. Verification fell out of the scope of this project. The agricultural advisor for the Channel Islands thought there was no cultivation anywhere on the islands. The small publicity campaign (an advertisement) did not yield positive responses either. The New Atlas data indicates *A. strigosa* is extinct in Northern Ireland, mainland Scotland, Cornwall, and has very few locations left in Wales. In the current assessment only one case of actual *A. strigosa* cultivation in Wales was found, however this result may indicate insufficient publicity in Wales for the assessment. There is anecdotal evidence that *A. strigosa* was still cultivated in North-western part of Northern Ireland in recent history. More intensive field surveying would give more accurate assessment. It would moreover, create an opportunity to research the full geographical range of *A. strigosa* within the UK.

The relevance of this particular landrace / crop wild relative is wider than the British Isles. The scale of *A. strigosa* cultivation in Europe has declined to the point of extinction in many countries. In a recent survey of *Avena strigosa* survey in Denmark 20,000 fields were checked (0.8% of all arable land in Denmark) in the former strongholds of the crop. The field surveys were combined with herbarium studies, literature review and farmers interviews. The conclusion was that *Avena strigosa* was extinct in Denmark (Weibull, 2001). While in Lithuania four villages were the main sites for small oat cultivation in the country, the total area of cultivation being 9,000 square meter (Weibull, 2001). *A. strigosa* only occurs as a seed contaminant nowadays in Poland (Kièc, 2003) and is probably extinct in its former centre of origin Spain (Laguna, pers. comm.). The UK may therefore hold one of the single largest remaining areas of *Avena strigosa* cultivation in Europe.

4.6.9 Research needs

It seems likely that there are distinct *Avena strigosa* varieties growing across the UK. On the Western Islands *A. strigosa* was referred to as 'small oat', 'black small oat' or 'little oat'. On Shetland, it is called 'Shetland oats' and at least one farmer referred to it as 'grey oat', remarking that there may be more than one type. Also oats from the Northern Islands introduced to Uist did not perform well. The current small oat germplasm collection held by the John Innes Centre lacks some passport data so it is unknown if the Western Isles are represented.

No bere has been reintroduced to the North from John Innes Centre germplasm collection over the last 10 years (Ambrose pers. comm.). As with *A. strigosa* it has been suggested that there may be two types of Bere, that the types grown in the Western Islands are distinct and unsuitable for the Orkney and Shetland environment. Previous morphological and isozyme work on bere was hampered by the lack of passport data of the germplasm accessions available.

Rye has never been an important crop for the UK and no landraces are known from the historical literature, nor has any characterisation or collecting been undertaken on the small populations of rye currently grown on the Western Isles.

Research issues emerging from this assessment are:

- There is a need to clarify the origin of the cereal landraces cultivated on the Western, Orkney and Shetland islands.
- The process and extent of seed translocation and re-introduction between the Western, Orkney and Shetland Islands, and their interaction with gene banks holding needs investigation.
- There is a need to establish more precisely the number of hectares on which oat / rye and bere barley are grown on the Outer Hebrides and to establish a precise number of cereal growing crofters.
- To establish through characterisation and evaluation how much morphological and genetic variety is present in landraces between the West and North, and within the islands and how these UK cereal landraces relate to continental European landraces; this will involve fresh collection because of the lack of passport data for many currently conserved UK accessions.

4.6.10 Conclusions for cereal landraces

The differentiation between derived or secondary and original or primary landraces as proposed earlier in this report, proved useful. The time dimension of the found materials differed widely between the two classes and justified the distinction between derived landraces that were obsolete cultivars maintained as landraces and original landraces. Many of the criteria generally applied to define landraces were present for the Scottish landraces: historical origin, local adaptation, lack of formal improvement, seed saving on farm, distinct identities and at least between the islands, heterogeneity. Seed exchange and seed swapping were also practiced. Cereals have been cultivated in the Northern Islands over generations; seed saving occurred over generations; local adaptation is evident as the lack of formal improvement; the scale of cultivation was relatively large allowing mixing through seed exchange and seed replacement[23], the usage of mixtures to guarantee yield in bad years; and a relatively traditional agriculture, i.e. low-input agricultural management on small fields. The criteria of heterogeneity, important from a point of view of genetic diversity, could not be assessed as no field work was planned. The extent and periodicity of re-introductions needs to be established in further work. Usage of mixtures of species is a very traditional management: mixtures of species as maslin (wheat and rye), dradge (oat and barley) and beremancorn (rye, wheat and barley), are known from medieval times (Slicher van Bath, 1960).

In contrast, the majority of other cereals fall into the category of derived landraces. They have been documented as being selections from landraces or cultivars developed in the 19th or early 20th

[23] This element was pointed out and emphasised by Dr. ir. A. Zeven

century. Among the long straw wheat varieties, only April Bearded and Rivet wheat are historical landraces. However, these can be considered reintroductions from germplasm collections. Home seed saving for this category ranged from 6 to 80 years. Local adaptation was only in few cases the particular reason for seed saving over a longer period. Traditional uses were present for all, ranging from church ceremonies to thatch. However, also potential new uses were suggested by inquiries: uses for ecologically friendly furniture, in organic agriculture.

An overview of the cereal landraces found present is given in Table 17. It is likely that bere barley, small oat and rye cultivated on the Outer Hebrides and the Northern Islands are centuries old and unique in a UK and even European context.

Table 17. Extant British Cereal Landraces 2003.

Variety	Pedigree	Number of farmers	Current use	Hectares	Location
Plumage-Archer	19th century	1	brewing	40.5	S. England
Sheriff Wheat	19th century	1	church	0.12	S. England
Squarehead's Master	19th century	7	thatch	221	S. England
Rampton Rivet	Early 20th century	3	thatch	10.2	S. England
April Bearded	old Welsh farmers' variety	2	thatch	10.1	S. England
Rivet	Centuries old	2	thatch	10.2	S. England
Little Joss	1908	1	thatch	2	S. England
Forward oat	1950	1	several on farm uses	8	Scotland
Several oat, rye	Obsolete cultivars	dozen	biodynamic	162	England
Bere barley	8th century (?)	< 50	food, feed	20.2	Orkney, Shetland, Outer Hebrides
Shetland oat	before 17th century	< 10	feed, basketry	1.6	Shetland
Small oat and rye	before 17th century	100-200	feed	Est. 121	Uists & Benbecula

So summarise it can be recommended that:

- Seed availability and the bulking up of seed for small producers is restricting obsolete varieties use.
- Actual or potential use of the varieties may be highly localised (e.g. Forwards oat), thus is too localized for commercial breeding. Networks of traditional cereal growers should be encouraged and seed exchange of obsolete and landraces legally.

