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PRESENT STATUS OF AGROBIODIVERSITY AND GENETIC RESOURCES IN THE BEKA' DRYLANDS

-HERBAL SPECIES-

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PROJECT ON CONSERVATION AND SUSTAINABLE USE OF AGROBIODIVERSITY IN THE DRYLANDS

UNDP/GEF AGROBIODIVERSITY PROJECT
LEBANESE AGRICULTURAL RESEARCH INSTITUTE

Contents

I. Site Selection and Agro-Ecological Zoning

I.1. Biodiversity survey

A number of field visits were undertaken by a multidisciplinary team of national and international experts, to several potential target areas in an attempt to select the best sites for the project. In general, agro-ecological zoning is based on temporal information, spatial information, lithosphere information, climate, community type, and habitat diversity. The decision, made after further deliberations with other consultants, the national project coordinator and the national project manager, was based on the following specific criteria:

1. Selected areas had to be within the Beka' region.
2. Selected areas had to be under semi-arid climatic conditions.
3. Based on physical inspection, selected areas should contain some or all of the target species outlined in the project proposal, whether domesticated or wild.
4. Selected areas had to be diverse in terms of micro-environmental conditions such as vegetation cover, altitude and slope, and have a diversity of agronomic practices implying a high potential agro biodiversity.
5. Selected areas had to be good representatives of the Beka' drylands.

Based on the above criteria, several sites were visited and inspected, and the following sites were selected:

1. Ham and Maaraboun (thereafter referred to as the Ham main site), with an approximate area of 35 km^2.
2. Nabha, Kalile, Iaat and Bishwat (thereafter referred to as the Nabha main site), with an approximate area of 45 km^2.
3. Irsal, with an approximate area of 300 km^2.

The detailed agro-ecological zoning of the area required further thorough studies on soil types and vegetaion cover that are being conducted by the soil and taxonomy consultants to the project. However, and in order to initiate the basic botanical survey of the selected target areas, these areas were divided into agro-ecological zones, based on the criteria of classification of IPGRI into the following:

Forest	Wooded grassland
Arable land	Grassland
Wasteland	Woodland
Shrubland	

II. Area Vegetation and Sampling Methodology

II. 1. Background information on vegetation characteristics in the area under study

The combination of precipitation, temperature ranges and physiography has contributed to the formation of a number of vegetation-soil-climate groups. The area's vegetation mainly falls under the pre-steppic group of vegetation (the other being the Mediterranean group). As is obvious from precipitation records as well as through inspecting the area, it is an area of limited water due to low annual precipitation, with relatively wide extremes in seasonal as well as diurnal temperatures. The characteristic vegetation of the area is mainly shrubs and annuals, and a limited number of dispersed trees, depending on location, and sometimes concentrated within well-defined areas. One distinguishing feature is the almost complete absence of conifers, abundant on the western slopes and other areas of Lebanon. Consequently, the overall landscape does not resemble that of a forest, but rather leaves the impression of being bare. Theseare very fragile systems, even more so because they are usually grazed intensively during Spring and, to a lesser extent, in Autumn.

Expected plant species in this area differ according to elevation and precipitation, with roughly three distinct zones being observed. The first includes the highest elevations down to about 1,700 m, the second is from 900 to 1,700 m , and the last, the Beka'a plain with an average elevation of 900-1,000 m. Within each zone, differences occur based on physiography and to a geater extent, water availability. Some of the more common species include (Mouterde, 1966; Post, 1933; and Van Slageren, 1994):

Acer hermoneum	*Aegilops biuncialis*	*Aegilops caudata*
Aegilops columnaris	*Aegilops cylindrica*	*Aegilops ovata*
Aegilops triuncialis	*Aegilops umbellulata*	*Aegilops vavilovii*

Amygdalus korschinskii	*Amygdalus orientalis*	*Asphhodelus microcarpus*
Astragalus coluteoides	*Avena alba*	*Avena sterilis*
Bromus tomentellus	*Carex stenophylla*	*Carthamus flavescens*
Cerasus prostrata	*Cicer species*	*Cratagus azarolus*
Dactylis glomerata	*Erodium romanum*	*Festuca valesiaca*
Ficus sp.	*Hordeum bulbosum*	*Hordeum ochroleuca*
Hordeum spontanum	*Juniperus excelsa*	*Lathyrus species*
Lolium perene	*Medicago radiata*	*Medicago rigidula*
Medicago rugosa	*Other Medicago sp.*	*Noaca mucronata*
Onobrachis cornuta	*Ononis natrix*	*Pistacia atlantica*
Pistacia palestina	*Poa bulbosa*	*Poa diversifolia*
Poa libanotica	*Poa sinaica*	*Poterium spinosum*
Poa tomoleontis	*Prunus microcarpa*	*Prunus prostata*
Pyrus syriaca	*Quercus calliprinos*	*Quercus infectoria*
Rhamus libanotica	*Scandix iberica*	*Trifolium pilulare*
Trifolium stellatum	*Other Trifolium sp.*	*Triticum boeoticum*
Triticum dicoccoides	*Triticum turgidum*	*Triticum urartu*
Vicia angustifolia	*Vicia ervilia*	*Vicia hybrida*
Vicia narbonensis	*Vicia villosa*	*Other Vicia sp*

II.2. Commonly used sampling methodologies[1]

II. 2. a. Plot Sampling

The plot sampling method is a common and basic method for sampling many types of organisms. A *plot* is generally a rectangle or a square, but circles or other shapes can be used. In plot sampling, one takes a manageable area of known size and identifies, counts and often measures all individuals within it. This sampling procedure is then repeated (*replicated*) for a number of plots to obtain an adequate representation of the population or community. The plot method is most widely used for sampling land plants.

1 Adapted from Brower et al., 1977.

For sampling plants, rectangular plots have been found to yield better results than other shapes; a rectangle with sides in a 1:2 ratio usually is the best.

For closely spaced herbaceous vegetation: use rectangular plots, 1 m^2 (0.71x1.41m).

For bushes, shrubs, and saplings up to 3-4 m tall: use 10 m^2 plots (2.24x4.47m).

For forest trees over 3-4 m high: use 100 m^2 (7.07x14.14 m).

Adjustment of these areas can be made based on *species-area curves* and *performance curves.* The location of each plot should be determined either by a grid or other systematic method, or by any random procedure.

Data and Calculations:

i. **Density** (D) is the number of individuals in a unit area:

$$D_i = \frac{n_i}{A}$$

where D_i is the density for species i, n_i is the total number of individuals counted for species i, and A is the total area sampled. *Relative species density* (*RD*) is the number of individuals of a given species (n_i) as a proportion of the total number of individuals of all species (Σn):

$$RD_i = \frac{n_i}{\Sigma n}$$

ii. **Frequency** (*f*) is the chance of finding a given species within a sample:

$$f_i = \frac{j_i}{k}$$

where f_i is the frequency of species i, j_i is the number of samples in which species i occurs, and k is the total number of samples taken. **Frequency is highly dependent on the size and shape of the plots used**. *Relative frequency* (*Rf*) is the frequency of a given species (*f*) as a proportion of the sum of the frequencies of all species (Σf):

$$Rf_i = \frac{f_i}{\Sigma f}$$

iii. **Coverage** (*C*) is the proportion of the ground occupied by a vertical projection to the ground from the aerial parts of the plant:

$$C_i = \frac{a_i}{A}$$

where a_i is the total area covered by species i (estimated by basal area, foliage area, or basal coverage), and A is the total habitat area sampled. The *relative coverage* (RC_i) for species i is the coverage for that species (Ci) expressed as a proportion of the total coverage (TC) for all species:

$$RC_i = \frac{C_i}{TC} = \frac{C_i}{\Sigma C}$$

where ΣC is the sum of the coverages of all species.

iv. The sum of the above three relative measures for species i is an index called the **importance value** (IV_i):

$$IV_i = RD_i + Rf_i + RC_i$$

The value of IV may range from 0 to 3.00 (or 300%). Dividing IV by 3 results in a figure that ranges from 0 to 1.00 (100%), and this is referred to as the **importance percentage**. The importance value, or the importance percentage, gives an overall estimate of the influence or importance of a plant species in the community.

