ICELAND:

COUNTRY REPORT TO THE FAO INTERNATIONAL TECHNICAL CONFERENCE ON PLANT GENETIC RESOURCES

(Leipzig,1996)

Prepared by:

Thorsteinn Tómasson

Reykjavik, June 1995

Note by FAO

This Country Report has been prepared by the national authorities in the context of the preparatory process for the FAO International Technical Conference on Plant Genetic Resources, Leipzig, Germany, 17-23 June 1996.

The Report is being made available by FAO as requested by the International Technical Conference. However, the report is solely the responsibility of the national authorities. The information in this report has not been verified by FAO, and the opinions expressed do not necessarily represent the views or policy of FAO.

The designations employed and the presentation of the material and maps in this document do not imply the expression of any option whatsoever on the part of the Food and Agriculture Organization of the United Nations concerning the legal status of any country, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

Table of contents

CHAPTER 1
Introduction to Iceland and its Agricultural Sector

1.1 BASIC INFORMATION ABOUT ICELAND

Iceland is an island located in the North Atlantic ocean between Greenland and Norway. The country borders the Arctic Circle and covers an area of 103,000 square kilometres. The coast is very indented, except for the south, with a total length of roughly 6,000 kilometres. The country is mountainous with only about one fourth of the area below 200 metres. The climate is oceanic with relatively mild winters and wet and cool summers. The soils are characterised by their volcanic basaltic origin and are mostly loessial and organic.

Iceland was settled in the ninth and tenth century, mostly from the Scandinavian countries with some Celtic element, and the population is now around 260,000. Throughout the history of the country subsistence agriculture was the main industry, but during this century fishing has increased in importance and now forms the backbone of the economy.

Iceland	Km^2	%
Total area	103,000	100
Vegetation	25,000	24
Cultivated land	2,000	2
Glaciers	12,000	12
Lava fields	11,000	11
Lakes	3,000	3

1.2 AGRICULTURE

Agriculture in Iceland is mostly based on livestock production with sheep and dairy industry dominating the production. Recently horse breeding has increased in importance. The farming is based primarily on grass cultivation and grazing on the open range which constitutes most of the country, save for lakes and glaciers. The grazing has had a profound effect upon appearance of

the countryside and tolerance to environmental fluctuations. It is estimated that around one fourth of the country was covered with some form of forest or shrub vegetation at the time of settlement in the ninth century, but presently only one percent of the area is covered by birch. Soil erosion and loss of vegetation is the single most serious environmental concern facing the farming community.

The commercial farms, of which there are roughly 4,000, are mostly mixed dairy and sheep family operations. The average size of the farms is around 350 hectares, of which 35 hectares are cultivated hayfields. In addition to this most farms have access to large tracts of common grazing in the highlands.

1.3 SEED PRODUCTION AND SEED TRADE

Seed of long lived perennial grass species for the hayfields and annual species for green fodder production dominate the trade. Three to four commercial companies handle most of the volume. Plant breeding is carried out by the Agricultural Research Institute, a governmental institution. Timothy (*Phleum pratense*) and a few other species are used for the permanent hayfields, and the bulk of this seed is produced abroad, and so is all the seed of annual species. Bred Icelandic varieties are also grown for seed abroad.

There is a need for hardy grass species for the land reclamation work being carried out under very demanding conditions. For this purpose both indigenous and introduced species are being used. Some of these species and varieties are not commercially available. Seed production has, therefore been initiated in the country for these species.

In recent years the emphasis in plant breeding and seed production has shifted more towards leguminous and other nitrogen fixing species. Most of these species have been introduced but the use of indigenous species is also being developed.

1.4 PLANT SPECIES USED IN AGRICULTURE AND LAND RECLAMATION 1994

Species	Amount of seed tons	No of varieties	
		Local	Introduced
Perennial grasses			
Phleum pratense	14	2	
Festuca rubra	27	1	
Poa pratensis	26		2
Deschampsia spp.	10	1	1
Leymus arenarius	20	x	
Others	28		x
Legumes			
Lupinus nootkatensis	7	x	
Trifolium spp.	0,3		2
Grain crops			
Hordeum vulgare	109		7
Avena sativa (greenfodder)	53		4
Animal fodder crops			
Annual grasses	54		5
Dicotyl. fodder crops	9		5
Potatoes	1,300	1	5

Vegetables are grown for domestic consumption. With the exception of Swedes (*Brassica napus* var. *naprobrassica*) all seed is imported and of foreign origin. Greenhouses, heated by geothermal water, cover about 18 ha. This area is about equally divided on ornamental crops and on tomatoes, cucumbers, paprika and a few other crops for human consumption.