- Many informants were not aware of the availability of landraces germplasm and the websites and the national germplasm collections should be more widely publicised.
- The benefits of growing long-straw cereals for landscape and biodiversity (low-input, small fields (many edges) and relatively extensive, prolonged harvesting) have not been researched nor credited in CSS and equivalent agro-environmental schemes.

4.7 National Listing and Conservation

4.7.1 Background

Landraces are often thought of as belonging to the past, especially in countries with highly industrialised agricultures as UK. Nonetheless, five extant forage landraces were found present on the UK National List and one forage local variety has only recently been delisted. However, landraces have not only survived, they have survived on the National List. In this section a closer look will be taken at how landraces survive within the National Listing or Common Catalogue system. Vegetable landraces and vegetable primitive varieties will be taken as an example. Because of their national importance both as crop and as a crop wild relative, the focus will be on the Brassicas.

Vegetables are the group with the widest variety of landraces types: (family) heirlooms, heritage varieties and private grower's strains are usually highlighted. UK heirloom varieties were recently surveyed Stickland (2001) and in this survey the definition of landraces included Open Pollinated varieties as was the case for the first survey of cruciferous landraces in the EU in the 1980's:

> *"Landraces are taken to be populations selected and multiplied in a traditional manner by growers. They will therefore possess genetic adaptation to local conditions and against annual variation."* (van der Meer *et al*, 1984: 24)

This approach is followed here. Besides Open Pollinated varieties, other criteria for landrace types on the National List emerged. Other researchers have investigated the mechanism by which National Listing system excludes heritage varieties (e.g. Cherfas, 1996; Stickland, 1998). In this section the perspective is on the different types of landraces on the National List, and the current and future maintenance of these landraces. A brief overview of the historical development of the National List will be given first.

4.7.2 National List Establishment

The first regulation of the seed trade in the 20th century was a scheme for seed certification of landraces. It was set up in the county of Montgomery in 1923 to produce seed of a local variety of red clover. The Welsh Plant Breeding Station assisted in the setting up of this scheme. Parallel to this, English certification schemes were set up for wild white clover. During the Second World War years, local varieties were encouraged and the Ministry's scheme for wild white clover certification was promoted (Kelly and Bowring, 1990). These early schemes of certification were voluntary. As was discussed above when seed certification was introduced special consideration was given to the local and historical origin of forage landraces and today special measures are sometimes available to facilitate the listing of local forages, for example Scots Timothy has reduced certification fees on the basis of its local character.

Pre-1972 growers were free to market their own selections of existing varieties, sometimes under a new name. The National Institute of Agricultural Botany started creating lists of synonyms of crop names in order to create some protection for breeders; the first for potatoes was published in 1920 and

for cereals in 1930. The work on synonymy necessitated the definition of what a variety actually was and this move was recognised as a key point in the development of seed quality control by Kelly and Bowring (1990) that ultimately resulted in the Plant Varieties and Seeds Act of 1964. The voluntary character of previous schemes was kept intact but this act was meant to safeguard the distinct characteristics of varieties (Kelly and Bowring, 1990). In this act Plant Breeders Rights were introduced and established via the mechanism of royalty payments based on varietal usage (Bould and Kelly, 1992). Criteria for varieties to be marketed were formulated in Schedule 2 as follows:

- "clearly distinguishable by one or more important morphological, physiological or other characteristics"
- "sufficiently uniform"[24]
- "stable in its essential characteristics"

These later were generally referred to as DUS criteria. At the same time, an Index of Plant Varieties was introduced prohibition of seed sale for varieties not listed on the Index were introduced. The establishment of a National List, as required by EEC directives when the UK joined the European Economic Community in 1973, replaced the Index. Thus schemes for seed quality control changed from voluntary to statutory and compulsory (Kelly and Bowring, 1990). Under the EU regulation seeds could only be marketed if the variety was registered on the Common Catalogue and only varieties that complied with the DUS (Distinct, Uniform and Stable) criteria and, for arable crops the VCU requirement (Value for Cultivation and Use), could be legally marketed (Green, 1997).

With the introduction of the National List system, aspects of local seed production became illegal, notably home seed saving, seed exchange and seed replacement of obsolete or otherwise not-listed varieties.

> *Marketing shall mean the sale, holding with a view to sale, offer for sale and any disposal, supply or transfer aimed at commercial exploitation of seed to third parties, whether or not for consideration* (2002/55/EC of 13 June 2002)

Some provisions for derogations were made, for example the use non-certified seed for research. Also, bere barley has been exempted from listing on the basis of article 16 (c) of Directive 70/457/EEC 29 September 1970, which states that pre-1972 varieties occupying less than 3% of the total national area used for seed multiplication were exempted from listing (Jarman, 1996). Species not included in the Common Catalogue allowed free marketing of uncertified seed and included emmer, parsnip (*Pastinaca sativa)* and small oat (*Avena strigosa*). Also species with less than 10 varieties in the Common Catalogue are considered as minor species and are exempt from certification. Since 1995 the farmers' rights to save seed on-farm was re-established on the condition of royalty payment and this was administered by the British Society of Plant Breeders.

4.7.3 National List and Vegetable landraces

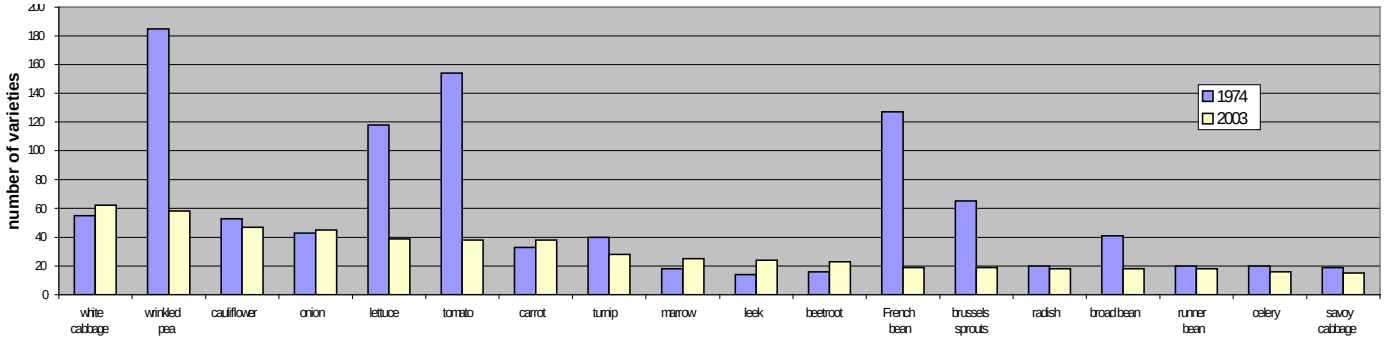
Vegetable landraces on the National list are often recognisable by the inclusion of their location in the name. These varieties represent a local breeding tradition developed over time in a specific location or even by a private grower strains and are kept as populations as they are Open Pollinated varieties. Well known examples are Cottagers kale, Bedford and Evesham Special among the Brussels