II. 2. b. Transect sampling

In some types of vegetation, the use of plots may be impractical and time-consuming. Transects are useful in these instances and are especially advantageous and efficient in studies of contiguous stages in ecological succession or of communities at transition zones.

i. A **belt transect** is a long strip of terrain in which all organisms are counted and measured. Knowing the width and length of the transect, one may use the computational procedures of plot sampling, considering the belt transect to be a very long rectangular plot. In addition, the belt may be divided into intervals representing zones to be studied, and each interval may be treated as a plot.

ii. Another transect method used mainly by plant ecologists is the **lineintercept technique**. Data are tabulated on the basis of plants lying on a straight line cutting across the community under study. For line intercept sampling, extend a wire or measuring tape to mark the line between two points. The line may be 10, 25, 50, or 100 m long, with the longer transects useful for more widely spaced organisms. Mark

off 1-, 5-, or 10-meter intervals on the line, using larger intervals for communities consisting of widely spaced individuals. Each interval will be treated as a separate unit of the transect. For counting plants, count all individuals that are intercepted within a 1-cm strip of the line. Include also those plants whose aerial foliage overlies the transect.

If the objective of transect sampling is to determine species composition in a given habitat then the directional orientation of thetransect should be determined by connecting two randomly selected points in the community to be studied. If, however, the specific desire is to study a community transition or some ecological gradient then the transect length should be oriented along that transition or gradient. *Several replicate transects should be used in the same study area.*

Coverage data collected from sampling plants by the line-intercept method differ from those obtained from plots or belt-transects. In line intercept sampling, the measurement of **intercept length** (or intercept distance) is used to estimate coverage. This length is that portion of the transect length intercepted by the plant measured at or near the base of the plant or clump of plants, or by a perpendicular projection of its foliage intercepted by the line.

a. For a given species, *i,* the **linear density index**(ID_i) is calculated as:

$$ID_i = \frac{n_i}{L}$$

where n_i is the total number of individuals of species *i* collected, and L is the total length of all the transects sampled. The species' relative density (RD_i) is:

$$RD_i = \frac{n_i}{\Sigma n}$$

where Σn is the total number of individuals counted for all species.

b. The **linear coverage index** (IC_i) for a species is:

$$IC_i = \frac{l_i}{L}$$

where l_i is the sum of the intercept lengths for species i (i.e. the total length of the transects intercepted by the species). The relative coverage of species $i(RC_i)$ is:

$$RC_i = \frac{l_i}{\Sigma l}$$

where Σl is the sum of the intercept lengths for all species.

c. The **frequency** of species i is defined as:

$$f_i = \frac{j_i}{k}$$

where j_i is the number of line-intercept intervals containing species i, and k is the total number of intervals on the transects. The relative frequency of species i (Rf_i) is:

$$Rf_i = \frac{f_i}{\Sigma f}$$

where Σf is the sum of the frequencies of all species.

d. As discussed earlier, the **importance value** of species i is:

$$IV_i = RI_i + RC_i + Rf_i$$

In the line-intercept method, the probability of being sampled is dependent on the size of the plant. A large rare plant is more likely to be detected than a small rare plant. Large dense species will appear more frequently than small dense species.

II. 2. c. Point-quarter sampling

The plot method of sampling is often very laborious and time-consuming, and results are dependent on the size, shape, and number of plots used. Plotless methods have been devised to reduce such problems. The most popular plotless method for plant analysis is *the point-quarter* or *quadrant* method. The accuracy of the point-quarter method is sensitive to departures from a random distribution of individuals, especially if only a small number of individuals are counted. Thus the method **should not** be used for populations with either highly *aggregated* or *uniformly* spaced individuals. An aggregated population will give an underestimate of density, while a uniform population will tend to give an overestimate. Distribution pattern, however, may be less

important when using a modification of the point-quarter method called *"wandering-quarter"* sampling.

The procedure of the point-quarter method differs to a certain degree from the previous methods. First select a number of randomly determined points. These points may be set randomly through the entire stand or randomly along a line transect running through it. Each point represents the center of four compass directions (N, S, E, W), which divide the sampling site into four quarters or quadrants. In each quadrant measure the distance from the center point to the center of the nearest individual, *regardless of species.* Only one plant per quadrant is measured so that a total of four plants are recorded for each point sampled. Identify and record the area covered by that plant. If plants are widely or non-randomly spaced, then the point quarter method should not be used since the same plant may be counted more than once. If the centers of two plants are fairly close, be sure to measure the distance of both, note the smaller distance, and record that smaller distance from the center point.

This procedure may be modified to determine the density of single species by measuring the point-to-plant distances in each quadrant for that species only, assuming that random distribution is still maintained.

A variation of point-quarter sampling, the wandering-quarter method appears to be independent of distribution pattern. A line transect is set up, and a starting point near the beginning of the transect is selected at random. With the aid of a compass, set up one quadrant (90° angle) with the transect line bisecting the angle. Then measure point-to-plant distance of the nearest plant in that quadrant, identify the plant, and estimate coverage. This plant then serves as the apex of a new quadrant whose angle is bisected by a line running parallel to the transect. Repeat this procedure until you reach the end of the transect.

Calculations for the point-quarter and the wandering-quarter methods are the same, except that frequency calculations do not apply to the latter method.

a. The **mean density per unit area** is estimated as follows:

$$\bar{d} = \frac{\Sigma d_i}{\Sigma n}$$

where *d-bar* is the mean point-to-plant distance, d_i is the point-to-plant distance for individual number *i*, and Σn is the total number of individuals measured. The mean area in which a single plant occurs is equal to the mean distance squared. Then:

$$\bar{A} = \bar{d}^2$$

where $\bar{A}$ is the mean area per plant. $\bar{A}$ is the inverse of the total density (*TD*), the total number of individuals of all species per unit area such that:

$$TD = \frac{u}{\bar{A}}$$

where *u* represents the number of area units to be used in expressing density. If the mean area per plant ($\bar{A}$) is in terms of square meters, and the desired number of area units is one square meter, then $u = 1$ and $TD = 1/\bar{A}$, the units of $\bar{A}$ are square meters, and the units for *TD* are numbers per square meter. If the unites $\bar{A}$ are square meters, and it is desired to compute density on the basis of 100 square meters, then *u* is 100 and $TD = 100/\bar{A}$ will be an expression of numbers per 100 square meters.

b. The **relative density** (*RD*) for each species is calculated as:

$$RD_i = \frac{n}{\Sigma n}$$

where n_i is the number of individuals of species *i* counted, Σn is the total number of individuals of all species counted, and RD_i is the relative density of species *i*.

c. The **absolute density** (*D*) for species *i* is:

$$D_i = (n_i/\Sigma n)(u/\bar{A})$$

d. **Frequency** for a given species is estimated in a similar manner as in plot sampling:

$$f_i = \frac{j_i}{k}$$

where *fi* is the frequency of species *i*, *j* is the number of sampling points at which species *i* was counted, and *k* is the total number of points sampled. The relative frequency of species *i* (Rf_i) is:

$$Rf_i = \frac{f_i}{\Sigma f}$$

where Σf is the total of frequencies for all species.

e. **Coverage** for species *i* (*Ci*) is estimated from the sum of the areas covered for that species and the species density:

$$C_i = (a_i)(D_i)/n_i$$

where a_i is the sum of the foliage coverages, basal areas, or basal coverages, for species*i*, *Di* is the density of species, and n_i is the total number of individuals sampled of that species. *Relative coverage* for species *i* is:

$$RC_i = \frac{C_i}{\Sigma c}$$

where Σc is the total coverage or basal areas for all species.

The **importance value** can then be calculated as previously discussed.