1.5 TRENDS IN PLANT PRODUCTION AND BREEDING

Productivity in Icelandic agriculture increased considerably during the decades following the second world war, resulting in overproduction of most commodities in the seventh decade and onwards. This development was made possible by the availability of commercial fertilisers and by bringing new land into cultivation. In most districts this was to a high degree based on drained boggy areas, and the drainage exceeded the needs for cultivation. The natural

rangeland did not sustain the increased stocking following the easy procurement of winter fodder. Sustainable use of the natural rangelands and the introduction of quota system in both the dairy and sheep industry have been developed.

Simultaneously, a popular movement for land reclamation and afforestation has arisen. Research and plant breeding have been focused to a considerable degree towards this task, supported by seed production. Large efforts have been put into the introduction and adaptation breeding of both ligneous and herbaceous species. Especially, the plant introduction work has given considerable success, with many new species coming into cultivation. Recently, the value of plant introduction has become increasingly debated on environmental and ethical grounds.

CHAPTER 2
Indigenous Plant Genetic Resources

2.1 THE ICELANDIC FLORA

The position of Iceland as an island in the North-Atlantic Ocean, rather far from any continent and other islands, has been a substantial hindrance for the natural colonisation of many plant species after the glaciations. The Icelandic Flora has only about 485 species of vascular plants which is far less than expected on the grounds of growing conditions alone. A number of species, perhaps 100-200, may have survived the glaciation which was not complete. Others have immigrated naturally, and it is expected that around 130 have been brought by man, either intentionally or as weeds. The early introductions have included forages, medicinal plants, vegetables and spices. The introductions have been most active during the first centuries of inhabitation and in modern times. They have included new forms of naturally introduced species. A number of the most recent successful introductions have not been included in the Flora as counted above.

Nonvascular plants have been of considerable importance in the past and are of potential interest for the future. Best known is the lichen Iceland moss (*Cetraria islandica*) which has been used as food and for medical purposes, but several other lichens and sea weeds are also of interest.

2.2 UTILIZABLE PLANT RESOURCES

Forages

The most important species that grow on Icelandic hayfields are the following:

	Mean percentage cover
Poa pratensis	28
Deschampsia caespitosa	15
Phleum pratense	13
Agrostis spp.	13
Festuca rubra	11

	Mean percentage cover
Poa annua	8
Alopecurus pratensis	4
Dicotyledons	5
Other species	3

The majority of fields are more than ten year old. *Phleum pratense* was introduced during the past century and is the most widely sown grass species. However, it often gives way in the competition with other species, both sown cultivars and naturally invading indigenous grass species. Hence, the haymaking relies heavily on domestic grasses. This has prompted the interest for selection and breeding in these species. The noncultivated fields are widely used for grazing. Earlier, extensive natural meadows were also used for haymaking. Of particular importance were low lying seasonally inundated meadows with *Carex* species especially *C. lyngbyei* as the dominating vegetation. They are still of interest as reserves if the grass growth on cultivated fields fails.

Wild species of economic value and wild relatives of crop plant

The bulk of the naturally occurring species are of value indirectly through their contribution to the grazing value of the land. Very few wild species have been utilised directly by man and these do not seem to be in any imminent danger through genetic erosion. Historically the following species were the most important plants for human consumption:

Angelica archangelica
Rumex longifolius
Rumex acetocella
Cochlearia officinalis
Vaccinium uliginosum
Vaccinium myrtillus
Empetrum nigrum
Cetraria islandica
Rhodymenia palmata

The use of wild plants for dyeing was highly developed, making use both of vascular plants and lower plants such as lichens.

Leymus arenarius, a distant relative of wheat, used to be harvested for the grain and also root fibre. Possibly valuable traits like drought resistance and tillering capacity could be of value in relation to wheat breeding programmes.