[24] The interpretation of 'sufficiently' was later further clarified (for details see Bould and Kelly p. 145).

sprouts, Ormskirk Savoy and Cotswold Queen White cabbage. However, it is noteworthy that the total number of vegetable varieties on the National List dropped from 1380 in 1974 to 628 in 2003. This is a loss of more than 50% of UK listed vegetable varieties over 30 years. The average number of varieties per crop also dropped over the same time period from an average of 56 varieties per crop to 29 in 2003. The only crops that have not seen a reduction in number of varieties since 1974 are white cabbage, carrot and onion. An overview of number of vegetable varieties is given in Figure 8.

The general decline has been ascribed to fewer varieties being maintained, bred and tested in the UK. Maintaining a high number of varieties has become economically not viable. The strongest decline is found in traditional UK vegetables such as wrinkled pea, French bean, Brussels sprouts and spinach. Some of these trends are EU-wide trends, related for example to a decline in consumption of Brussels sprouts (Figure 9) with 30%. While for French bean and wrinkled pea the decline reflects the large-scale rationalisation of the industry towards large-scale production for freezing, see Figure 10 for wrinkled peas. For cauliflower however, the EU trend and the UK trends diverge as can be seen in Figure 11. The EU increase is largely due to a major influx of hybrid varieties. As can be seen in Figure 12, for many crops the number of hybrids has increased and is over 70% in 1999. As breeding for most crops is geared towards the breeding of hybrids, the number of primitive varieties or Open Pollinated varieties is continuously declining. The seed company Selminis dropped 2000 Open Pollinated varieties from the Common Catalogue in 2000 (Swann, 2001).

Figure 8. Numbers of vegetable varieties 1974 – 2003.



For Brassica breeders worldwide the main breeding objective is crop uniformity, while nutritional quality is ranked among the lowest priorities. High uniformity has been seen as almost impossible to achieve with open-pollinated varieties owing to the outbreeding habit of Brassicas. The expectation within the breeding industry is that within the next five years, hybrid varieties will inevitably replace the remaining open-pollinated populations (Monteiro and Lunn, 1999).

4.7.4 B-listing

At the time of the introduction of the National List, exemptions were allowed from listing as well as exemptions from the DUS standards in order to facilitate continuation of older pre-1972 vegetable varieties on the list. This mechanism for retention was the so-called B-list, which comprised varieties marketed as ‘standard seed’ in contrast to A-list or certified and / or standard seed. These pre-1972 varieties were added on the Common Catalogue without having to undergo the DUS testing and without the requirement for maintenance fees but with a maintainer requirement. A transitional period until 1978 that allowed ’upgrading’ of these older varieties to pass the DUS testing and become A-listed varieties. Thus vegetables on the A-list can be marketed as either standard seed or certified seed.

Figure 9. Number of Brussels Sprout varieties grown in the EU and UK from 1974 – 2003(National List, 2003).

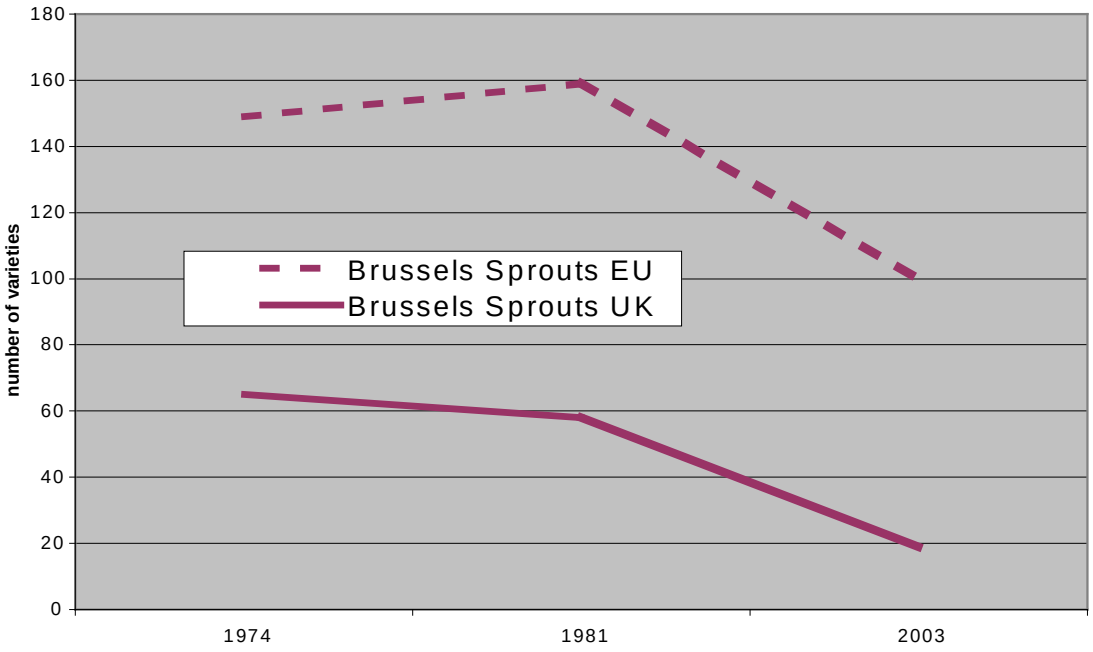


Figure 10. Number of wrinkled pea varieties grown in the EU and UK from 1974 – 2003(National List, 2003).