II. 3. Selected sampling methodology

From each target main site a number of sampling sites (or subsites) were randomly chosen based on existing maps (1:20,000 scale). On these maps 1 km^2 grids were drawn and each was further subdivided into four equal sub-grids. A total of thirteen sites from Nabha and 14 sites from Ham were surveyed, while no survey was done in Irsal because of time restrictions of the project staff. These selected random sites together constituted about 10% of the total area of each main site. In addition to the random sites, more sites were non-randomly chosen (referred to hereafter as "selected" sites) because they contained high target species richness and density. These sites were identified by the Project staff and consultants to be later used as monitoring sites for Project activities (Tables A1 and A2, Appendix). The result was three selected sites from Nabha and five selected sites from Ham. All sites were sampled using a **modified plot sampling technique**, and the effective sampling area was 1 hectare. Additionally, to determine the presence of species regardless of distribution in a single site, the Project staff inspected the area of each site and enumerated all target species that were found in each site but fell outside the random or selected sampling areas.

The selected sampling methodology was a modified combination of two known methodologies plot and transect sampling (see above section for details). The selected methodology was based on the nature of the areas sampled and the expected distribution of target species. Combining plot and transect sampling techniques provided the needed flexibility of sampling for small areas while maintaining the necessary degree of randomness.

After each sampling site was identified and reached, a random point representing the center of a hypothetical circle, was selected. Five plots (replicates), each having an area of 1 m^2 (0.71 x 1.41m) were randomly selected based on the above modified sampling technique. The distribution of the plots was as follows:

- 1st plot: 77° N-W, 8m from the center.
- 2nd plot: 46° from the first quadrate, 37m from the center.
- 3rd plot: Exactly in the south direction, 20m from the center.
- 4th plot: 63° from the 3rd quadrate in a S-E direction, 46m from the center.
- 5th plot: 77° from the 4th quadrate in an E-N direction, 17m from the center.

The common point from which all those plots were determined was the center of a circle of 56 m radius, with an effective total sampling area of 1 hectare. If the site was heterogeneous, it was further divided into sub-sites and the number of plots sampled from each sub-site, following the same modified sampling methodology, was determined based on that sub-site's area. Whether the site was homogenous or heterogeneous, the total number of plots surveyed per site was always five.

Target and associated species were both surveyed and enumerated, and survey forms following IPGRI's (Appendix) were filled for each species and site. Fruit trees were not included in this survey pending development of a common survey methodology of all participating countries.

III. Statistical Analysis of the Eco-Botanical Survey

III. 1. Statistical methodology

The statistical methodology used had to satisfy two objectives. The first was to clearly present an inventory of species present at the different sites based on different distribution characteristics. The other was to relate the different sites to each other and assess their diversity based on presence, absence and characteristics of the present target species.

Based on the modified sampling technique described above, **data on density frequency and coverage were collected on all encountered target species**. The selected sampling methodology was a modified combination of two known methodologies, plot and transect sampling (see above section for details). Frequency, density and coverage were then tabulated for all found species within each area, Ham and Nabha, such that each single table contained an inventory of the species from all the different sites of that area. No further statistical analysis, on the species level, was necessary.

To compare the different sites and assess the overall level of diversity in the two target areas, cluster analysis was performed using the unweighted pair-group method using arithmetic averages (UPGMA), based on frequency, density, and coverage data of target species. Cluster analysis was used to find the similarity between sites within each area.

III. 2. Results[2]

Regarding the target species, there was a marked difference in species abundance between the Nabha and Ham areas. While many randomly selected sites in Nabha contained many target species, only eight of twenty seven species were found in random sites of Ham (Table 1). Therefore, and only based on a random selection of sites, Nabha seems a richer area in target species. However, those results only reflect the limited abundance of target species and should not be interpreted to mean that the target species were not altogether present. This is clearly illustrated when figures from table 1 are contrasted with results presented in tables 2 and 3 which indicate whether a certain species is present anywhere within the site, even if it falls outside

2 Some of the results presented in this report also appear in a thesis presented as part of the Diploma of Agricultural Engineer requirements at the Lebanese University (El -Saliby, 2000).

sampling areas. Although random sampling did not "find" many species, nevertheless they were present in many sites. Actually, some single selected Ham and Nabha sites contained morethan 60% of all target

Table 1. Presence of target species falling within sampling units in random sites in Nabha and Ham regions.

Species	Number of sites in which target species was present	
	Nabha (out of 13 sites)	Ham (out of 14 sites)
A. ovata	7	1
A. biuncialis	7	1
A. triuncialis	3	0
A. caudata	4	0
A. cylindrica	0	0
A. vavilovii	0	0
A. columnaris	5	0
A. umbellulata	3	0
T. dicoccoides	0	0
T. urartu	1	0
T. boeoticum	1	0
H. bulbosum	7	8
H. nodosum	1	1
H. spontanum	0	3
Lathyrus sp	3	1
Lens sp	2	7
M. coronata	1	0
M. radiata	5	2
M. rigidula	3	0
Tr. anguistifolium	2	0
Tr. fragiferum	1	0
Tr. pilulare	4	0
Tr. stellatum	6	0

Table 1, continued

Tr. tomentosum	1	0
V. ervilia	1	0
V. hybrida	2	0
V. sativa subsp. *amphicarpa*	1	0

species. The direct implication of those results is that, with proper protection, target species can be successfully conserved *in situ* in both areas since they are already present there but are under direct threat of disappearing, reflected in their present low abundance. *A. ovata, A. biuncialis, H. bulbosum*, and to a lesser extent *Tr. Stellatum* were the most abundant species in Nabha. In Ham, *H. bulbosum* and *Lens sp.* were most abundant (Table 1).

Selected sites, those chosen after the presence of one or more of the target species was established, cannot be treated as random sites in terms of derived information, conclusions or recommendations for further action. In other words, a random survey is necessary to document the general characteristics and speciation of an area. It is sufficient only if no further and immediate steps of conservation are required. On the other hand, conservation efforts require non-random selection of sites with target species. Choosing random sites leads to valid conclusions related to distribution of species, any species, within an area. The next step, that related to conservation and monitoring, should be based on selected sites in which the species are known to be present.

An important observation that cannot be overstressed is the presence of so many wheat wild types in single sites (Tables 2 and 3). The extent of such diversity and species richness has not been noted before. For instance, site 5S in Nabha contains no less than eight different species, and site 3S in Ham contains a total of six species. The richness of diversity in those and other sites is relatively rare and presents an invaluable source of biodiversity that should be maintained and utilized to the best degree possible. Not only do those findings indicate the uniqueness of these areas in terms of species richness, but also point to the actual and potential dangers that do threaten so many species concentrated in a small area.

Table 2. Distribution of target species found within the sampling area but outside the sampling units in Nabha.

Site* number	Target species
1**	*A. caudata, A. biuncialis, A. ovata, A. triuncialis., H. bulbosum*
2+1S	*T. urartu, A. columnaris, A. biuncialis, A. caudata, A. umbellulata.*
3+2S	*A. biuncialis, A. ovata, A. caudate, H. bulbosum,T. pilulare, T. stellatum, A. triuncialis, M. radiata, Tr.* anguistifolium
4	*A. caudata, A. biuncialis, A. ovata, A. triuncialis, A. columnaris.*
6	*A. umbellulata, A. columnaris.*
8	*A. ovata.*
10	*A. ovata, A. biuncialis, A. columnaris.*
11	*A. ovata, A. biuncialis.*
13	*A. ovata., T. anguistifolium, Tr. pilulare, Tr. stellatum*
3S	*A. biuncialis, A. columnaris, A. caudata, A. ovata.*
4S	*A. ovata, A. umbellulata, A. columnaris, A. biuncialis, A. triuncialis, V. hybrida, Lens sp*
5S	*T. dicoccoides, T. urartu, A. biuncialis, A. triuncialis, A. caudata, A. vavilovii, A. columnaris, A. ovata, H. spontanum, Tr. pilulare, Tr. stellatum .*

*Absence of a site number implies that none of the target species were found in that site.
**Numbers indicate random site numbers. S stands for a selected, non-random site, which can be the same as a random site (so marked by a "+" sign).

Table 3. Distribution of target species found within the sampling area but outside the sampling units in Ham.