2.3 TREES AND FORESTS

The native tree species are downy birch (*Betula pubescens* Ehrh.), mountain ash (*Sorbus aucuparia* L.) and aspen (*Populus tremula* L.) It is unclear whether or to what extent these species survived the glaciations in Iceland. Activities aimed at conserving the remaining stands of native species have been carried out by the Iceland Forest Service. From the beginning, the aim of these activities has been dual; (i) to conserve genetically unique forest tree populations, and (ii) to conserve woodland ecosystems. However, there are no policies or guidelines for preventing possible "gene contamination" in the native species, e.g. planting of non-native sources within or in the vicinity of natural woodlands.

CHAPTER 3
Conservation Activities

The national efforts for preservation of plant genetic resources for food and agriculture are centered around the Nordic Gene Bank, and the national program of Iceland is fully integrated into its program.

3.1 THE NORDIC GENE BANK

The Nordic Gene Bank (NGB) was officially established January 1, 1979 as a joint Nordic undertaking. It reports to and is funded by the Nordic Council of Ministers (NMR), an executive assembly to promote cooperation among the Nordic countries: Denmark, Finland, Iceland, Norway and Sweden. Its headquarters are in Alnarp, southern Sweden.

The NGB is responsible for carrying out projects relating to the use of genetic resources in the member states. The NGB represents the Nordic countries in international cooperation of direct use for the institute. It is also trusted to carry out projects which are funded by external sources. The NGB collaborates on matters relating to the Convention on Biological Diversity.

The work of NGB is organized in six permanent internordic groups and coordinates several time limited plant breeding projects. Iceland participates actively in the permanent working groups on: Forage plants, Potato, Vegetables and Roots. The Icelandic members of the NGB Board of Trustees and the working groups constitute of the Icelandic gene bank committee.

The NGB mandate is to preserve, document and encourage utilization of genetic diversity in Nordic agricultural and horticultural plants and their wild relatives, and to distribute both material and information freely to plant breeders, plant scientists and other *bona fide* users.

NGB has a general strategy stating that:

- the activites of NGB shall always be consistent with the convention, as will other international commitments concerning plant genetic resources;
- the primary aim of NGB is to be a prominent Nordic centre in the global network for the conservation and use of plant genetic resources;

- NGB takes a long-term responsibility for the conservation of Nordic material of the mandate species;
- NGB considers as Nordic material, besides material growing in the wild in the Nordic countries, modern varieties produced in the Nordic countries by Nordic breeders as well as all other material produced by Nordic researches and breeders;
- NGB will, in accordance with article 8 in the Convention, investigate if and how far *in situ* conservation of wild growing material may complement or replace the *ex situ* conservation and in the cases it can apply, NGB will cooperate with the national authorities for nature conservation;
- NGB will continue to increase and improve the information on the material stored, through initiating, taking part in and financing projects aiming at description of the material;
- NGB is a Nordic information centre regarding plant genetic resources, making available information on the material in its collection, as well as material in international collections, including general information on plant genetic resources, so called non-accessional information;
- the material and information of NGB shall be freely available, without restrictions, as long as this in accordance with the interpretation of the Convention on Biological Diversity made by the Nordic countries;
- NGB will be an important resource for the Nordic countries in the transfer of knowledge and technology to developing countries.

Ex situ collections

In *ex situ* conservation, the organism or parts of it such as seeds, tubers, etc. are removed from the original habitat and transferred to a gene bank. The collected material constitutes an accession which, in the case of whole organisms, may be planted in clonal archives or, in the case of seeds, stored under suitable conditions.

NGB preserves currently in *ex situ* less than 100 species and stores as seeds the following total number of accessions:

- The ordinary collection: 8,667 accessions
- Special seed collection (genetic stocks): 15,574 accessions
- Safety Base Collection: 3,780 accessions
- Duplicates for other gene banks: 3,102 accessions

Of vegetatively propagated crops NGB stores: onions: 10; rhubarb: 243; potato, long-term: 49; potato, pending: 43; fruits and berries: 2,856.