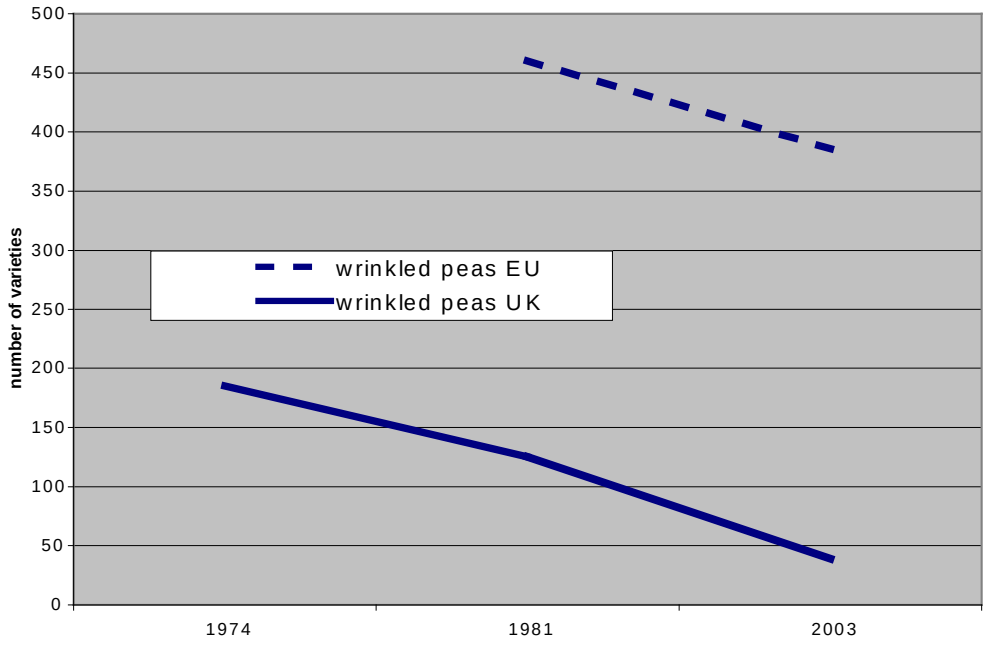


Figure 11. Number of cauliflower varieties grown in the EU and UK from 1974 – 2003 (National List, 2003).

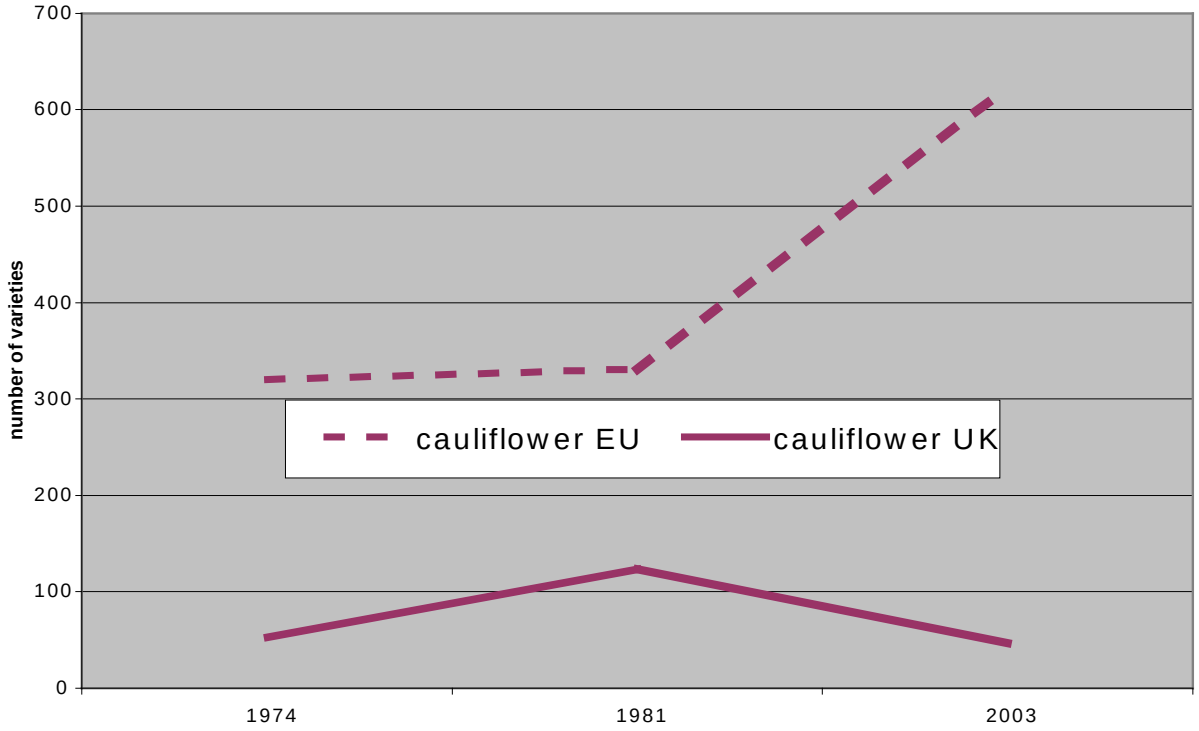
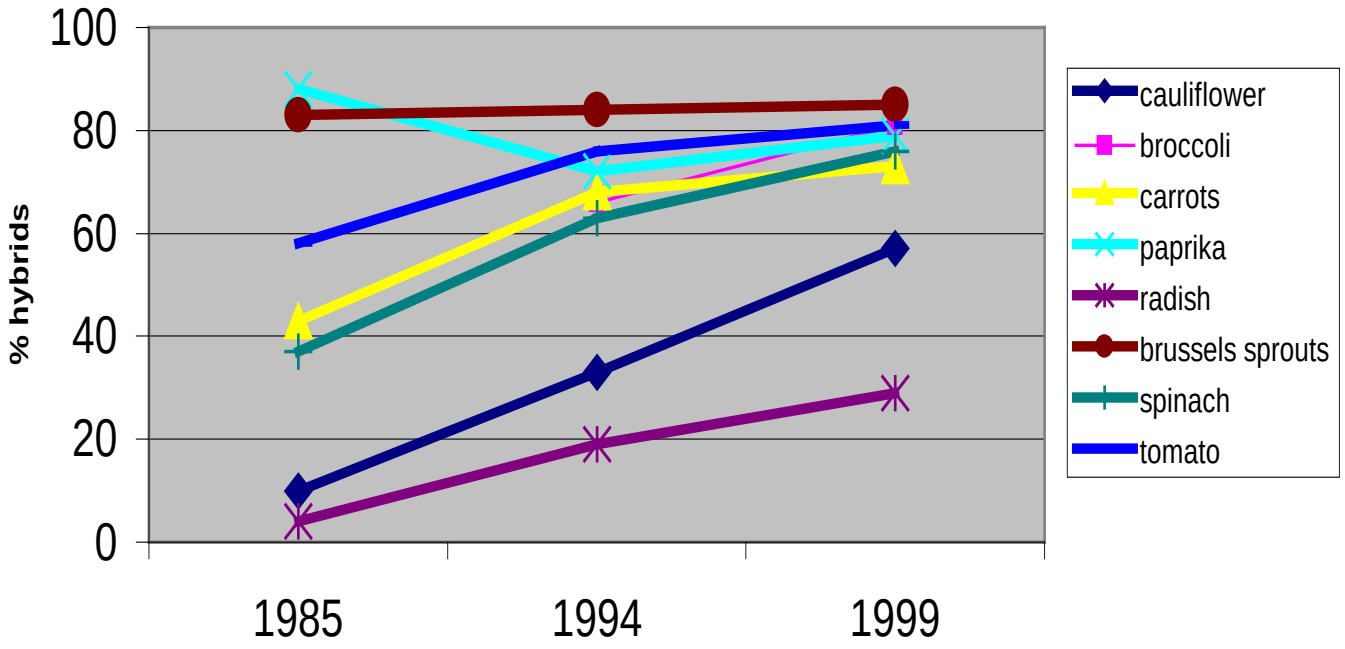