Site* number	Target species
3	*Lens sp.*
6	*Lens sp.*
7	*Lens sp.*
8	*Lens sp.*
9	*Lens sp.*
10+1S**	*A. ovata, A. biuncialis., Lens sp.*
12	*Lens sp.*
2S	*T. dicoccoides, A ovata, A. biuncialis, T. urartu, A. caudata.*
3S	*A. triuncialis, A. biuncialis, A ovata, A. umbellulata, A. columnaris, T. dicoccoides.*
4S	*T. dicoccoides, T. boeoticum, A. biuncialis, A. triuncialis, A. ovata.*
5S	*A. biuncialis, A. triuncialis, A. vavilovii, T. boeoticum, T. dicoccoides.*
6S	*A. ovata, A. triuncialis Lens sp., Tr. anguistifolium.*

*Absence of a site number implies that none of the target species were found in that site.
**Numbers indicate random site numbers. S stands for a selected, non-random site, which can be the same as a random site (so marked by a "+" sign).

Aegilops ovata, A. biuncialis, H. bulbosum, Tr. Pilulare and *Tr. stellatum* were the most commonly found species in the surveyed areas, with frequencies around 25%, and higher densities and coverage than any other species (Table 4). As to Ham, random sampling indicated that *H. bulbosum* and *Lens sp.* were by far the most abundant species, followed to a lesser extent by *A. ovata* and *A. biuncialis*. Higher frequencies usually indicated relatively high densities and coverage (Table 4), demonstrating that studied grasses usually formed colonies, probably originating from single plants, dispersed among the landscape. This is particularly evident when frequencies and percentage coverage are compared, with a highly significant and positive correlation coefficient of 0.91.

Table 4. Average frequency, density and coverage of target species surveyed in random sites from the Nabha and Ham areas[3].

	Nabha			**Ham**		
Species	**Frequency (%)**	**Density m^{-1}**	**Coverage (%)**	**Frequency (%)**	**Density m^{-1}**	**Coverage (%)**
A. ovata	23	3.06	1.09	14	0.057	0.08
A. biuncialis	25	7.60	1.95	14	0.057	0.04
A. triuncialis	08	0.77	0.38	00	0.000	0.00
A. caudata	08	0.18	0.08	00	0.000	0.00
A. cylindrica	00	0.00	0.00	00	0.000	0.00
A. vavilovii	00	0.00	0.00	00	0.000	0.00
A. columnaris	15	1.05	0.46	00	0.000	0.00
A. umbellulata	08	0.22	0.14	00	0.000	0.00
T. dicoccoides	00	0.00	0.00	00	0.000	0.00
T. urartu	02	0.02	0.02	00	0.000	0.00
T. boeoticum	02	0.02	0.02	00	0.000	0.00
H. bulbosum	22	0.97	0.88	34	21.49	3.34
H. nodosum	02	0.02	0.02	02	0.02	0.02
H. spontanum	00	0.00	0.00	13	0.37	0.31

3 Detailed frequencies, densities and coverage for each site within both areas are listed in tables A5, A6 and A7 in the Appendix.

Table 4, continued

Lathyrus sp	14	0.49	0.15	02	0.02	0.02
Lens sp	03	0.08	0.05	26	1.57	0.35
M. coronata	02	0.05	0.02	00	0.00	0.00
M. radiata	11	0.22	0.14	05	0.14	0.05
M. rigidula	06	0.11	0.06	00	0.00	0.00
Tr. anguistifolium	06	0.34	0.09	00	0.00	0.00
Tr. fragiferum	02	0.02	0.02	00	0.00	0.00
Tr. pilulare	22	2.91	0.95	00	0.00	0.00
Tr.stellatum	23	2.69	0.49	00	0.00	0.00
Tr. tomentosum	03	0.09	0.03	00	0.00	0.00
V. ervilia	02	0.03	0.08	00	0.00	0.00
V. hybrida	09	0.91	0.09	00	0.00	0.00
V. sativa subsp. *amphicarpa*	02	0.02	0.02	00	0.00	0.00

Studied habitats (Appendix, Tables A3 and A4) were found to play a minor role in determining distribution of some target species while influencing others. In Nabha, *A. ovata, A. biuncialis*and *A. triuncialis* were found in grasslands, arable areas, woodlands and in wooded grasslands, implying that there is no direct effect of habitat on their distribution. *A. caudata* was found in two grasslands, one woodland and in three out of four surveyed wooded grassland sites, indicating that wooded grasslands were more suitable for it. On the other hand,*A. columnaris* was found in two out of two surveyed woodlands and in three of four wooded grasslands, indicating that its distribution was directly related to habitat. *A. umbellulata* found in two wooded grasslands, one grassland and one woodland site, exhibited a clear preference for wooded grasslands. On the other hand, *T. boeoticum* and *T. urartu* were only found in woodlands and wooded grasslands, which might indicate that trees have an indirect role in protecting these species. However, the above observations are the result of one year's data and should only be viewed as probable indicators of species-habitat relationships. Prior to any definite conclusions on the relationship of habitat to species distribution, more data should be collected over multiple years. As to microenvironment effects, since all species were recorded within hillsides, valleys and plains, it does not seem to have a significant effect on the distribution of studied species

Again, as noted earlier, further surveys are needed to confirm this observation.

Similar conclusions could not be drawn based on survey results from the Ham area because fewer species were found upon random selection of sampling sites (Table 4). The most probable reason for the absence of most species is believed to be overgrazing of inspected sites. Other than the obvious physical evidence to the heavy presence of livestock, wild species were frequently found only near cultivated lands where no grazing was allowed. Also, whenever found, species were more abundant in protected pockets near trees or within bushes, namely of *Poterium spinosum* . Whether soil erosion is a consequence of, among other factors, overgrazing as is probable, or not, it still plays a significant role in species disappearance. Relationships between overgrazing, soil erosion and species abundance in the specific areas of the study should be further investigated.

Three species were deemed to be rare or endangered. These are *A. cylindrica, A. vavilovii, and T. dicoccoides*. Those three species were not found upon sampling from either random or selected sites, and were only found as scattered associated species in a minority of sites (Tables 2, 3, 4 and 5). *A. cylindrica* in particular was found outside both random and selected sites, growing only near stream banks. While the exact reasons for this rarity need further investigation, the fact that many individual plants, and especially *T. dicoccoides* were found near stream banks may be an indication of their narrow habitat niche in terms of water availability. Another probable reason could be preference by grazers over other species. In either case, the potentials and risks facing these species have to be more closely assessed, and special efforts should be directed towards their preservation.

Relative abundance of species in selected sites was comparable to those from random sites, although higher in absolute value, justifying the use of the random survey methods (Table 5). Comparing results from random and selected sites showed that *A. ovata* and *A. biuncialis* were relatively widespread and are far more abundant in a wider region than any other species. As previously mentioned, *A. cylindrica, A. vavilovii, and T. dicoccoides* were absent in selected sites. Although many target species are present in the same sites, survey results point to the difficulty of choosing sites that contain all target species. This implies that if monitoring sites are to be established, a larger number will be needed to cover specific species, with the possibility of

Table 5. Average frequency, density and coverage of target species surveyed in selected sites from the Nabha and Ham areas.