Icelandic seed material preserved in the Nordic Gene Bank (number of accessions)

Species	Varieties	Landraces	Wild	Breeding lines	Total
Cereals					
*Leymus arenarius**	0	0	22	0	22
Forage plants					
Agrostis capillaris	0	0	25	0	25
Deschampsia caespitosa	2	1	2	0	5
Festuca pratensis	0	1	0	0	1
Festuca rubra	0	0	70	4	74
Phalaris arundinacea	0	1	0	0	1
Phleum alpinum	0	0	0	1	1
Phleum pratense	1	1	0	0	2
Poa pratensis	0	0	84	6	90
Forage plants, total	3	4	181	11	199
Root, Oil & Pulses					
Brassica napus napobrassica	0	11	0	0	11
Potatoes					
Solanum tuberosum	0	1	0	0	1
Total	**1**	**16**	**203**	**13**	**233**

* **This collection is also conserved *in situ* in Iceland and has 25 entries altogether.**

3.2 OTHER COLLECTIONS OF DOMESTIC PLANT RESOURCES

Species of economic importance have repeatedly been collected within the country. Some of these collections have been partly included in the collections of the NGB as tabulated above. Collections that have not been conserved include other collections of some of the same species such as *Phleum pratense, Deschampsia caespitosa*. Collections that are currently available include:

	No. of genotypes/populations
Phleum pratense	22
Alopecurus pratensis	100
Trifolium repens	334
Trifolium pratensis	62

	No. of genotypes/populations
Anthyllis vulneraria	7
Lathyrus japonicus	13
Lathyrus palustris	5
Lathyrus pratensis	10
Vicia cracca	23
Vicia sepia	5

3.3 FOREIGN INTRODUCTIONS

Icelandic agriculture has relied heavily upon plant introductions for agricultural production as well as land reclamation purposes. The introductions have been most extensive for forests and amenity. Many of the introduced plants have the potential to become or have already become permanent members of the Icelandic Flora. The great majority of introductions however, has not become established. The introductions have mostly come through contacts with plant breeders and research institutes. Several expeditions have collected forest trees, amenity species and agricultural plants in areas at similar latitudes with comparable climate to that of Iceland.

The botanical gardens in Akureyri in the north of the country and Reykjavík in the south acquire seeds from foreign expeditions that are made available through seed lists. The botanical gardens in Iceland likewise make seedlists themselves for distribution within the country and in their exchange with foreign botanical gardens. Included in this seed distribution are seeds of foreign introduced plants as well as seeds of cultivated indigenous species and seeds collected in nature.

3.4 CONSERVATION OF WILD RESOURCES

The law on natural conservation provides a legal basis to conserve wild plant resources. There are three national parks in the country. There is a long list of other areas and locations with varying degree of protection, some of which are protected for their vegetation. There are 31 species that are threatened to become extinct and are totally protected for any kind of destruction.

The neighbourhood of hot springs is a habitat with several rare species that is particularly vulnerable, for natural changes as well as for human activities harnessing this very valuable source of energy.

The semipermanent nature of Icelandic hayfields implies that the natural genetic resources of forage plants, the currently most important culture plants, are not in general in risk of becoming extinct. There is a risk, however, that monocultures for land reclamation purposes and forest plantations may eliminate rare species in certain areas.

3.5 CONSERVATION OF WOODLANDS

As regards the need for gene conservation of forest trees, Iceland´s situation is relatively unique among the European countries. The native tree species are few, and the continued viability of the country´s forests and of its forest sector is very much dependent on gene conservation of these introduced species in their native habitats (*in situ*), as well as the maintenance of viable breeding populations outside their native distribution (*ex situ*).

During this century, numerous conifer and broadleaved species have been introduced and some have proven successful in Iceland. Afforestation programs have been based mainly on the cultivation of *Larix sibrical, Picea abies, Picca sitchensis, Picea glauca* and *Pinus contoral*. These species are planted for purposes such as land reclamation, amenity and wood production, and are often planted in mixture with the native species.

The Iceland Forest Service Research Station administers the import of forest regenerative material of exotic species and manages gene banks of native and exotic species. Records are maintained of the exact origin (provenance) of afforestation material and on the stand history. For introduced species, precommercial and commercial thinning is generally carried out in ways compatible with the aims of gene conservation.

In recent years, forestry, based on the cultivation of northern Russian sources of *Larix sibrica,* has replaced traditional forms of land-use in some regions of the country. Unfortunately, the demand for Russian larch seed far exceeds the supply. One reason is the disappearance of much of the larch stands in North Russia, owing to the encroachment by competing species. This highlights the fact that conservation on forest genetic resources is an international problem, and must be dealt with by cooperation across national/political boundaries.