Figure 12. Numbers of hybrids varieties of vegetables between 1985 and 1999 (Hagel, 2001).



However, after this transitional period expired the B-list remained functional and the majority of varieties nowadays are marketed through the B-list, as standard seed. The B-listing system is applied differently in different EU countries e.g. for Brassicas in The Netherlands the B-listed is composed of 91% hybrids as opposed to 17% in the UK, with an EU average of 71%. In the UK the B-list has retained its original function of making pre-1972 varieties available as opposed to the Netherlands where it is used to launch new hybrids. The absolute number of hybrid Brassicas on the Dutch B-List brings the average number of B-list hybrids to 71% (Table 18).

The requirement for B-listed varieties to have a maintainer was dropped in a revision of the Directive in 2001, as it "should help to retain more of them on the National List" (PVS Gazette November, 2001). Again this points to the UK interpretation of the B-list as a means of conserving traditional material. This interpretation of the use of the B-list and the fact that many landraces are already included would make it relatively easy to transform the B-list into a Second Register for landraces to be distributed on a small scale. This way, the UK could contribute to the introduction of the new EU directive on 'conservation' and amateur varieties.

Table 18. Comparison of B-listed cabbage varieties, European, UK and the Netherlands 2003[25]

Crop	EU Total varieties	EU Number Of Hybrids	NL Numbers On B-List	NL Hybrids On B-List	UK Numbers On B-List	UK Hybrids On B-List
Curly kale	31	15	20	15	2	
Cauliflower	620	412	279	248	35	2
Broccoli	134	108	84	80	0	0
Brussels sprouts	98	81	66	63	6	1
Savoy cabbage	178	146	97	92	7	2
Cabbage	510	402	251	234	35	11
Red cabbage	84	74	49	42	1	1
Turnip	116	11	17	9	17	1
TOTAL	**1771**	**1249**	**863**	**783**	**103**	**18**
% OF TOTAL		**71%**		**91%**		**17%**

[25] Data source: Common Catalogue 2003.
A-listings and B-listings at European level do not necessarily add up as one variety can be listed in more than one country, can be listed both as B and as A in different countries.

4.7.5 Conservation of Landraces by Seed Growers

As the example of the sainfoin landrace Hampshire Common demonstrates, it is possible for landraces to be conserved over generations by an enthusiastic grower family, but this is only possible as long as the grower thinks it reasonable or economically sound to pay the fees associated with maintaining varieties on the National List. The example also illustrates and highlights the plight of these enthusiastic growers; with the spiralling cost of National Listing the particular grower has now withdrawn the landrace from the List. The link between local seed production and maintenance of local varieties and landraces is still visible on the National List. Of the pre-1972 arable crop varieties the second largest maintainer is Church of Bures ranks, behind the Scottish Executive For Rural Affairs Department which maintains a large number of pre-1973 potato varieties at SASA, with or without joint maintenance with the Department of Agriculture For Northern Ireland (see Table 19). For vegetables, the number of landraces on the National List is larger; a review of maintainers of cabbage landraces is given in Table 20. Obviously some of the maintainers are keeping their landraces on the National List for sound commercial reasons, but others are undertaking the expense because of their commitment to germplasm conservation and it is these enthusiastic maintainer that require further support or in time all of their material will be lost.

Table 19. Current maintainers of pre-1972 arable crop varieties 2003 (National List, 2003).

Pre-1972 Arable Crop Varieties And Their Maintainers		
Maintainers	**Number of varieties listed**	**Among these local forages**
SEFRAD	19	
T.Church	9	2
IGER	3	3
PBI	3	
Advanta Seeds	2	
Barenbrug NL	2	
KWWCPRC	2	2
Nickerson UK	2	
Dlf trifolium DEN	2	
STGA (Scotland)	1	1
TOTAL	**38**	**8**

Table 20. Maintainers of cabbage landraces in 2003 (National List, 2003).

VARIETY	MAINTAINER(S)
Cottagers	E.W. King
Dwarf Green Curled	W.W. Johnson, A.L.Tozer
All the year round	Nickerson Zwaan, W.W. Johnson

Bedford	Nickerson Zwaan, E.W. King, Sutton's, W.W. Johnson, A.L.Tozer
Evesham Special	E.W. King
Ormskirk	W.W. Johnson
Christmas Drumhead	E.W. King
Cotswold Queen	E.W. King
Durham Early	E.W. King
First Early Market 218	W.W. Johnson, A.L.Tozer, Nickerson Zwaan
Offenham 1	Nickerson Zwaan, A.L.Tozer
Wheelers Imperial	Nickerson Zwaan, W.W. Johnson, E.W. King

4.7.6 Local Strain Landraces

The marketing of local grower's strains of cabbages and Brussels sprouts was common practice throughout Great Britain, ranging from Cornwall to Northumberland and Durham until at least the 1960's (Anon, 1960). In the early 1970's 155 'stocks' divided among 19 groups of Brussels sprouts grower's strains were collected by G. Johnson for HRI and tested at NIAB. There were for example two Evesham groups with 12 local strains, one Ashwell group with 18 local strains, one Lancashire group with 2 strains and 6 Cambridge strains divided over two groups. Only 27 of these 'stocks' were F1 hybrids as the first hybrids were only first entering the market. An indication of the presence of local or private vegetable strains on the National List is indicated by the number of so-called Approved Maintenances. These form a special category in the National List and are selections within existing, often longstanding varieties. They can be seen as breeder's strains or private strains and represent local breeding activities. In 2003 there were only seven cases of Approved Maintenances for Brussels sprouts. If we take the number of local strains collected by Johnson as equivalent to those of current Approved Maintenances, then the production of local or grower's strains went down from 155 to 7 in 30 years. Leaving aside the question of quality of these strains, in terms of locally produced diversity this forms a massive decline. Current extant Approved Maintenances include selections on heritage landraces as Ailsa Craig, Bedfordshire Champion onion, Giant Winter for leeks, Bedford for Brussels sprout, January King, Ormskirk, Christmas Drumhead, First Early Market, Offenham and Wheelers Imperial among the cabbages. An overview of all maintainers of Approved Maintenances for 2003 is given in Table 21.