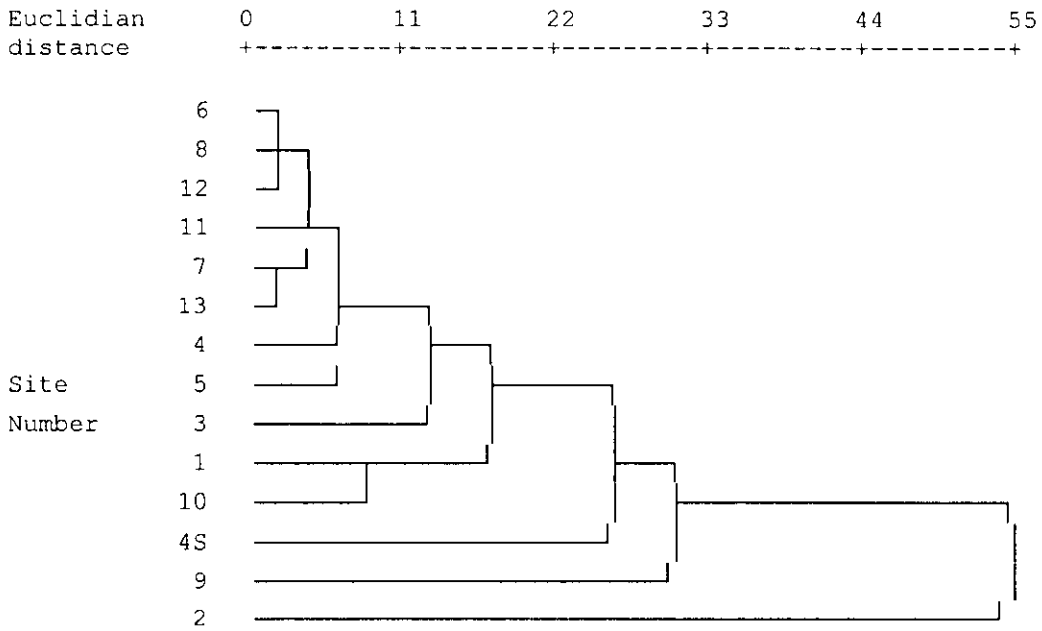
	Nabha			Ham		
Species	**Frequency (%)**	**Density m^{-1}**	**Coverage (%)**	**Frequency (%)**	**Density m^{-1}**	**Coverage (%)**
A. ovata	44	03.20	1.96	36	2.96	0.72
A. biuncialis	72	27.88	9.60	36	1.12	0.48
A. triuncialis	28	05.60	2.88	44	5.04	2.60
A. caudata	24	01.84	0.56	08	0.16	0.08
A. cylindrica	00	00.00	0.00	00	0.00	0.00
A. vavilovii	00	00.00	0.00	00	0.00	0.00
A. columnaris	56	14.92	4.08	12	0.48	0.32
A. umbellulata	16	01.40	0.48	04	0.04	0.04
T. dicoccoides	00	00.00	0.00	36	2.64	1.36
T. urartu	08	00.80	0.24	08	0.72	0.16
T. boeoticum	04	00.04	0.04	00	0.00	0.00

establishing monitoring sites for each set of target species. The better alternative is to seed some monitoring sites with desired species and use them to collect data and as a basis of comparison for monitored but uninterrupted sites. Also, if other plant families are to be included within monitoring sites, the number of such sites will certainly have to be expanded, but more surveys are needed to confirm such a conclusion. Tables 1, 2 and 3 should be consulted when deciding on monitoring sites, species within monitoring sites, in addition to any available information about other species of interest.

Sites, like individual species, were compared based on collected data per site. Data from species frequency, density and coverage were used to compare the different sites in order to draw some conclusions regarding their diversity or similarity. Such information can then be used to assess the general diversity available, the general areas where this diversity or lack of exists, and the minimum number of sites that should be monitored for a single or multiple target species.

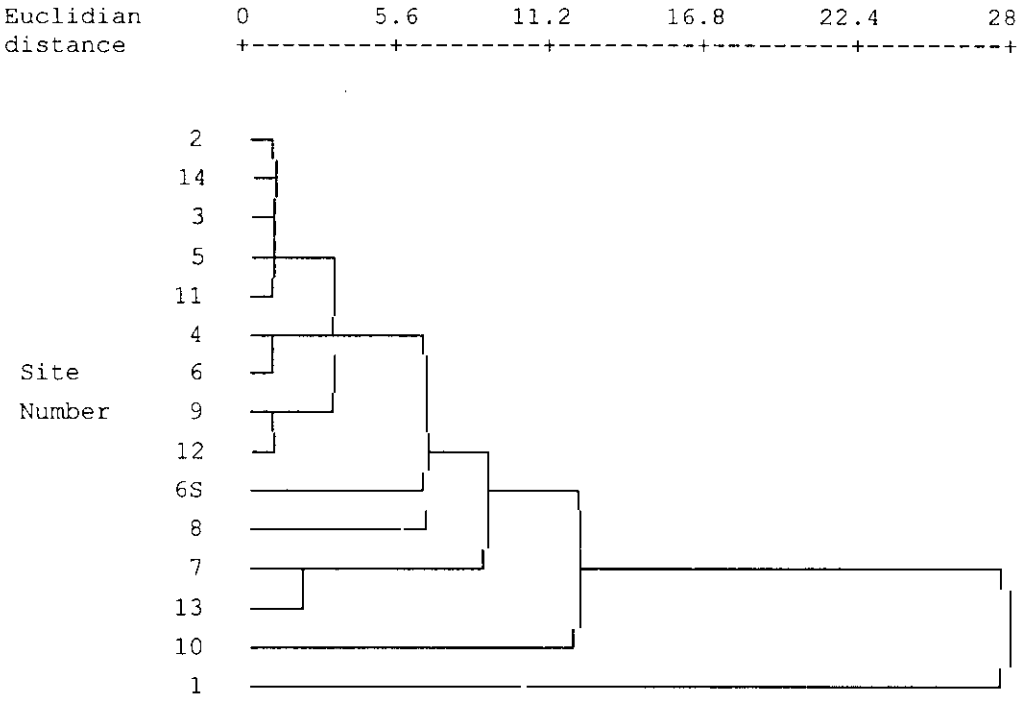
Overall, sites in Nabha showed considerable variation and (Figure 1), but no clear differences based on habitat, microenvironment or altitude could be discerned. It should be noted that a lot of the perceived similarity might be due to absence of many target species from many sites resulting in a similarity of 100 % (or a difference of 0%). Based only on utilized species characteristics, sites cannot be classified into meaningful categories. It might therefore be advisable to include more species information to arrive at better categorization, increase the number of species, and include more site-specific data in the analysis. Cluster analysis of Ham survey data resulted in a certain degree of similarity, with results biased by the absence of target species from many sites (Figure 2). However, as with results from Nabha, no clear association between grouping and habitat was apparent. One possible explanation for differences and resultant groupings can also be directly or indirectly attributable to human activity and intervention, as demonstrated by the use of these sites. As with the Nabha results, more information should be included, at the species and site levels, for a more accurate categorization of the sites.

Fig 1. Similarity between different random and additional sites* based on species frequency, density and coverage. (Nabha)



* Only fourteen sites with information on all target species were included in the analysis.

Fig 2. Similarity between different random and additional sites* based on species frequency, density and coverage. (Ham)



* Only fifteen sites with information on all target species were included in the analysis.

IV. Conclusions and Recommendations

a. The most abundant species were *A. biuncialis, A. ovata, A. columnaris, H. bulbosum, Tr. pilulare and Tr. stellatum* while the least abundant were *A. cylindrica, A. vavilovii, and T. dicoccoides.*
b. Target species can be successfully conserved *in- situ* in both Ham and Nabha areas since they are already present there but are under direct threat of disappearing, reflected in their present low abundance.
c. Unlike most other areas in the region and perhaps in the world, a high number of *Aegilops* species and, to a lesser extent, *Triticum* species were present in single sites, making such sites of particular interest globally.
d. If monitoring sites are to be established, a larger number will be needed to cover specific species, with the possibility of establishing monitoring sites for each set of two or three target species or seeding with all target species
e. Studied habitats were found to play a minor role in determining distribution of some target species while influencing others. However, prior to any definite conclusions on the relationship of habitat to species distribution, more data should be collected over multiple years.
f. As expected, overgrazing and soil erosion, and their interaction, are the major threats to biodiversity. The direct role of human activity in promoting those threats has also to be considered. Relationships between overgrazing, soil erosion and species abundance in the specific areas of the study should be further investigated.
g. Site diversity was moderate but appeared less than it actually is because of the common absence of many studied species.
h. Monitoring areas, as well as surveys of other species, are needed to verify the rate of loss of biodiversity, gather more information on environmental requirements and adaptation of target species, and establish areas were endangered species can be preserved *insitu.*
i. Molecular analysis is needed to establish the extent of diversity within each species or populations of one species.
j. Controlled experiments are needed to accurately define and differentiate between the characteristics of present and future collected material.

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VI. *Appendix*

Table A1. Geographical characteristics of random and selected sites of Nabha.