CHAPTER 4
In-Country Uses of Plant Genetic Resources

Forage crops

Varieties of forage crops sown to establish hayfields were originally of foreign origin only, although naturally invading grasses in reality constitute more than a half of the sward. Grass seed for amenity purposes is all imported, although some varieties may be partly of Icelandic origin. In the latter half of this century selections from collections of genotypes within the country have produced new varieties. In some cases, such as for timothy, the genotypes derive from earlier plantings and are better adapted than the original seed. For some species the seed has to be grown abroad, and for others the use of domestic varieties has been hampered by difficulties in seed production.

Recently, breeding and breeding research for northern areas of the Nordic countries has been carried out in cooperation among the countries, sponsored by the NGB. The participating countries, Finland, Iceland, Norway and Sweden, have provided their breeding lines into the program, and Denmark has participated for the production of seed. Lines from Greenland have also been included. This cooperation has now been extended to include red and white clover (*Triofolium pratense* and T. *repens*).

Land reclamation

Land reclamation is now to a high degree based on domestic production of seed, although about a half of the grass seed sown is still imported. Continuously new species and varieties are being tested for this purpose. Some of the imported seed, such as *Lolium* spp., is early establishing and is used to provide temporary cover only while a more hardy vegetation becomes established. The approximate seed production is as follows annually:

Leymus arenarius	20 tn
Deschampsia caespitosa	1 "
Deschampsia beringensis	8 "
Festuca rubra	1 "
Lupinus nootkatensis	7 "

Two of these species, *Deschampsia beringensis* and *Lupinus nootkatensis,* are introductions from Alaska and have been included in breeding programs. In the lupine the breeding aim is among others to develop sweet lupines, and interspecific crosses are being attempted. The seed production of *Leymus arenarius* is from natural populations only. Breeding research which also includes foreign populations of *Leymus mollis* is in progress. The seed production of *Deschampsia caespitosa* and *Festuca rubra* is of selected Icelandic varieties. Presently the emphasis in research is on nitrogen fixing plants, based on recent expeditions especially within Iceland and in Norway, but also some accessions derive from collections from Alaska, eastern Siberia and some other regions.

Cereals

Breeding projects in *Hordeum vulgare* are partly based on two land races. *Leymus arenarius,* a distant relative of wheat, used to be harvested for the grain and the root fibre. Possibly valuable traits like drought resistance and tillering capacity could be of value in relation to wheat breeding programmes.

CHAPTER 5
National Programmes

The national programme is integrated into the strategy and work programme of the Nordic Gene Bank. The national Gene Bank committee linked to the NGB is the forum for discussions and planning in this field.

5.1 GOVERNMENT INSTITUTIONS AND TRAINING

Research on plant genetic resources including plant breeding is primarily carried out at the Agricultural Research Institute. The National Conservation Board is responsible for the monitoring of the natural Flora and issues a list of species and habitats that are considered threatened. There is no formal contact between these two bodies but will soon be established.

Funding of these tasks is within the budget of these institutions.

At the University of Iceland and the Agricultural College of Iceland education leading to B.Sc. in biology is offered including courses in genetics and ecology, but no specific courses in plant breeding or genetic resources are offered. Presently master programmes in cooperation with the research institutions open the possibilities for training in this field. Education and training in the field of plant genetics and breeding has therefore been sought at universities in other countries. There is a very close cooperation among the five Nordic countries in graduate training in the field of plant genetics and breeding and the staff of the NGB has been involved in the joint Nordic courses arranged in the programme. These Ph.D. courses have therefore become an important venue for information on the work programme of the NGB.

Icelandic students have also studied plant genetics in other European countries and in the United States.

CHAPTER 6
International Collaboration

Iceland has ratified the convention on Biological Diversity, and currently work is under way on the Country Action Plan.

Through its participation in the NGB Iceland now takes part in the ECP/GR.

Also in cooperation with the other Nordic countries the Icelandic Development Agency ICEIDA participates in the development of a regional Gene Bank of the SADC countries in southern Africa where NGB acts as a management consultant of the project. Similarly the NGB acts as a vehicle for cooperation with the Baltic countries which aim at developing a joint regional Gene Bank.