4.7.7 *Ex situ* Collections and the National List

The three UK statutory seed testing centres have different policies on retaining obsolete varieties in their reference collections. NIAB in general does not retain obsolete varieties, while DARDNI has approximately 700 obsolete forage varieties retained in its reference collection (Michael Camlin, pers. comm) and SASA theoretically retains 100% of obsolete registered varieties in its reference collection and these are stored in medium to long term conditions. However, with the exception of wheat, barley, oat, potato and pea, SASA does not regenerate obsolete cultivars but their coverage of commercial cultivars is estimated to be 90 – 95% (Green, feedback on current assessment). A overview of *ex situ* collections at the three institutes has been given by Green (1997).

Table 21. Maintainers of Approved Maintenances 2003(National List, 2003).

Maintainer	Country	Number Of Varieties
Sutton's Consumer products	UK	12
E.W. King	UK	9
A.L. Tozer	UK	9
Nickerson Zwaan	UK	8
W.W. Johnson & Sons	UK	5
Elsom Seeds Ltd.	UK	4
Fersey Morse Seeds	USA	4
W. Robinson & Sons	UK	2
Ashgrow	USA	2
Stretton and Sons	UK	1
B.G. Fowler and Sons	UK	1
Samual Yates Ltd	UK	1
Sunseeds	USA	1
TOTAL		**59**

In the current assessment, the example of sainfoin illustrates the role of these statutory collections and their potential for conservation and future utilisation. The landrace Cotswold Common sainfoin, falls out of IGER's remit as it is regarded as a minor legume but the material is duplicated in one ECP/GR designated gene bank in the Czech Gene bank and is also stored at DARNI because it has been certified in the past. While for the second sainfoin landrace, Hampshire Common, no accessions could be found in European gene banks or in SINGER. However, there is one *Onobrychis viciifolia*, accession in the USDA collection, donated in 1959 by NIAB, under the name Hampshire Common but with the remark 'unverified name'. The statutory collection at DARNI at Crossnacreevy, however, conserves this landrace with a verified name. The UK statutory accessions are not currently publicly accessible as the legal status of statutory accessions requires clarification, but therefore technically, re-introduction of the Hampshire Common landrace (other than the one remaining current farmer) is impossible at the moment.

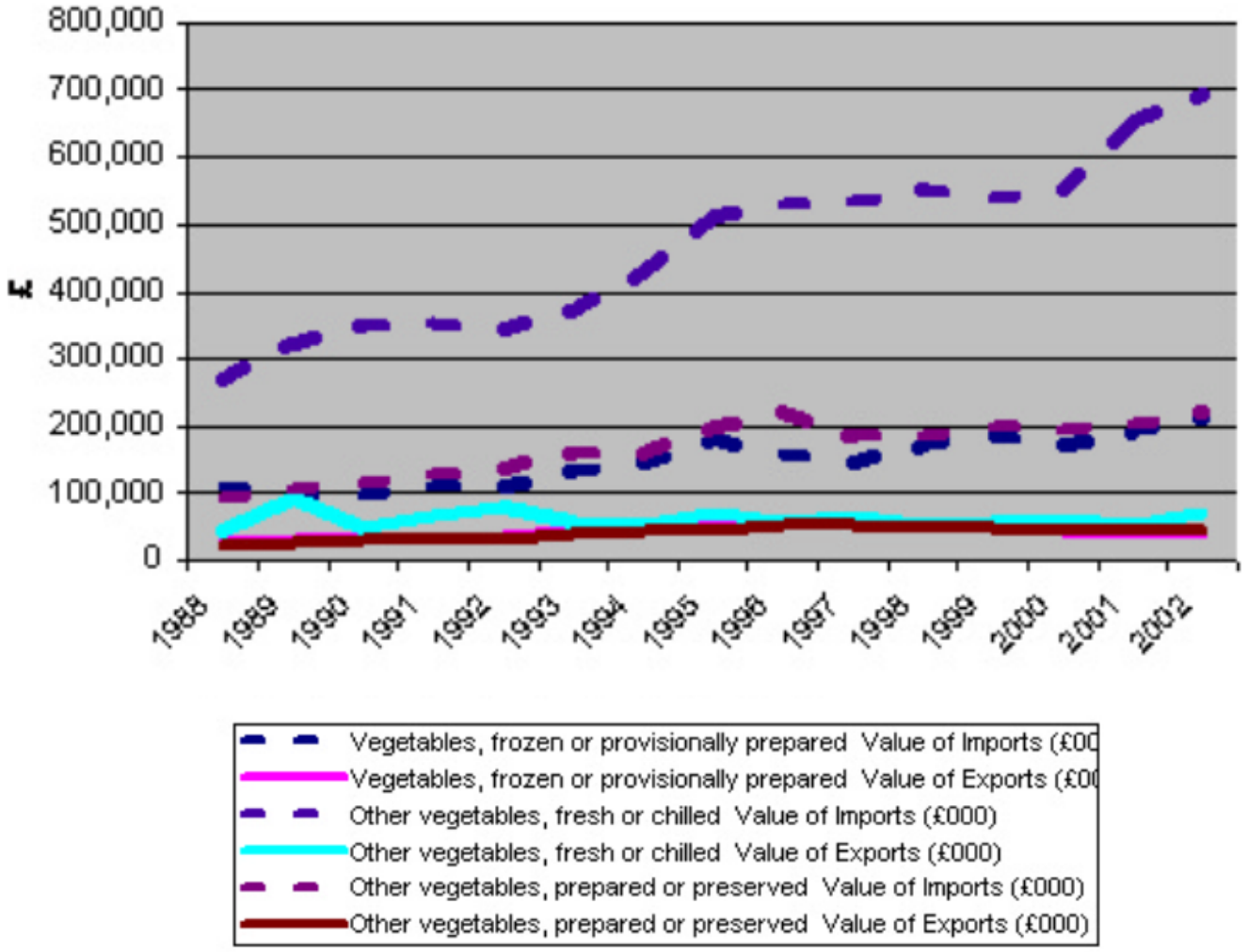
4.7.8 Conservation Implications for Landraces

Plant breeding is increasingly oriented towards large-scale field production, which as a consequence implies neglecting the less competitive local varieties of lower commercial value. Breeding for smaller local and emerging markets has become not feasible in the UK leading to significant trend in de-regionalisation for seed production (Efken, 2002). This trend is not only true of the localised varieties within the UK but is also true in general, as is illustrated by the seed production for vegetables in the UK the majority of which now have their origin outside of the UK, see Figure 13.