Target Area	Site number	Long. (°E)	Lat. (°N)	Alt. (m)	Slope (°)
Nabha	1	36.14.272'	34.13.274'	1540	40
Nabha	2+1S	36.12.649'	34.12.711'	1650	50
Kalile	3+2S	36.13.961'	34.12.731'	1475	40
Nabha	4	36.13.286'	34.12.549'	1300	30
Nabha	5	36.12.980'	34.11.919'	1600	20
Nabha	6	36.14.272'	34.11.919'	1200	35
Nabha	7	36.12.649'	34.11.376'	1490	50
Nabha	8	36.13.961'	34.11.376'	1170	30
Nabha	9	36.10.045'	34.11.107'	1550	50
Nabha	10	36.12.324'	34.10.838'	1035	55
Nabha	11	36.13.299'	34.10.564'	1000	5
Nabha	12	36.14.610'	34.10.564'	1020	5
Nabha	13	36.12.000'	34.10.000'	1200	25
Nabha	3S	36.12.703'	34.10.473'	1130	5
Nabha	4S	36.12.659'	34.11.130'	1075	2
Bishwat	5S	36.08.744'	34.09.649'	1450	5

Numbers indicate random site numbers. S stands for a selected site, which can be the same as a random site (so marked by a "+" sign).

Table A2. Geographical characteristics of random and selected sites of Ham.

Target Area	Site number	Long. (°E)	Lat. (°N)	Alt. (m)	Slope (°)
Ham	1	36.13.571'	33.54.515'	1625	25
Ham	2	36.11.954'	33.54.255'	1450	35
Ham	3	36.12.928'	33.53.968'	1700	10
Ham	4	36.13.896'	33.53.968'	1715	5
Ham	5	36.12.272'	33.53.707'	1600	15
Ham	6	36.11.954'	33.53.436'	1500	30
Ham	7	36.11.928'	33.53.436'	1565	20
Ham	8	36.12.590'	33.53.170'	1465	45
Ham	9	36.12.928'	33.52.909'	1750	55
Ham	10+1S	36.11.603'	33.52.331'	1490	40
Maaraboun	11	36.11.311'	33.51.829'	1500	20
Ham	12	36.13.571'	33.51.829'	2000	25
Ham	13	36.12.590'	33.51.553'	1800	15
Maaraboun	14	36.11.311'	33.51.281'	1450	0
Ham	2S	36.10.999'	33.51.933'	1700	20
Ham	3S	36.11.948'	33.51.830'	1525	0
Ham	4S	36.13.009'	33.51.371'	1750	25
Ham	5S	36.13.252'	33.51.493'	1800	0
Maaraboun	6S	36.12.477'	33.50.747'	1600	30

Numbers indicate random site numbers. S stands for a selected site, which can be the same as a random site (so marked by a "+" sign).

Table A3. Habitat type, microenvironment and altitude of sites at Nabha.

Site number	Habitat	Microenvironment	Altitude
1	Grassland	Hillside	1540
2+1S	Wooded grassland	Hillside	1650
3+2S	Woodland	Hillside, valley	1475
4	Wooded grassland	Hillside	1300
5	Grassland	Hilltop	1600
6	Wooded grassland	Hillside	1200
7	Wooded grassland	Hillside	1490
8	Grassland	Hillside	1170
9	Forest	Hillside	1550
10	Woodland	Hillside	1035
11	Arable, Grassland	Plain	1000
12	Arable	Plain	1020
13	Arable, Grassland	Hillside, valley	1200
3S	Grassland	Plain	1130
4S	Arable	Hillside	1075
5S	Grassland	Plain	1450

Numbers indicate random site numbers. S stands for a selected site, which can be the same as a random site (so marked by a "+" sign).

Table A4. Habitat type, microenvironment and altitude of sites at Ham.

Site number	Habitat	Microenvironment	Altitude
1	Grassland	Hillside	1625
2	Grassland	Hillside	1450
3	Grassland	Hilltop	1700
4	Grassland	Valley	1715
5	Grassland	Hillside	1600
6	Grassland	Plain	1500
7	Grassland	Hillside	1565
8	Arable, Grassland	Hillside, roadsides	1465
9	Grassland	Hilltop	1750
10+1S	Grassland	Hillside	1490
11	Grassland	Hillside	1500
12	Grassland	Hillside	2000
13	Grassland	Hilltop	1800
14	Arable	Plain	1450
2S	Wooded grassland, near cultivated field	Hillside	1700
3S	Grassland	Roadsides	1525
4S	Grassland	Bank	1750
5S	Fallow	Bank	1800
6S	Grassland	Hillside	1600

Numbers indicate random site numbers. S stands for a selected site, which can be the same as a random site (so marked by a "+" sign).

Table A5. Species frequency in random sites from Nabha.

Species	Site number												
	1	2	3	4	5	6	7	8	9	10	11	12	13
A.ovata	0.6	0	0.2	0.2	0	0	0	0.4	0	0.2	1	0	0.4
A.biuncialis	0.6	0.4	1	0.2	0	0.2	0	0	0	0.2	0.6	0	0
A.triuncialis	0.4	0	0.4	0.2	0	0	0	0	0	0	0	0	0
A.caudata	0.2	0.4	0	0.2	0	0.2	0	0	0	0	0	0	0
A.cylindrica	0	0	0	0	0	0	0	0	0	0	0	0	0
A.vavilovii	0	0	0	0	0	0	0	0	0	0	0	0	0
A.columnaris	0	0.6	0.2	0.2	0	0.8	0	0	0	0.2	0	0	0
A.umbellulata	0	0.4	0.2	0	0	0.4	0	0	0	0	0	0	0
T.dicoccoides	0	0	0	0	0	0	0	0	0	0	0	0	0
T.urartu	0	0.2	0	0	0	0	0	0	0	0	0	0	0
T.boeoticum	0	0	0.2	0	0	0	0	0	0	0	0	0	0
H. bulbosum	0.2		0.6	0.4	0.6	0	0.4	0	0	0.2	0.4	0	0
H. nodosom	0		0	0	0	0	0	0	0	0.2	0	0	0
H. spontanum	0		0	0	0	0	0	0	0	0	0	0	0
Lathyrus sp	0		0	0	0	0.8	0	0	0.6	0	0	0	0.4
Lens sp	0.2		0	0	0	0	0	0	0	0	0	0.2	0
M. coronata	0		0	0	0	0	0	0	0	0	0	0.2	0
M. radiata	0		0	0	0	0.4	0.2	0	0.4	0	0	0.2	0.2
M. rigidula	0		0.2	0	0	0	0	0.2	0	0	0	0	0.4
Tr. anguistifolium	0		0.6	0	0	0	0	0.2	0	0	0	0	0
Tr. Fragiferum	0		0	0	0	0	0	0.2	0	0	0	0	0
Tr. Pilulare	0		1	0	0	0	0	0.6	0	0.6	0.6	0	0
Tr. Stellatum	0		0.4	0	0	0	0	0.6	0	1	0.6	0.2	0.2
Tr. Tomentosum	0		0	0	0	0	0	0	0	0.4	0	0	0
V. ervilia	0		0	0	0	0	0	0	0	0	0	0.2	0
V. hybrida	0.2		0	1	0	0	0	0	0	0	0	0	0
V. sativa subsp. *amphicarpa*	0		0	0	0	0	0	0.2	0	0	0	0	0

Table A6. Species density in random sites from Nabha.