CHAPTER 7
National Needs and Opportunities

Plant genetic resources in Iceland are on the whole not considered to be in much danger from genetic erosion or en-ven extinction, except species that have always been rare in the country. Preservation of land races and bred grass varieties is taken good care of within the work programme of the NGB. The number of species in the country is unexpectedly small, due to the isolation of the country after the ice age. Numerous successful plant introductions of plant varieties and species indicate the need and value for Iceland of free and unhindered access to plant genetic resources in other regions. This applies both to new species of potential value as well as new genetic material of already acquired species for use in breeding programmes for increased adaptation as well as superior characteristics.

Special care has to be taken though in the introduction work to avoid species with undesirable characteristics. Also, vigorously competitive species may threaten habitat and plant association that are considered to be of specific conservation value.

CHAPTER 8
Proposals for a Global Plan of Action

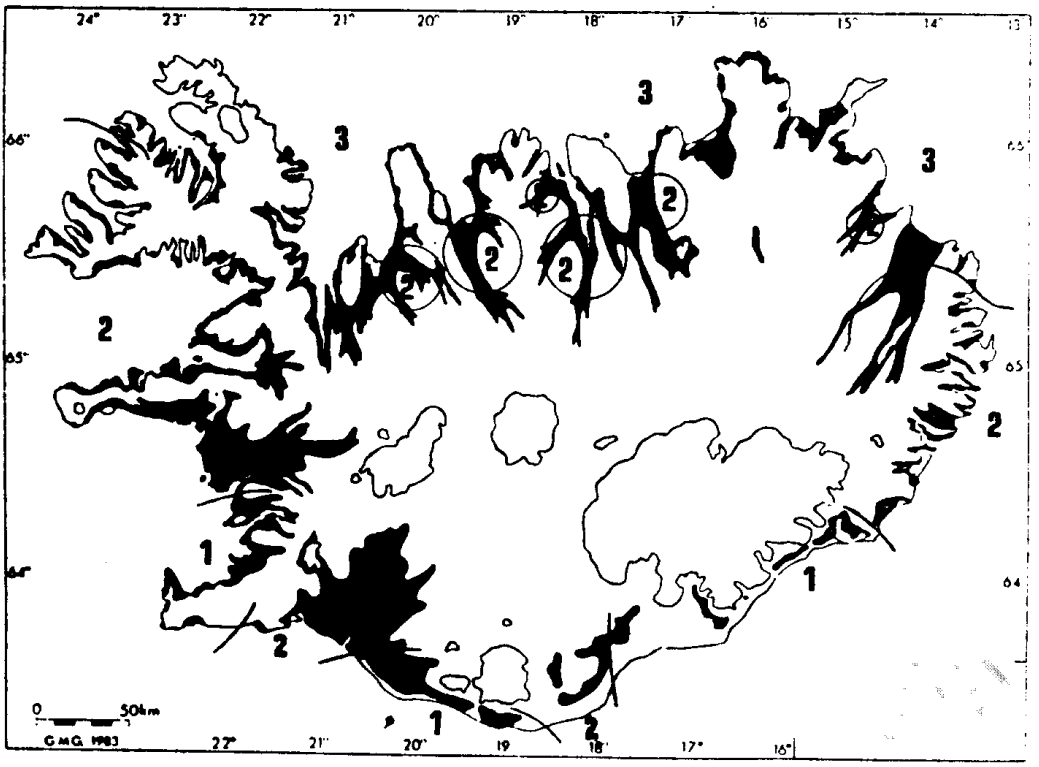
Through the strengthening of the Nordic Gene Bank and intensification of the regional work the Nordic countries are better qualified to play an active role in the international network. A global plan of action has to be based on cooperation of regional centers. In the first hand the NGB should therefore concentrate on developing contacts and cooperative projects in the near lying regions such as the Baltic states and Russia.

It is of clear interest to Iceland to have as free an access to plant genetic resources as possible due to the need for improved plant material for cultivation as well as land reclamation. Soil erosion is a serious problem and it is of great interest to be able to freely collect and try new species and provenances within species for these purposes in Iceland.

The Gene Banks should be operated in such a way that information on material stored is freely accessible through modern computerized information systems like the Internet.

GROWING ZONES IN ICELAND

(Inhabited parts of the country are shaded in black)



Zone	Growing condition
1.	Barley matures in 8 of 10 years
2.	Barley can be grown on favored sites. The zone contains the main vegetables growing area. Potatoes are grown on sandy soils in this zone and zone No 1. The best forestry areas are in this zone.
3.	Marginal growing zone, only hay and green fodder for animal production.