The scale of National Listing fees in proportion to profit margins in the seed industry disproportionately discourages seed companies or individual growers registering new varieties or

maintaining existing varieties. Also, for some crops the DUS-criteria are a big hurdle, especially for heterogeneous crops such as onion or non-hybrid Brassicas. For specific niche markets, as for example organic farming, VCU protocols need adjustment to allow for differentiation in VCU criteria. Proposals of this kind are currently being discussed by the Forum on Seeds for a Sustainable Environment (FOSSE).

Figure 13. Trends in seed exports / imports for vegetables 1988 – 2002 (DEFRA, 2003).



Landraces and local seed production are intimately associated, as was evidenced from the history of local forages in the UK which historically was associated with numerous local forage seed growers groups. Many vegetables on the National List can be identified as landraces not only because they are Open Pollinated but also because they represent a long local breeding tradition, a historical origin and grower's private strains and this local link is often incorporated into their name. Farmer's varieties are the result of farmers producing and exchanging seed while selecting and managing crops in a 'traditional' (low-input) regime. This is usually done as a strategy to stabilise rather than maximise

production and often mixtures of varieties or even species are used to provide yield security. Both farmer's and natural selection may result in local adaptation. Examples of home seed saved varieties were discovered during this assessment that were locally adapted, e.g. the manganese-deficient tolerant cereals of the Machair soils of the Western Isles and Forward oat on Aberdeenshire poor soils. Highly localised emerging or niche markets are likely to remain too small for the mainstream breeding industry to be profitable and yet also fall out of the remit of public breeding institutions – this is a clearly identified conservation gap.

Interest was shown during the assessment by many individuals and organisations in several aspects of traditional cereal varieties cultivation, notably the whisky industry, eco-furniture producers, flower arrangers, green manure users, church ceremonies, corn dollies, ecotourism, education and breeding for organic agriculture. Survival of landraces has been shown to be linked with development and marketing success (Negri, 2003). One of the most successfully marketed UK landraces is the Jersey Royal potato, which has European Protection and is marketed as a named variety by Waitrose. The potential of bere barley for whisky distilling seemed the most obvious candidate for testing of its marketing potential coming out of this assessment.

Promotion of landrace cultivation is currently not only hindered but hampered by seed legislation. A socio-economic evaluation of ten on-farm conservation projects in Germany showed however that for half of these, current EU seed legislation was a limiting factor (Becker *et al.*, 2002). For the UK, the lack of landrace seed availability has proved to be crucial to continued and further cultivation. Legalising seed exchange of obsolete varieties for conservation purposes and also the promotion of highly localised niche markets will be necessary not only to encourage local seed activities but to ensure the survival of extant landraces. Reform of the current EU seed legislation as to proposals in terms of Heritage and Amateur varieties should be implemented as soon as possible. This could take the form of a Second Register on the National List in order to provide a legal context for these new variety types. It has been shown that the current B-list in the UK has preserved characteristics of a second register, which could thus be transformed into a Conservation list. Simplification and reduction of costs of maintainership for the National List is advocated. Gene banks and National Testing Centres may have a role in *in situ* conservation of landraces by taking the role of maintainer of varieties, as for example SEERAD currently undertake for potatoes.

This assessment has shown examples of the use of mixtures as farming strategy. Another important reason to legalise this aspect of landraces is that new landraces are emerging in participatory breeding programs in the organic sector. Elements of farming strategies known from past landraces are reformulated as new breeding objectives: the use of mixtures or populations as strategy to reduce disease and pest pressure, farmers selecting within these populations, according to their local needs and preferences. European-wide this approach is taken in the ECO-PB initiative, of which in the UK Elms Farm is a representative using composite cross populations of wheat. Although the starting point of this program is formal breeding, the outcome of the mixtures is going to be determined by farmers on the basis of the local 'new landraces[26]'. Another UK example of local seed activities linked with breeding for local adaptation is the Seed Development Project of the Biodynamic Agricultural Association, focused on Open Pollinated vegetable varieties.[27] Conventional varieties were used as the starting point in participatory selecting trials in The Netherlands for onions, carrot and wheat

[26] Dr. Martin Wolfe, Elms Farm, kindly made time to bring 'new landraces' to my attention.
[27] www.anthrop.uk

(Lammerts-van Bueren, 2001), which involved commercial growers and CGN. As an integral and necessary part of these trials, new protocols for VCU testing have been developed, tested and approved for organic wheat in the Netherlands (Lammerts-van Bueren, 2001). For some obsolete vegetable varieties, this may be a mechanism for re-listing. It is notable that a lack of vegetable varieties for the UK organic market has been observed in a recent study (Firth 2003).

The example of the Outer Hebrides indicated the importance and potential of agro-environmental schemes for the cultivation of landraces. In the new Rural Stewardship Schemes, which are going to be replaced the existing ESA schemes, explicit reference is made to the need to conserve the Machair. Having traditional and rare native animal breeds is build into the tier system with credits. However, the RSS has been criticized for being discretionary and favouring larger farms. Crofters feel disadvantaged since they have difficulty obtaining the necessary points (Custodians of Change, 2002, page 47). "Crofters and farmers in the Isles have low expectations of RSS; the current scoring system favours large, diverse holdings. Local agencies and NGO staff fear that many of the benefits of the ESA will be lost as farmers are forced to intensify or abandon uneconomic, labour intensive practices". Although the Scottish Executive emphasises natural and cultural heritage, there is no explicit reference to traditional crops as part of Scotland's cultural or natural heritage. The term 'agricultural heritage' may be coined for this purpose, combining both cultural and natural elements. A gap in current conservation thinking has been observed in biodiversity approaches (Gauchan, 2000), the agricultural dimension is missing in the current interpretation of biodiversity or the lack of an agro-biodiversity perspective.