Species	Site number												
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
A.ovata	17.6	0	1.8	1	0	0	0	1.4	0	2	14.6	0	1.4
A.biuncialis	4.2	3.6	52.6	1.6	0	0.4	0	0	0	0.6	3.4	0	0
A.triuncialis	0.8	0	3.2	6	0	0	0	0	0	0	0	0	0
A.caudata	0.2	1.6	0	0.4	0	0.2	0	0	0	0	0	0	0
A.cylindrica	0	0	0	0	0	0	0	0	0	0	0	0	0
A.vavilovii	0	0	0	0	0	0	0	0	0	0	0	0	0
A.columnaris	0	3.6	4	0.2	0	5.4	0	0	0	0.4	0	0	0
A.umbellulata	0	0.6	1.4	0	0	0.8	0	0	0	0	0	0	0
T.dicoccoides	0	0	0	0	0	0	0	0	0	0	0	0	0
T.urartu	0	0.2	0	0	0	0	0	0	0	0	0	0	0
T.boeoticum	0	0	0.2	0	0	0	0	0	0	0	0	0	0
H. bulbosum	0.4		3	2.6	5.2	0	0.4	0	0	0.6	0.4	0	0
H. nodosom	0		0	0	0	0	0	0	0	0.2	0	0	0
H. spontanum	0		0	0	0	0	0	0	0	0	0	0	0
Lathyrus sp	0		0	0	0	2	0	0	1.4	0	0	0	3
Lens sp	0.2		0	0	0	0	0	0	0	0	0	0.8	0
M. coronata	0		0	0	0	0	0	0	0	0	0	0.6	0
M. radiata	0		0	0	0	0.6	0.2	0	1	0	0	0.8	0.2
M. rigidula	0		0.6	0	0	0	0	0.2	0	0	0	0	0.6
Tr. anguistifolium	0		4.2	0	0	0	0	0.2	0	0	0	0	0
Tr. Fragiferum	0		0	0	0	0	0	0.2	0	0	0	0	0
Tr. Pilulare	0		15.8	0	0	0	0	2.6	0	19.2	2	0	0
Tr. Stellatum	0		2.2	0	0	0	0	1.2	0	20.8	7.4	3.2	0.2
Tr. Tomentosum	0		0	0	0	0	0	0	0	1.2	0	0	0
V. ervilia	0		0	0	0	0	0	0	0	0	0	0.4	0
V. hybrida	0.8		0	0	11	0	0	0	0	0	0	0	0
V. sativa subsp. *amphicarpa*	0		0	0	0	0	0	0.2	0	0	0	0	0

Table A7. Species coverage in random sites from Nabha.

Species	Site number												
	1	2	3	4	5	6	7	8	9	10	11	12	13
A.ovata	0.044	0	0.006	0.004	0	0	0	0.004	0	0.002	0.076	0	0.006
A.biuncialis	0.012	0.04	0.188	0.002	0	0.002	0	0	0	0.002	0.008	0	0
A.triuncialis	0.004	0	0.016	0.03	0	0	0	0	0	0	0	0	0
A.caudate	0.002	0.004	0	0.002	0	0.002	0	0	0	0	0	0	0
A.cylindrical	0	0	0	0	0	0	0	0	0	0	0	0	0
A.vavilovii	0	0	0	0	0	0	0	0	0	0	0	0	0
A.columnaris	0	0.018	0.02	0.002	0	0.018	0	0	0	0.002	0	0	0
A.umbellulata	0	0.006	0.008	0	0	0.004	0	0	0	0	0	0	0
T.dicoccoides	0	0	0	0	0	0	0	0	0	0	0	0	0
T.urartu	0	0.002	0	0	0	0	0	0	0	0	0	0	0
T.boeoticum	0	0	0.002	0	0	0	0	0	0	0	0	0	0
H. bulbosum	0.002		0.022	0.022	0.052	0	0.008	0	0	0.004	0.004	0	0
H. nodosom	0		0	0	0	0	0	0	0	0.002	0	0	0
H. spontanum	0		0	0	0	0	0	0	0	0	0	0	0
Lathyrus sp	0		0	0	0	0.008	0	0	0.006	0	0	0	0.006
Lens sp	0.002		0	0	0	0	0	0	0	0	0	0.004	0
M. coronata	0		0	0	0	0	0	0	0	0	0	0.002	0
M. radiata	0		0	0	0	0.004	0.002	0	0.004	0	0	0.006	0.002
M. rigidula	0		0.002	0	0	0	0	0.002	0	0	0	0	0.004
Tr. Anguistifolium	0		0.01	0	0	0	0	0.002	0	0	0	0	0
Tr. Fragiferum	0		0	0	0	0	0	0.002	0	0	0	0	0
Tr. Pilulare	0		0.042	0	0	0	0	0.008	0	0.064	0.01	0	0
Tr. Stellatum	0		0.004	0	0	0	0	0.006	0	0.04	0.008	0.004	0.002
Tr. Tomentosum	0		0	0	0	0	0	0	0	0.004	0	0	0
V. ervilia	0		0	0	0	0	0	0	0	0	0	0.01	0
V. hybrida	0.002		0	0.01	0	0	0	0	0	0	0	0	0
V. sativa subsp. *amphicarpa*	0		0	0	0	0	0	0.002	0	0	0	0	0

Table A8. Species frequency in random sites from Ham.

Species	Site number													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
A.ovata	0	0	0	0	0	0	0	0	0	0.2	0	0	0	0
A.biuncialis	0	0	0	0	0	0	0	0	0	0.2	0	0	0	0
A.triuncialis	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A.caudata	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A.cylindrica	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A.vavilovii	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A.columnaris	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A.umbellulata	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T.dicoccoides	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T.urartu	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T.boeoticum	0	0	0	0	0	0	0	0	0	0	0	0	0	0
H. bulbosum	1	0	0	0.2	0.2	0.2	0.6	0.6	0.4	0	0	0.4	0.8	0
H. nodosom	0	0	0	0	0	0.2	0	0	0	0	0	0	0	0
H. spontanum	0	0	0	0.6	0	0.2	0	0	0	0.6	0	0	0	0
Lathyrus sp	0	0	0	0	0	0	0	0	0	0	0.2	0	0	0
Lens sp	0	0	0.4	0	0	0	0.2	0.8	0.4	0.8	0.2	0.6	0	0
M. coronata	0	0	0	0	0	0	0	0	0	0	0	0	0	0
M. radiata	0	0	0	0	0	0	0	0	0	0.4	0.2	0	0	0
M. rigidula	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tr. anguistifolium	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tr. Fragiferum	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tr. Pilulare	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tr. Stellatum	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tr. Tomentosum	0	0	0	0	0	0	0	0	0	0	0	0	0	0
V. ervilia	0	0	0	0	0	0	0	0	0	0	0	0	0	0
V. hybrida	0	0	0	0	0	0	0	0	0	0	0	0	0	0
V. sativa subsp. *Amphicarpa*	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A9. Species density in random sites from Ham.

Species	Site number													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
A.ovata	0	0	0	0	0	0	0	0	0	0.8	0	0	0	0
A.biuncialis	0	0	0	0	0	0	0	0	0	0.8	0	0	0	0
A.triuncialis	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A.caudate	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A.cylindrical	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A.vavilovii	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A.columnaris	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A.umbellulata	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T.dicoccoides	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T.urartu	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T.boeoticum	0	0	0	0	0	0	0	0	0	0	0	0	0	0
H. bulbosum	262	0	0	0.8	0.6	0.6	6.8	1.2	2.4	0	0	2.2	7.8	0
H. nodosom	0	0	0	0	0	0.2	0	0	0	0	0	0	0	0
H. spontanum	0	0	0	2.4	0	2	0	0	0	1.8	0	0	0	0
Lathyrus sp	0	0	0	0	0	0	0	0	0	0	0.2	0	0	0
Lens sp	0	0	0.4	0	0	0	0.2	5.6	1.4	10.6	0.4	1.8	0	0
M. coronata	0	0	0	0	0	0	0	0	0	0	0	0	0	0
M. radiata	0	0	0	0	0	0	0	0	0	1.2	0.6	0	0	0
M. rigidula	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tr. anguistifolium	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tr. Fragiferum	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tr. Pilulare	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tr. Stellatum	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tr. Tomentosum	0	0	0	0	0	0	0	0	0	0	0	0	0	0
V. ervilia	0	0	0	0	0	0	0	0	0	0	0	0	0	0
V. hybrida	0	0	0	0	0	0	0	0	0	0	0	0	0	0
V. sativa subsp. *Amphicarpa*	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A10. Species coverage in random sites from Ham.