The anthropomorphic character of many habitats and hence the human directed creation of biodiversity is often not translated into policy. Low-intensity agricultural practices play a significant role in nature conservation in other parts of Europe: 41 of the habitat types in Annex 1 of the Council Directive 92/43 EEC on conservation of natural habitats (habitats directive) are related to rural practices (Osterman, 1998). Traditional cropping for example of small oat, rye and barley on the machair has not been valued on its merits. Landraces pre-date the high-input agricultural era and in this quality fit in well with agricultural practices aimed at reducing inputs. The crediting of landraces within Countryside Stewardship Schemes in England and Wales and similar schemes in Scotland and Northern Ireland may form an alternative route to stimulate the demand side of landraces in the UK, an indirect way of marketing. Further study is needed to clarify the legal dimension of crops within agro-environmental schemes at EU and UK level. Opportunities to integrate these crops with CAP reform schemes as Land Management Contracts may be explored. Crediting landraces in the context of agro-environmental schemes such as Countryside Stewardship Schemes can provide resource efficient mechanisms to monitor landraces. An initial audit and annual inspection are already part of these schemes and reporting how many acres of landraces are grown will give a very accurate assessment of the number of farmers and the area on which landraces are grown[28].

The scope of the current assessment was restricted to a (desk-top) survey of forage and cereal landraces. As such the National Inventory is merely a starting point, there is a need for further desk study of other crop groups linked to field verification. For vegetable and arable landraces present on the National List further work would be required to assess their market position. The crop types with the highest number of landraces: fruits, vegetables and potatoes fell out of the scope of this assessment

[28] This idea was formulated by Mr. Henry Edmunds, Cholderton Estate Manager who combines years of experience in the cultivation of a forage landraces with Countryside Stewardship Schemes

and should be followed up on in order to achieve a comprehensive National Inventory. This assessment focused on quantitative aspects of extant landraces as areas of cultivation and number of farmers. For some of the landraces further documentation as to their identification, cultivation, processing and diversity will be necessary.

A full threat assessment analysis is necessary for extant landraces; both for those commercially available as well as those landraces managed 'on-farm'. No criteria have been developed as to which landraces to prioritise for conservation action. The generation of a Red List for plant genetic resources in general has been suggested, which would involve landraces (Eisele, 2002). Bere barley and Shetland Cabbage may form candidate varieties not only as a pilot study for the generation of Red List criteria for landraces but also for urgent conservation implementation.

4.8 Landrace Inventory Recommendations

R8 Comprehensive inventories of all extant UK landraces, particularly for fruits and vegetables which will likely yield the highest number of extant landraces, are urgently required as a prerequisite to their efficient conservation.

R9 Agricultural and socio-economic studies should explore the legislative and policy environment within which UK landraces are grown searching for so-called 'perverse incentives' that mitigate against continued cultivation, as well as investigating alternative uses and novel marketing opportunities. One suggestion for the maintaining of forage landraces would be to include landraces in conservation mixtures recognised within Countryside Stewardship Schemes.

R10 Gene banks or other public institutions should be encouraged to take the role of nominated landrace maintainer to ensure sustainable landraces diversity on the UK National List.

R11 The legal status and public accessibility of *ex situ* collections used for reference or genetic resources purposes by the national statutory testing centres associated with seed certification (NIAB, SASA and DARDNI) should be clarified and made compatible with conservation and use priorities.

R12 The possibility of transforming the UK National B-list, which already functions as a register for pre-1972 vegetable varieties and landraces, into a Heritage Seed List should be investigated. Existing DUS protocols need to be adapted to allow further landraces to be added to the National List.

R13 Current governmental support for breeding activities should be reviewed to take into account changes in breeding objective associated with non-industrial production, such as the organic, low input and alternative product sectors. In this context, adaptation of current VCU criteria for agricultural landrace varieties may be recommended.

R14 There is a need to review the traditional uses made of crops that are often associated with 'specialised niche' landraces, these landraces should be credited with Heritage Variety status and seed exchange for these landraces legalised.

R15 Diversity knowledge should be reviewed particularly for the most economically important UK landraces (i.e. notably cereals) and representative *ex situ* conservation of landraces diversity should reflect their pattern of diversity.

R16 To ensure continued cultivation of ancient cereal landraces, measures should be adopted to support crofting in general and cereal production by crofters more specifically. This should be linked to an exploration of widening marketing opportunities and/or the creation of local employment directly or indirectly linked to cereal production. One option would be to incorporate the cultivation of landraces into agro-environmental schemes as a means of safeguarding our living agricultural heritage.

R17 To support current farmers and growers of landraces and to encourage wider utilisation of landraces, the creation of a newsletter or nation-wide network of landrace growers is recommended to facilitate information exchange concerning landraces agronomy, current and alternative usage, seed supply and conservation.

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APPENDIX 1. Examples of Historical Vegetable Varieties On The National List.

Variety	Crop	Year Or Origin
Giant Zittau	Onion	1883
White Lisbon	Onion	1819 or before
Giant Rocca Brown	Onion	1860's
Red Italian	Onion	1879
Barletta	Onion	1897
Paris Silverskin	Onion	19th century
White Windsor	Broad bean	1729
Green Windsor	Broad bean	1835
Bunyard's Exhibition	Broad bean	1884
Masterpiece Green Longpod	Broad bean	1897
Imperial Green Windsor	Broad bean	Before 1800
Musselburgh	Leek	1834
The Lyon	Leek	1883
Mammoth Poth	Leek	1890's
Giant Red/ Manchester Red	Celery	1876
Golden Self Blanching	Celery	19th century
James Scarlet Intermediate	Carrot	1878
St. Valery	Carrot	1887
Chantenay Red-cored	Carrot	1890
Early French Frame	Carrot	19th century
Green Top Stone	Turnip	1877
Snowball	Turnip	1877
Purple Top Milan	Turnip	1885
Cheltenham Green Top	Beet root	1889
Burpee's Golden	Beet root	1828
Egyptian turnip Rooted	Beet root	1871
Cilindra	Beet root	1880's
Batavian Green	Endivie	1800
Green Curled	Endivie	1806
Broad leaved Batavian	Endivie	1824
White Curled	Endivie	1825
De Ruffec	Endivie	1863
January King	Savoy	19th century
Black Spanish Long	Radish	1717
Black Spanish Round	Radish	1768
White Turnip	Radish	1819
China Rose	Radish	1845
French Breakfast	Radish	1865
Scarlet Globe	Radish	1890
Little Marvel	Pea	1900
Sugar dwarf de Grace	Pea	1857
Gradus	Pea	1898

Little Marvel	Pea	1900
Veitch's Autumn Giant	Cauliflower	1874
Perpetual Spinach	Leaf beet	1790