Species	Site number													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
A.ovata	0	0	0	0	0	0	0	0	0	0.004	0	0	0	0
A.biuncialis	0	0	0	0	0	0	0	0	0	0.002	0	0	0	0
A.triuncialis	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A.caudate	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A.cylindrica	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A.vavilovii	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A.columnaris	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A.umbellulata	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T.dicoccoides	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T.urartu	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T.boeoticum	0	0	0	0	0	0	0	0	0	0	0	0	0	0
H. bulbosum	0.262	0	0	0.004	0.01	0.004	0.068	0.012	0.026	0	0	0.012	0.036	0
H. nodosom	0	0	0	0	0	0.002	0	0	0	0	0	0	0	0
H. spontanum	0	0	0	0.024	0	0.006	0	0	0	0.01	0	0	0	0
Lathyrus sp	0	0	0	0	0	0	0	0	0	0	0.002	0	0	0
Lens sp	0	0	0.004	0	0	0	0.002	0.012	0.004	0.016	0.002	0.006	0	0
M. coronata	0	0	0	0	0	0	0	0	0	0	0	0	0	0
M. radiata	0	0	0	0	0	0	0	0	0	0.004	0.002	0	0	0
M. rigidula	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tr. anguistifolium	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tr. Fragiferum	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tr. Pilulare	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tr. Stellatum	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tr. Tomentosum	0	0	0	0	0	0	0	0	0	0	0	0	0	0
V. ervilia	0	0	0	0	0	0	0	0	0	0	0	0	0	0
V. hybrida	0	0	0	0	0	0	0	0	0	0	0	0	0	0
V. sativa subsp. *Amphicarpa*	0	0	0	0	0	0	0	0	0	0	0	0	0	0

IPGRI SURVEY FORMS

GENERAL

1. SITE NO.			
2. SURVEYOR NAME (S)			
3. NO. OF FICHE			
4. DATE (DD/MM/YY)			
5. FAMILY			
6. GENUS			
7. SPECIES			
8. SUB.SPECIES/VARIETY			
9. LOCAL SPECIES NAME	LANGUAGE	ETHNIC GROUP	
10. COUNTRY			
11. PROVINCE			
12. LOCATION		SITE NO.	
13. LAT. (N'S)	LONG (EW)	ELEVATION (masl)	
14. MAP AND REFERENCE			

15. PARTS OF PLANTS USED

1.stalk/trunk	2.branch/twig	3.leaf	4.bark
5.rhizome	6.flower/inflorescence	7.fruit	8.seed
9.root	10.tuber	11.sap/resin	

16. PLANT USES

1.food	2.medicine	3.beverage	4.fibre
5.timber	6.craft	7.fodder, forage	8.buiding
9.omamental	10.other (specify)		

17. NO. OF PLANTS PER POPULATION	area covered by the population (m^2)
18. PHOTOGRAPH number	
19. HERBARIUM sample no.	

20. SOIL TYPE (UNESCO/FAO)	SOIL DESCRIPTORS
21. SOIL PARENTAL ROCK	
22. SOIL DEPTH (analysis of soil sample)	
23. SOIL PHYSICAL ANALYSIS (Distribution of particle size)	
24. SOIL CHEMICAL ANALYSIS (P,K,Ca, organic content, etc.)	
25. ANNUAL RAINFALL (mm)	CLIMATIC DESCRIPTORS
26. RAINFALL SEASONALLY	
JAN FEB MAR APR MAY JUN	
JUL AUG SEP OCT NOV DEC	
27. MEAN ANNUAL TEMPERATURE	
28. TEMPERATURE SEASONALLY	
JAN FEB MAR APR MAY JUN	
JUL AUG SEP OCT NOV DEC	
29. FROSTS (Occurrence and severity)	
30. CURRENT PROTECTION OF SITE (specify)	PROTECTION OF SITE
31. IS THE PROTECTION EFFECTIVELY ENFORCED? (yes, no, do not know)	
32. PROTECTED SITE (re local community stewardship or use rights)	

Additional descriptors for CULTIVATED SPECIES

33. MICRO-ENVIRONMENT

1.boundaries	2.forestmargins	3.watercourse
4.forest clearing	5.houseyard	6. wood lot
7.others (specify)		

34. LANDTENURE

1.Public lands	2.0pen communal lands	3. Freehold	4.Tenancy
5.reserves/parks	6.0thers (specify)		

35. POST HARVEST HANDLING (gender division of labor)

	male	female
1.husking/milling		
2.fermentation		
3.drying		
4.seed selection		

36. COMMERCIALIZATION

1.mostly consumed locally	2.mostly for sale-local markets
3.mostly sold to buyers outside community	4.partly sold

Additional descriptors for WILD SPECIES

37. SITE PHYSIOLOGY

1.plain	2.basin	3. valley	4.plateau
2.upland	6.hill	7.mountain	8.other (specify)

38. HABITAT

1.forest	2.woodland	3.desert	4.shrubland
5.grassland	6. wooded grassland	7.desert	8.swampland
9.arable land	10.wasteland		

39. MICROENVIRONMENT

1.mountaintop/hilltop	2.rockface/cliff	3. Hillside
4.valley bottom	5.plains/steppe	6. forest margins
7.burnt forest area	8.burnt grassland	9.roadside
10. Urban /peri-urban	11.shore (river/sea)	12. others (specify)

40. SOIL DRAINAGE (3. poor, 5. moderate, 7.well drained)

41. SLOPE (degree)

42. SLOPE DIRECTION (N,S,E,W)

43. SOIL TEXTURE

1.clay	2.loam	3.silt
2.sandy loamy	5.fine sand	6.coarse sand
7.organic	8.combinations -e.g. silty clay	9.other (specify)

44. STONINESS

0.none	3.low	5.medium	7.high

45. SOIL CHEMICAL PROPERTIES			
a) pH		Estimate.	Filed measurement
	1.very acid	(pH 2-5)	
	2.acid	(pH 5-6.5)	
	3.neutral	(pH 6.5-7)	
	4.alkaline	(pH >=7.5)	
b) salinity	3.low	5.medium	7.high
46. SOIL SAMPLE (1.yes 0.no)			
47. OTHER NOTES ON SOIL (e.g colour)			
48. HUMAN MANAGEMENT OF HABITAT			
1.grazed areas	2.managed forest	3.fallows	
4.abandoned fields	5.regenerated forest	6.no human management	
7.others (specify)			
49. DISTURBANCE FACTORS -			
a) describe if an area is regulal1y used or traversed by large mammals and humans			
b) key animal species using the habitat			
c) other factors, e.g. fire, flooding, mining, logging			
50. MAJOR THREAT TO THE SURVEYED POPULATION - Genetic erosion			
here to add from AB			
51. WHAT IS THE NATURAL MODE OF PROPAGATION ?			
1.seed	2. vegetative	3.seed and vegetative	4.apomictic
52. IS THE POPULATION WELL ISOLATED FROM OTHERS ? (1.yes 0.no)			
53. WHAT ARE THE BARRIERS BETWEEN POPULATIONS IN THE AREA			
54. WHAT IS THE PLANT POPULATION DENSITY?			
1.few scattered individuals		2.very scarce (<10%ground cover)	
3.scarce (1-5% cover)		4.present (>5% cover)	
5.hiqh (>25%)			
55. WHAT IS THE SPATIAL DISTRIBUTION OF INDIVIDUAL PLANTS IN THE POPULATION?			
1.patchy	2.uniform/mixed stand	3.pure stand	
56. WHAT IS THE DOMINANT SPECIES?			
57. WHAT ARE THE ASSOCIATED SPECIES			
58. CLOSEST METEOROLOGICAL ST A TIONS			
59. COMMENTS ON MORPHOLOGICAL VARIATION			
60. COMMENTS ON DISEASES AND PESTS			
61. ARE RELATED FORMS GROWN NEARBY?			
62. VALUE OF SPECIES ACCORDING TO LOCAUPOTENTIAL USES			
1.low	3.medium	5.high	
63. PLANT .USE PERIOD (OPTIMUM)			
64. PLANT GROWTH STAGE DURING EXPLOITATION			
65. WHICH ANIMALS ARE USING THE PLANT?			
66. PALATABILITY			
1.low	3.medium	5.high	
67. NUTRITIONAL VALUE FOR ANIMALS			
68. NUTRITIONAL VALUE FOR HUMANS			
69. ADDITIONAL COMMENTS FROM LOCAL USERS			
70. OTHERS			